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PRODUCTIVITY OF NORTH KORDOFAN CATTLE

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ABSTRACT: *The present study focused on the sedentary cattle husbandry production system in North Kordofan (western Sudan). Seven farms (designated as A, B, C, D, E, F, and G) around El-Obeid city were randomly selected. Recently calved cows in each farm were closely monitored through a period of 365 days. The recently calved cows were monitored for post-partum ovarian activity using milk progesterone radioimmunoassay. Days to conception were taken as non-return to oestrus. The results revealed that there was a wide variation in both days to first ovulation and days to conception. The majority of cows showed delayed post-partum activity and days to conception with longest days to resumption of ovarian activity showed by farm G (167.00±59.68days) and lowest days in farm C (61.78±14.99 days). The interval to conception was longest in farm B (226.06±52.63 days) and lowest in farm C (102.67±48.93 days). Cows in all farms showed gradual increase in BW from calving up to 90 days. BCS was found to decrease from calving to 60 days. Dry season showed an adverse effect on fertility compared with the rainy season. Wet season showed significant negative correlation with BWT at calving, milk yield at 30, 60 and 90 days with days to ovulation. It could be concluded that, poor reproductive performance in cows kept under extensive traditional system was due to poor management practices, which ignored high-energy supplementation during late pregnancy and early lactation, especially during the dry season when rangeland pastures deteriorate drastically. Suckling further exacerbated the effect of poor nutrition resulting in extended post-partum anoestrus and low conception rates. Controlled mating and suckling together with good feeding strategies may greatly enhance reproductive performance of cows kept under extensive systems of management.*

Keywords: *Cattle, sedentary system, nutrition, reproductive performance, El Obeid, Sudan.*

ORIGINAL ARTICLE

INTRODUCTION

Sudan has a livestock population of 138 million; approximately 42 million are cattle (MAR, 2007). The majority of the cattle population is of the local beef type living under the pastoral system of management. Production from Sudan beef cows has remained comparatively lower than those from other areas of the world due to inadequate feed, both in quality and quantity, poor management of the available feed resources and the reproductive wastage due to low conception and calving rates, delayed age at puberty and first calving, high mortality due to diseases and inadequate health care. In mammals, nutrition exerts a significant influence on reproductive function through changes in body weight and condition (Downing and Scaramuzzi, 1991). Nutritional requirements shift abruptly at parturition as milk production rapidly increases and cows enter negative energy balance (NEB). The severity and duration of NEB is primarily related to dry matter intake which, in turn, is related to body condition at calving. NEB during the first 3–4 weeks postpartum is highly correlated with the days to first ovulation, because a shorter delay to first ovulation is positively associated with conception rate later during the breeding period. The length of the postpartum interval to first ovulation represents an important interaction of energy status on reproductive performance (Butler, 2003). Under-nutrition contributes to prolonged postpartum anestrous, particularly among cows dependent upon forages to meet their feed requirements (Montiel and Ahuja, 2005). Also the suckling stimulus is another factor affecting the duration of resumption of postpartum ovarian cycles (Williams, 1990; Das et al., 1999). In beef cattle, reducing the frequency and intensity of suckling reduces the duration of the postpartum anoestrous period (Mackey et al., 2000). Nutrition and suckling affect hypothalamic, pituitary and ovarian activity and thus inhibit follicular development and, finally, ovulation rate (Scaramuzzi et al., 2006). The present study was undertaken to investigate assessment effect of nutrition on the reproductive performance of cattle herders in North Kordofan state.

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MATERIALS AND METHODS

Study area

The present investigation focused on the reproductive performance of cows kept under sedentary husbandry system at peri-urban area around El Obeid city located at about 600 km west Khartoum capital (Latitude 11° 15. and 16° 30.N, Longitude 27° and 32°E). It lies within a semi-arid area: temperatures ranges between 30.35°C -40°C during the dry season (April to June). The rainy season extends from July to October. The dominant vegetation is a varying mixture of grasses and shrubs (Technoserve, 1987). The cattle farms are concentrated around urban centers and are the main suppliers of milk to the inhabitants.

Husbandry practice

Seven sedentary farms were randomly selected at different geographical sites around Elobied City. They were designated as group A, B, C, D, E and G. The study targeted the recently calved DerElreeh cows (DerElreeh is ecotype of zebu cattle). Mature animals were kept in open enclosures made from local materials or barbed wires, their sizes differed according to the number of the animals (Table 1).

Table 1. Herd structure of farms under study

Farms	Lactating cows	Dry cows	Heifer	Calve	Bull	Total
A	78	97	35	45	5	250
B	72	21	114	28	3	238
C	15	9.0	15	7.0	2	48
E	10	7.0	12	5.0	1	35
D	8.0	11	15	8.0	1	42
F	18	12	16	8.0	1	46

During the rainy season cattle spend around 6-9 h grazing during the day, moving over small distances (3.4 km). Surface water from natural ponds and catchment areas is their source of drinking water. During the dry season, more time is spent in grazing (8.10 h) moving over longer distances (7.8 km) in search of good quality forage. They come back to the farms and then move another 1.2 km to find drinking water from deep wells in the city.

Calves were kept in separate sheds with roofs for protection against the sun. Except for farm A which was kept under the open space. During the night each animal was tethered to a wooden peg. Milking was done twice day with calf at food, in the morning before animals leave for grazing and in the evening on their return. Calves were allowed to suckle for milk let down, and then were kept apart from their dams, but were allowed to graze during the day light hours not far from the farms. In farm C cows sometimes were milked once to enhance earlier conception and this called (Towgeeb), weaning was natural, insemination was also natural with bulls running freely with dams all times. Vaccine against Rindderpest and Anthrax were done only when outbreak were expected. Prevailing disease were pneumonia internal and external parasites.

Milk Sampling

Milk samples (10 ml) were collected into tubes containing sodium azide at weekly intervals beginning at 10 days from parturition and every week thereafter until the animal was confirmed pregnant by non-return to oestrus. Milk samples were centrifuged for 10 minutes at 2500 r to remove fat and then stored in a sealed plastic container at 20C° until assayed for progesterone. Concentrations of progesterone in the defatted milk were measured using the solid-phase RIA system supplied by the Joint FAO/IAEA Division (Plazier, 1986). Progesterone concentrations greater than 1 nmol/l were considered to indicate cyclic ovaries.

Body weight and body condition score

Body weight was determined by measuring the heart girth using a weigh band. Body condition score was carried out according to one-to-nine scale (1 emaciated, 9 obese) (Nicholson and Butter Worth, 1986). The above parameters were measured at calving and at 30, 60 and 90 days post calving. In addition to measuring the milk progesterone profile, body weight, body condition score and milk yield were also recorded, whenever possible.

Statistical analysis

The data were treated with the analysis of variance with the general linear model procedure of (SAS, 1994) and least significant difference (LSD) was used to detect statistical significance between means.

RESULTS

Resumption of ovarian activity and conception

There was a wide variation in the resumption of ovarian activity between farms. All cows in farm G showed 100% interval to 1st progesterone (P_4) rise above 90 days, 50% were observed in farms D and E, 40% in farms B and E, while 28% of the cows that resumed ovarian activity above 90 days were in farm A (Table 2). Interval or days

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from calving to first P_4 rise for cows in the different farms are shown in (Table 4). It could be seen that longest days to 1st P_4 rise were shown by farm G followed by farms B, D and F, then A and E and finally farm C (Table 4).

In (Table 3), it was shown that longest days (above 120 days) was exhibited by cows in farm G where 60% of the cows conceived within 121-300 days and 20% did not conceive, followed by farm D. Cows in all other farms conceived with decreasing order for conception rates within 121-300 days (Table 2). Days to conception for cows in the different farms were illustrated in (Table 3). Longest days to conception was recorded by farm B followed by farms D, G, F then A and E and finally C with lowest days to conception (Table 3).

Body weights and body condition score

Body weight was lowest in farm G compared to the other farms. The body weight than decline with entire milk production (Table 5). The body condition score declined progressively up to 60 days in farms A, B, D, E and C and G ($P<0.05$) compared to farm C and F (Table 6).

Table 2 - Percentage of cows ovulating within different ranges in all farms

Range (days)	Farms														All farms n=73	
	A n=25		B n=15		C n=9		D n=8		E n=5		F n=6		G n=5			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
15-45	8	32	2	13.3	1	11.1	2	25	2	40	2	33.3	-	-	17	23.3
46-60	7	28	3	20	3	33.3	1	12.5	-	-	1	16.7	-	-	15	20.5
61-90	3	12	4	26.7	5	55.6	1	12.5	1	20	-	-	-	-	14	19.2
91-120	4	16	2	13.3	-	-	3	37.5	2	40	2	33.3	2	20	14	19.2
121-300	3	12	4	26.7	-	-	1	12.5	-	-	1	16.7	4	80	13	17.8

Table 3 - Percentage of cows conceived within different ranges in all farms during the study period

Range (days)	Farms														All farm n=73	
	A n=25		B n=15		C n=9		D n=8		E n=5		F n=6		G n=5			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
30-60	4	16	-	-	1	11.1	-	-	-	-	-	-	-	-	5	6.8
61-90	5	20	-	-	4	44.4	1	12.5	1	20	-	-	-	-	11	15.1
91-120	7	28	1	6.7	2	22.2	1	12.5	4	80	2	33.3	1	20	18	24.7
121-300	9	36	14	93.3	2	22.2	4	50	-	-	2	33.3	3	60	34	46.6
NC	-	-	-	-	-	-	2	25	-	-	2	33.3	1	20	5	6.8

NC: Not conceived

Table 4 - Days from calving to first progestrone (P_4) rise and conception

Farms	Intervals from calving to P_4 rise (Mean±SD)	Intervals from calving to conception (Mean±SD)
A	71.72±44.6^{bc}	111.32±46.07^{bcd}
B	92.13±54.3^{b}	226.06±52.63^{a}
C	61.78±14.99^{bc}	102.67±48.93^{bcd}
D	85.5±39.17^{b}	174.17±81.60^{b}
E	71.2±35.87^{bc}	103.2±16.21^{bcd}
F	74.5±48.74^{bc}	112.2±21.83^{bcd}
G	167.00±59.68^{a}	165.75±57.16^{bc}

^{abcd,} values with the same column bearing different superscript vary significantly at $P<0.05$

Table 5 - Body weight (kg) changes in all farms under study period

Farms	Body weight (BWT kg)			
	1	2	3	4
A	320.36±41.4^{a}	306.4±38.24^{a}	307.00±39.76^{a}	313.44±39.43^{a}
B	312.53±46.95^{a}	297.2±45.44^{a}	295.8±38.33^{a}	297.2±48.13^{a}
C	286.22±23.62^{a}	270.56±25.56^{a}	282.44±21.39^{a}	293.00±26.1^{a}
D	298.5±29.33^{a}	286.63±34.85^{a}	282.75±35.97^{a}	287.00±35.81^{a}
E	295.8±50.24^{a}	290.00±49.33^{a}	289.6±44.07^{a}	296.6±45.01^{a}
F	291.5±37.78^{a}	278.67±34.55^{a}	287.00±24.35^{a}	294.17±23.56^{a}
G	240.4±91.14^{b}	239.2±92.23^{b}	217.4±93.71^{b}	225.2±101.6^{b}

^{a,b} Values with the same column bearing different superscript vary significantly at $P<0.05$. 1,2,3 and 4:Representing parturition,30,60 and 90 days from parturition

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Table 6 - Body condition score (1-9 scale) in all farms under study period

Farms	Body condition score (BCS)			
	1	2	3	4
A	5.08±1.15[b]	4.08±0.10[b]	4.32±1.35[b]	5.12±1.09[b]
B	4.73±1.16[a]	4.07±0.16[b]	4.0±0.93[b]	4.67±1.05[b]
C	5.56±0.53[a]	4.67±0.71[a]	5.22±0.97[b]	5.78±0.76[a]
D	5.0±1.07[b]	4.13±0.64[b]	3.88±0.83[b]	4.63±0.92[b]
E	5.0±1.41[b]	4.4±1.14[b]	4.0±0.71[b]	5.2±0.45[a]
F	5.67±0.82[a]	4.67±0.82[a]	5.17±0.75[a]	5.5±0.55[a]
G	5.0±1.00[b]	4.0±1.00[b]	3.8±0.45[b]	4.8±1.10[b]

[a,b] Values with the same column bearing different superscript vary significantly at P <0.05. 1,2,3 and 4:Representing parturition,30,60 and 90 days from parturition

DISCUSSION

Fertility of cows kept under traditional extensive systems was shown to be low as indicated by long post-partum anoestrus period and long days to conception in the majority of cows investigated. This was largely correlated with nutritional and other environmental stress. Similarly, other studies revealed the low fertility of zebu cattle in tropical and subtropical areas (Fitzpatrick, 1994). Other factors, which might have influenced fertility, included, body condition score (BCS), body weight (BWT) and health disorders (Mukasa-Mugerwa, 1989; Williams, 1990). In the study, farm C showed the shortest days to ovulation and conception as this farm used controlled suckling. Similarly, it has been shown that calf creep feeding strategies improved conception through reduced suckling (Schlink et al., 1988). The effect of body weight on fertility was clearly demonstrated by farm G where all cows in this farm had significantly low body weight, which was reflected on extended post-partum anoestrus and long days to conception. Similarly, the studies of Singh (1990) on the combination effect of age and body weight revealed that conception rate depended largely on body weight than age. Low body weight at birth and slow growth rate during pre-pubertal period may have been responsible for the poor fertility of these cows.

Numerous studies have shown that the inhibitory effect of suckling is mediated by inhibition of luetinizing hormone (LH) secretion (Peters and Lamming, 1990; Williams et al., 1987) through a reduction of pulsatile secretion of hypothalamic Gonadotropin releasing hormone (GnRH) (Carruthers et al., 1980). On the other hand weaning was shown to hasten oestrus (Short et al., 1990; Carter et al., 1980).

During the rainy season animals were allowed to graze the native pasture without additional supplemental feeding, which failed to fulfill the requirement for meat and milk production. Milking cows were supplemented with concentrate diets during the dry season only. Cows in their pre-partum period received no supplementation and hence were likely to calve in poor condition. Due to significant negative correlation between body condition score after calving and entire lactation period, it has been shown that cows, which calve in poor body condition, have only a small pool of recruitable (2.5 mm) follicles and few if any growing (6.9 mm) follicles for a prolonged period post-partum (Fitzpatrick, 1994).

Prolonged post-partum anoestrus in lactating cows under extensive systems may reflect an adaptive mechanism, which prevents re-conception until nutritional, or other environmental conditions become favorable for reproduction. Furthermore, it has been shown that during the wet season significant negative correlation existed between body weight at calving and post-partum resumption to ovarian activity. This results on line with Buck and Light (1982). Furthermore, it has been shown that responses to pre-partum body weight change may depend on body condition score at parturition, since pregnancy rate of cows in good body condition at calving is affected little by minimal body weight changes either before or after parturition (Dun and Kaltenbach, 1980; Rakestraw et al., 1986) whereas dramatic body weight losses after calving can reduce pregnancy rate (Rakestraw et al., 1986).The negative correlation between milk yield and fertility parameters could be related to body weight and body condition score which were affected milk production at different stages of lactation and rate of mobilization of body fat reserves which contributed to fix milk production (Dominguez et al., 1996).

Days to conception were significantly longer and conception rates were significantly lower in the dry season compared to the wet season where ambient temperatures exceeded 40C^{o}. Similar findings were reported by other workers (Thatcher et al., 1986), which could be related to the inhibitory effect of thermal stress resulting in reduced hypothalamic GnRH secretion, lack of LH secretion and consequently affecting ovarian follicle development (Peters, 1991). This condition might also be exacerbated by poor nutritive value of the pasture. Although concentrates offered by farmers were of good quality, they were not offered in adequate quantities as they were sometimes given every other day due to their high cost. This could place cows in negative energy balance and thereby affecting the calving to conception interval and conception rates. Farms A and B did not seem to benefit from extra night grazing during the dry season. Most of the cows in both farms (A and B) showed long days to conception which could be attributed to poor quality of the pasture and extra energy expenditure during grazing. Heat stress seemed to impose an adverse effects on the cross breeds as reflected on longer days to conception and lower conception rates. Poultry/manure molasses used as a complete diet showed to reduce intervals to resumption of ovarian activity.

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CONCLUSION

Management of post-partum anoestrus under extensive tropical environments should focus on the conservation of body weight and body condition score by strategic and adequate supplementation during late pregnancy and early lactation. Restricted suckling would reduce stimulus of cow-calf interaction and hence reduce days to conception.

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CORRELATION BETWEEN SEED TESTS AND FIELD EMERGENCE OF TWO MAIZE HYBRIDS (SC704 AND SC500)

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ABSTRACT: *Early emergence and stand establishment of maize (Zea mays L.) are considered to be the most important yield-contributing factors. The influence of seed vigor on these factors is vital. Therefore, five laboratory tests and field experiment were conducted on basis of a randomized complete block design (RCBD) with five replications in 2011, to evaluate the correlation among the seed vigor tests and field emergence of two maize hybrids (SC704 and SC500). In laboratory tests, differences between two hybrids for cold test and electrical conductivity test were significant (P≤0.01). The leachates of hybrid SC500 was 35% higher than the leachates of hybrid SC704. However, high germination percentage was obtained by hybrid SC740 in cold test. A Statistically significant difference was found between hybrids in field emergence percentage (P≤0.05). The field emergence of hybrid SC704 and hybrid SC500 was 71% and 37%, respectively. The farm emergence percentage had the significant negative correlation (-0.71) with conductivity test, but positive correlation (0.79) with cold test. No significant correlation between the standard seed germination and the field emergence was detected. Therefore, the standard germination test was not a good indicator for field emergence percentage. However, cold and conductivity tests were the best predictor of field emergence than all the other laboratory tests.*

Keywords: *Field emergence, seed vigor, seed viability, zea mays L.*

ORIGINAL ARTICLE

INTRODUCTION

Maize (*Zea mays* L.) is one of the most useful emerging crops having wider adaptability under varied agro-climatic conditions (FAO, 2010). Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals (Guzobenli, 2010). It is cultivated on nearly 150 million hectares (ha) in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% in the global grain production (FAO, 2010). In Iran, total maize cultivation area and its average production are 225390 ha and 7 ton/ha, respectively. Maize grain is used for the preparation of corn starch, corn syrup, corn oil dextrose, corn flakes, gluten, grain cake, lactic acid and acetone, which are used by various industries such as textile, foundry, fermentation and food industries (Hussain, 2009).

One of the main problems observed in the field is poor seedling establishment, which is influenced by seed quality, climatic conditions and field management practice (Zhu et al., 2010). Seed quality includes several attributes leading to near maximum germination capacity to produce seedlings, which emerge rapidly from the seedbed and continue to grow uniformly thereafter (McDonald, 2000). Sometimes standardized laboratory germination procedures are criticized as not predicting field performance very well (Fawad et al., 2002). These critics suggest using a variety of test conditions to find an optimum for each seed lot. Vigor testing is one possible solution (AOSA, 2009). Seed vigor tests, therefore, have been proposed to detect differences in potential seed lot performances.

Seed vigor is the sum total of those properties of the seed that determine the level of activity and performance of the seed during germination and seedling emergence (ISTA, 1987). Consequently, vigor tests such as growth test, conductivity test, cold test, accelerated aging test and brick grit test were developed to predict the field emergence of seed lots (Hempton and Tekrony, 1995). The growth tests principles are based on vigorous seeds grow at a faster rate than poor vigor seeds even under favorable environments (AOSA, 2009). Vigorous seeds rapidly germinate, metabolize and establish in the field. Therefore, any method used to determine the rapidity of seedling growth will give an indication of seed vigor level (AOSA, 2009). Conductivity test principles are based on weakening of cell membrane in poor vigor seeds causes leakage of water soluble compounds like sugars, amino

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acids, electrolytes and etc. when immersed in water (AOSA, 2002). On the other hand fresh seeds having intact membrane leach less quantity of these chemical. The measurement of electrical conductivity of the leachate by a good and sensitive conductivity meter gives an accurate estimation of membrane permeability. The EC has been positively correlated with the emergence percentage of peas and broad beans (Panobianco et al., 2007). The cold test has been developed in USA to evaluate the seed vigor of maize. According to Wotza and Tekrony (2001) germination results obtained with applied cold test represent the most precise indicators of maize germination in the field. The test aims to differentiate between weak and vigorous seed lots by subjecting them to low temperatures prior to germination at optimum temperature. Accelerated ageing test has been developed for determining the storage potential of seed lots (Munamava et al., 2004). Studies of Leeks (2006) relating to seeds of Brassica (B. *rapa* × *campestris*, B. *campestris*, B. *napus*, B. *oleraceae* var. *alboglabra* L and B. *rapa* var. pekinensis) revealed that a high correlation between germination obtained by using accelerated aging and field emergence existed. The brick grit test is also known as the Hiltner test for detecting seed-borne Fusarium infection in cereals (Miloević et al., 2010).

The general strategy of determining seed vigor is to measure some aspects of seed deterioration or weaknesses, which is inversely proportional to seed vigor (Elias and Copeland, 1997). High vigor seed lots may improve crop yield in two ways: firstly, because the seedling emergence from the seedbed is rapid and uniform and the resultant plants are vigorous, and secondly because the percentage seedling emergence is high, the optimum plant population density can be achieved under a wide range of environmental conditions (Ghassemi-Golezani, 2008).

The objectives of this research were to predict field emergence of maize seed lots using several laboratory seed germination and seed vigor tests using correlation coefficients.

MATERIAL AND METHODS

The field and laboratory experiments were conducted in University of Maragheh, Iran to evaluation of relation between the seed vigor tests and field emergence of two maize hybrids (SC704 and SC500). All laboratory and field experiments were conducted on basis of Randomized Complete Block Design (RCBD) with five replications. The seeds with same size, weight and age were selected for eliminating of their effects on seed vigor. Seeds were disinfected by 1% Hypochlorite sodium for 10 minutes and then rinsed with distilled water three times before tests.

The following laboratory tests were conducted along the field experiment:

1. Conductivity test

A seed sample of 5 gram was weighted and surface sterilized with 0.1% Hypochlorite sodium for 10 minutes. The sample was washed thoroughly in distilled water. The clean seeds were immersed in 100 ml of water at 25±1°C temperature for 24 hours. After this the seeds were removed. The electrical conductivity of distilled water was measured in a beaker. The electrode was then cleaned with a tissue paper and conductance of the leachate was read. The electrode was thoroughly washed using a wash bottle and wiped with a clean tissue paper before reusing. To get the EC of leachate the reading of distilled water was subtracted from the sample reading. The reading was expressed as mmhos/cm/g of seed.

2. Cold test

After grinding and properly sieving the soil was filled in tray upto2 cm depth. Fifty seeds were placed over the sand and covered with another 2 cm thick layer of soil. The soil was compacted and enough water was added to make the soil about 70% of its water holding capacity. Water temperature should be l0°C after watering; the trays were covered with polythene bags and placed in the refrigerator maintained at 10°Ctemperature for one week. After one week the trays were removed and placed in the germinator at 25°C. The seedlings emerged after 4 days were counted.

3. Accelerated ageing test

One hundred seeds each in five replications were tied in a fine muslin cloth. The tied seeds were placed in jar on a wire mesh. The lower part of the jar was filled with water. There should not be a direct contact between water and the seeds. The jar was covered with the lid and sealed with paraffin wax to make it air tight. The jar was then placed in the accelerated aging chamber maintained at 45±2°C for 5 days. The jar was removed after this period and the seeds were cooled in a desiccator. The seeds were then tested in a normal germination test.

4. Brick grit test

In this test, seeds were planted on sand and covered with 3 cm of damp brick grit, then germinated in darkness at room temperature for 10 days. The percentage of normal seedlings from this test is considered to be an indication of the vigor level.

5. Laboratory germination, seedling growth and mean germination time (MGT):

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Five replicates of 50 seeds were germinated between double layered rolled germination papers. The rolled paper with seeds was put into plastic bags to avoid moisture loss. Seeds were allowed to germinate at 20±1°C in the dark for 21 days. Germination was considered to have occurred when the radicles were 2 mm long. Germinated seeds were recorded every 24 h for 21 days. Mean germination time (MGT) was calculated to assess the rate of germination. $MGT = \sum(D * N)/\sum N$ R=1/MGT [eq. 1]

Where N is the number of seeds germinated on day, D is the number of days counted from the beginning of the test and is mean germination rate. The seedlings with short, thick and spiral formed hypocotyls and stunted primary root were considered as abnormally germinated. At the end of germination test (21 days), radicles and shoots were cut from the cotyledons and then dried in an oven at 75±2°C for 24 hours. The dried radicles and shoots were weighed to the nearest milligram and the mean radicle and shoot dry weight and consequently mean seedling dry weight were determined.

Field experiments

Field emergence evaluation studies using the same seed lots used in laboratory experiments were conducted at the Maragheh University Campus (37° 22' N, 46° 15' E, elevation 1275m) field station. Two maize hybrids with five replications were conducted using a randomized complete block design. The field was fallow during the previous year, and no plant residues were present. The field was tilled by shovel and seed bed was well prepared before planting. No chemical fertilizer was applied because the only seedling emergence was under consideration. Early season rainfalls were sufficient for the plant emergence. Each plot consisted of 10 rows of 20 seeds, planted 0.25 m apart and 0.04 m deep. Emergence (when green leaf could be seen inside coleoptiles) was recorded at 24±1 h intervals and continued until no further emergence occurred. In the notations used for field studies, G (germination) was replaced by E (emergence).

Correlations among measured laboratory germination parameters and emergence variables were calculated using PROC CORR procedure of SAS.

RESULTS

The T-test analysis of laboratory seed tests showed that there were no meaningful differences between two hybrids for MGT (mean germination test), BGT (brick grit test), AAT (accelerating aging test), GT (germination test) and other seedling growth parameters but the germination and emergence percentage of two hybrids for EC (electrical conductivity test) and CT (cold test) tests were significant (Table 1). According to Table 1, the leachates of hybrid SC500 was 182.4 (mmhos/cm/g of seed) that this value was 35 percentage more than the leachates for hybrid SC704.

We found a statistically significant difference between two hybrids in field emergence percentage (Table 1). The results showed that the field emergence of hybrid SC704 with 71 percentage was greater than those the hybrid SC500.

Table 1 - Means comparison of seed vigor tests, germination test and seedling parameters

H	MGT	EC	BGT	CT	AAT	FE	SL	SoL	RL	SG	RDW	SoDW	SeDW
704	2.143	119.30	0.800	0.272	0.736	0.712	18.15	6.70	11.45	0.952	0.4405	0.5248	0.9093
500	2.085	182.40	0.832	0.024	0.648	0.376	16.75	6.85	9.90	0.944	0.4869	0.3845	0.8714
LSD (5%)	0.105	13.161	0.098	0.0583	0.1620	0.2609	4.1418	1.0569	3.2539	0.0505	0.1519	0.1723	0.3232

MGT (mean germination test), EC (electrical conductivity), BGT (brick grit test), CT (cold test), AAT (accelerating aging test), FE (field emergence), SG (standa (seedling length), SoL (shoot length), RL (root length), RDW (root dry weight), SoDW (shoot dry weight), SeDW (seedling dry weigth).

Table 2 - Correlation coefficient between variables measured on seed lots and field emergence

	MGT	EC	BGT	CT	AAT	FE	SG
MGT	1	-0.58696	0.38217	0.55735	0.09297	0.67213 *	0.45228
EC	-0.58696	1	0.22921	-0.9026 **	-0.43717	-0.70922 *	-0.27305
BGT	0.38217	0.22921	1	-0.0754	0.23047	0.30464	0.09836
CT	0.55735	-0.9026 **	-0.07754	1	0.36321	0.78981 **	0.1627
AAT	0.09297	-0.43717	0.23047	0.36321	1	0.21028	-0.0047
FE	0.67213 *	-0.70922 *	0.30464	0.78981 **	0.21028	1	0.06181
SG	0.45228	-0.27305	0.09836	0.1627	-0.0047	0.06181	1
SL	0.15599	-0.25347	0.25347	0.40902	-0.08944	0.51244	-0.18322
SoL	-0.03759	0.21817	0.19546	0.04161	-0.39786	0.11207	0.13491
RL	0.20342	-0.23119	0.25235	0.49068	0.01119	0.59648	-0.26672
RDW	-0.07352	0.34435	0.46121	-0.06977	-0.05823	0.02376	-0.9651
SoDW	0.30503	-0.42341	0.18486	0.69932 *	0.11922	0.55335	0.16019
SeDW	0.15377	-0.09412	0.34227	0.40118	0.04558	0.35633	0.05224

*,**: Significant at p≤0.05 and p≤0.01, respectively. MGT(mean germination test), EC (electrical conductivity), BGT (brick grit test), CT(cold test), AAT(accelerating aging test), FE (field emergence), SG(standard germination), SL(seedling length), SoL(shoot length), RL(root length), RDW (root dry weight), SoDW (shoot dry weight), SeDW (seedling dry weigth).

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The correlations among laboratory and field emergence tests are presented in Table 2. The correlations between MGT and other seed vigor tests were non-significant, But MGT test was significantly correlated (P≤0.01) with farm emergence percentage. The farm emergence percentage had significant negative correlation (P≤0.05) with EC test, but positive correlation with CT test. SG (viability percentage) had no significant correlation with farm emergence. Except for shoot dry weight that had significant positive correlation with CT test, the remaining seedling parameters were not significantly correlated to seed vigor tests and seed viability test (Table 2).

DISCUSSION

The standard germination tests were conducted under an optimal set of temperature and moisture conditions, which allowed for optimum seed germination with minimal stress (Fawad et al., 2002). However, the field emergence was measured under much more stressful conditions, which was reflected in a slower emergence and decreased crop stand (Garcia and Lasa, 1990). Therefore, reliance on the standard germination test cannot be correct to predict field emergence percentage. We found no significant correlation between the standard seed germination and field emergence (Table 1). The findings of the present study are consistent with those of Fawad et al. (2002) in subtropical corn hybrids and Tavakoli kakhki et al. (2006) in alfalfa, who found no significant correlation between the standard seed germination and field emergence. Some studies had reported strong correlations between the standard germination test and field emergence (Adebisi et al., 2003; Khan et al., 2010).

Regarding the results obtained by the cold test, among seed vigor and viability tests, cold test showed the highest significant positive correlation coefficient (0.79) with the field emergence (Table 2). Internationally, cold tests have gained wide acceptance for maize (*Zea mays* L.) and it was developed to evaluate the physiological potential of corn seeds, seeking to simulate adverse soil conditions (excessive water, low temperatures and presence of fungi in the soil) that frequently occur during the sowing season in the US Corn Belt. The efficiency of the cold test has been tested experimentally by several researchers as reported by Barros et al. (1999) and (AOSA, 2002; Damavandi et al., 2004).

Although in this study AAt and BGT tests had no significant correlations with the field emergence but there are some studies that show these tests could efficiently predict field emergence percentage. Fawad et al. (2002) reported that the accelerated aging test could detect differences among hybrids and showed the highest correlations (0.86 and 0.87, respectively) with the field emergence for the subtropical corn hybrids. Similar results have been reported for sweet corn (Wilson and Trawatha, 1991).

Significant negative correlations were found between the EC test and field emergence (Table 2). The high EC value is normally associated with the low seed quality. Ratajezak and Duczmal (1991) found that the electrical conductivity test was the best correlated with the field emergence than the other laboratory seed quality tests. Wang and Nan (2004) reported that electrical conductivity test was a good predictor of field emergence and showed a better correlation with the field emergence than the standard germination test. More ever Wilson et al. (1992) found that accelerating aging test and EC test could be used in field emergence prediction. Tavakoli kakhki et al. (2006) showed a significant correlation coefficient between EC and FE for alfalfa seed. They mentioned EC test had the highest correlation among laboratory tests with field emergence correlation coefficient. Rozrokh et al. (2002) also indicated that electrical conductivity and germination rate tests are suitable for evaluation seed vigor of chickpea (*Cicer arietinum* L.) in both laboratory and field experiments. The conductivity test correlated with the field emergence of dwarf French bean (Powell et al. 1986) and pea (Duczmal and Minicka, 1989). In cotrast, Yaklich and Kulik (1987) reported that field emergence and conductivity tests results were not consistently correlated.

One unanticipated finding was the positive correlation between MGT and FE (Table 2). Commonly there is an inverse relationship between MGT and seed germination rate [eq. 1]. ASOA (2002) considers germination rate as a good indicator of seed vigor. There are numerous studies that use seed germination rate to evaluate seed performance between non-treated and primed seeds (Farooq et al., 2006; Armin et al., 2010), but only a few studies have considered to compare germination rate of seed lot to predict the field emergence (Tavakoli et al., 2006). It is difficult to explain this result, but it might be related to differences between seed germination and seedling growth necessities. In the seed germination rate evaluation, only the time to radicle protrusion is considered as a parameter of germination rate. As a result, the use of seed germination rate in maize seeds as a vigor test might be mistaken.

CONCLUSION

When seed bed and environmental conditions are close to ideal, a field emergence will correlate well with germination and seed lot vigor is not an important factor. However, optimum field conditions are not often encountered in practice, and environmental stresses (e.g. low or high soil temperature, excess or low soil moisture) may lead to varying field performance depending on the vigor status of the seed lot. Usually, reach to entire suitable conditions for perfect seed lot performance is impossible and consequently heterogeneous emergence is the common events in the crop production. However, we need an easy method/or methods to detect the seed vigor variation. Several studies have been demonstrated that vigorous seeds generally show high stand establishment in variable field conditions. Therefore, the yield of crops that raised from high vigor seeds is high. The different

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performance of the tested hybrids may be related to the other aspects of seed vigor, i.e. genetic structure, possibly mechanical damage, seed filling conditions on mother plant and, etc. The results of experiments showed that conductivity test and cold test can be used to evaluate of maize seed lot performance in the field condition. As the EC test is a simple, low-cost and fast method so as a result, this test is preferable to the other seed vigor evaluating methods.

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PERFORMANCE OF GUINEA FOWL (NUMIDA MELEAGRIS) FED VARYING PROTEIN LEVELS

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ABSTRACT: *This study was conducted to investigate the effects of different protein levels on growth of guinea fowl keets (Numida meagris) of the same age under intensive system in a typical poultry house from 6th week to 12th week of age. They were fed commercial broiler starter for two weeks and maintained on same diet of 18% crude protein for 5 weeks of age and given water ad libitum. The birds were separated into three pens. One hundred and twenty old guinea fowls were assigned at grower period on 3 dietary protein levels of 14, 16 and 18% crude protein (CP) on same metabolizable energy level of 2800 kcal/ kg. The study was conducted in Kgatleng District in Botswana used to test the performance of the female birds. The birds were killed at the owner's farm by cutting the neck through the jugular vein. There was significant difference (P<0.05) in feed intake between the three treatments. The internal organs for the treatments were not significantly different.*

ORIGINAL ARTICLE

Keywords: *Dietary protein, guinea fowl, body weight gain, feeding performance*

INTRODUCTION

Guinea fowl is a wild bird found in most parts of Botswana. Many of them were captured and reared in captivity by farmers for the purpose of protein consumption of the people.

Guinea fowl (*Numidia meleagris*) can be kept both for meat and egg production (Smith, 2001). Guinea fowl adapt well to harsh environmental conditions, and they are less susceptible to poultry diseases, unlike chickens (Mathis and Mac-Donald, 1987). Guinea fowl production would not require excessive use of medicated feed (no antibiotics) as is common practice in intensive broiler production. Rearing of guinea fowl intensively has just begun in Botswana and is likely to accelerate the potential of the species. Guinea fowl meat has higher protein content than that of chicken. There are no cultural barriers against consumption of guinea fowl products (Saina et al., 2005). Guinea fowl can be raised under both intensive and extensive management systems. The problem facing poultry in developing countries is inadequate knowledge of the nutritional requirement of the domesticated birds (Adeyemo et al., 2006). It pays to give supplements to guinea fowl for growth from keets stage to maturity if they are kept under semi- intensive (Alawa and Nwagu, 1995). Information on guinea fowl production is rather lacking in Botswana which hampers rapid development of this industry (Nsoso et al., 2006). The study is aimed at examining dietary lysine levels at the growing stage.

MATERIALS AND METHODS

120 day old guinea fowls keets were kept together under a deep litter system with saw dust used as litter. These were fed commercial chick starter mash containing 21% crude protein (CP) and fed water *ad libitum*. At the beginning of 6th week, keets were randomly divided into three groups balancing for weight moved to grower pens. Three dietary protein levels were formulated to contain (CP) concentrations of 14, 16 and 18% CP respectively. The summary of the different dietary protein during the growing period and the composition of experimental diets fed from 6-12 weeks of age are shown in Table 1.

The diets were thoroughly mixed with a feed mixer. They were fed up to 12 weeks of age. Keets were raised under normal day light. The drinkers and the feeding troughs were thoroughly washed daily. The birds were weighed individually at the beginning of the experiment and every week, thereafter at end of the growing period of twelve weeks. Feed intake was determined weekly using a weighing balance. Body weight changes were determined using a measuring scale. Mortality was recorded as they occurred.

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Table 1 - Composition and proximate analysis of experimental diets			
Parameters	**14% CP**	**16% CP**	**18% CP**
Yellow maize	79.00	82.80	88.40
Sunflower	16.90	12.40	6.40
Salt	0.30	0.30	0.30
Calcium phosphate	1.00	1.00	1.00
Alfalfa meal	2.50	3.50	3.60
Vit-mineral mixture	0.30	0.30	0.30
Total	100.00	100.00	100.00
Proximate analysis			
Metabolizable energy (kcal/kg)			
Dry matter	2800	2800	2800
Moisture (%)	86.7	87.3	86.9
Crude Protein (%)	12.0	12.0	12.0
Ether extract (%)	18.06	18.07	18.08
Ash (%)	36.0	35.76	36.32
Nitrgen free extract (%)	11.60	11.76	11.48
Calcium (%)	14.73	14.64	14.59
Phosphorus (%)	21.78	21.95	21.87
Crude fat (%)	0.7	0.7	0.7

At 12 weeks of age six birds were randomly selected from each treatment, weighed and after being starved for 16 hours were killed by neck dislocation in the slaughter slab. Each bird was plugged; visceral organs, head, and wings were removed. The carcasses were eviscerated to determine the dressing percentage, heart, kidney and spleen weights. Length of intestine and oviduct were determined by using a meter ruler. The proximate analyses of the diets were carried out as per AOAC (1990).

The data were subjected to analysis of variance and significant differences among the means were determined using LSD test.

RESULTS AND DISCUSSION

The influence of the dietary protein level on feed intake, weight gain and feed efficiency is shown in table Table 2. Feed intake increased with increasing protein levels of 16% and 18 % crude protein respectively. These results are in agreement with Kingori et al. (2003) who reported increased feed intake as protein was increasd. In this study there was a general increase in body weight throughout the growing stage. Adeyemo et al. (2006) reported increased live body weight of guinea fowls fed different levels of crude protein. There was significant difference ($P<0.05$) in feed intake between the three treatments. This might be due to the differences in percentage crude protein content. This could also have been influenced by some ingredients in the diets to compel the birds to eat more to meet their body protein requirements. The weight gain increased significantly ($P<0.05$) between the treatments. Adeyemo et al. (2006) also reported significant difference of weight gain between birds fed 14 and 16% CP. Growth in animals is influence by genotype of birds, nutrition, hormones, tissue specific regulatory factors and other aspects of the bird's environment (Carlson, 1969). When birds consume below their protein requirement they do not improve protein utilization. The study showed that feed efficiency improved as protein was increased between 14, 16 and 18% crude protein (Table 2). Although slower growing than broiler chickens they are reported to out-perform replacement layer pullets in feed conversion efficiency (Olomu, 1983).

Table 2 - Influence of dietary crude protein level on feed intake, weight gain and feed conversion ratio from 6 to 12 weeks of age				
Parameters	**14%CP**	**16%CP**	**18%CP**	**P***
Average total feed intake (kg)	6.02^a	6.16^b	6.27^c	<0.05
Average total feed intake (kg)	6.02^a	6.16^b	6.27^c	<0.05
Body weight gain (g)	879^a	944^b	973^c	<0.01
Feed Conversion ratio	6.71^a	6.37^b	6.23^c	<0.05
% mortality	0	0	0	
Mean bearing different superscripts are significantly different (P<0.05)				

The dietary protein level did not influence increase in dressing percentage, weight of heart, spleen, liver, empty gizzard and kidney (Table 3). The length of the oviduct was not influence by increased dietary protein.

All parameters except body weight (live weight) were not significantly different. In this body weight increased significantly ($P<0.05$) with increased dietary protein. Ayorinde and Ayeni (1983) reported very low live body weights

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of 245.20 to 726 g at 12 weeks of age as compared with this study which reported 1.21 to 1.47 Kg at 12 weeks of age. However, heart weight, spleen weight and oviduct length tended to decline with increased protein level. Guinea fowl are reported to grow slowly and utilize feed less efficiently than chickens (Olomu, 1983). The problems of growth in guinea fowls can be associated with nutrition and selection. One cannot be sure that the birds were fed optimally. Though guinea fowls have similar gastrointestinal tract is may not be correct that it translate into similar nutrient requirements. There are other factors as genetics which contribute to the nutrient requirements. Various researchers have recommended high protein levels of 15-26% for good performance of guinea fowl with reduction as bird's mature (Nwagu and Alawa, 1995).

Table 3 - Effects of carcass parameters of guinea fowl fed varying levels of crude protein

Parameters	14%CP	16%CP	18%CP
Body weight (Kg)	1.21[a]	1.37[b]	1.47[c]
Dressing percentage (%)	87.5[a]	87.6[a]	87.5[a]
Heart weight/kg live weight (g)	3.89[a]	3.86[a]	3.85[a]
Spleen weight/kg live weight	1.98[a]	1.94[a]	1.94[a]
Empty gizzard weight (kg) live weight	26.53[a]	27.50[a]	26.48[a]
Liver weight g/kg live weight	22.13[a]	22.21[a]	22.20
Abdominal fat g/kg live weight	21.13[a]	21.16[a]	21.22[a]
Small intestine (cm)	130.23[a]	130.45[a]	130.43[a]
Oviduct length (cm)	8.75[a]	8.74[a]	8.73[a]
Kidney g/kg live weight	4.56[a]	4.63[a]	4.59[a]

Means bearing different superscripts are significantly different (P<0.05)

Sales and du Preez (1997) reported live weight of 1.56 at 12 weeks of age and it is higher than what it was found in this study. The three diets showed that guinea fowls need three different diets as reported by Blum et al. (1975). The live body weights of the birds were between 1.21 to 1.47kg at 12 weeks of age. Nsoso et al (2006) and Oguntona (1982) reported low growth rates of 1.29kg and 1.22kg respectively. Fajemilehin (2010) reported very low body weight of three breeds of guinea fowls at 0.510kg, 0.466kg and 0.478kg respectively as compared to this study which recorded 1.21, 1.37 and 1.47kg of body weight during 12 weeks of growth. There was no difference in length of oviduct of the birds fed the different protein levels at 12 weeks of age. There was no mortality in the dietary treatment groups.

CONCLUSIONS

The body weight gain increased with increasing dietary protein. Average feed intake increased with increased dietary protein. Feed conversion ratio decreased with protein increase. It is interesting that no mortality occurred during the study.

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LINEAR BODY MEASUREMENTS AS AN INDICATOR OF KENANA CATTLE MILK PRODUCTION

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ABSTRACT: *Data on (239) females from Kenana cattle population reared in the Um-Benein livestock Research Station and villages around in addition to some areas in the Gezira State were used in this study to determine milk production, the relationship between linear body measurements and between the latter and age and milk production. Traits studied were daily milk yield (DMY), days in milk (DM), height at withers (HTW), heart girth circumference (HGC), abdominal circumference (ABC) and body length (BL) with the ultimate goal to securing a valid indicators of dairy potential of Kenana cattle .The overall means of daily milk yield and days in milk for Kenana cattle were 4.3±0.376 (kg) and 249.98±2.96 days, respectively. Peak daily milk yield was 5.74±0.33 (kg) reach at the third lactation. The correlation coefficients between daily milk yield and linear body measurements were 0.36, 0.20, 0.54 and 0.28 for heart girth, abdominal girth, body length and height at withers, respectively. Prediction equation was derived to estimate milk yield with (0.52) coefficient of determination (R^2). Means daily milk yield (kg) obtained using the estimated method and developed equation using linear body measurement were 4.721±0.162 and 4.705±0.090, respectively. No significant differences (P≤0.05) in means of daily milk yield obtained using the two methods.*

Keywords: *Linear body measurements, milk yield, Kenana cattle, Sudan.*

ORIGINAL ARTICLE

INTRODUCTION

Almost since the beginning of the written history, man has been concerned with the productivity of his farm animals. The physical laws of nature dictate limits within which various body dimensions of our cattle may vary. Animals that are too productive for a particular environment are less well adapted. It is necessary to find animals that are well adapted to the environment of each farm and describe their type by objective measurements such as linear body measurements of different parts of the animals. Defining differences between animals is necessary if genetic progress is to be made. Body measurements allow detection of change that occur in the herd or breed earlier than they may be detected visually. A body measurement therefore quantifies change in animal performance over the time. They serve as supplemental information to performance test results (Bosman, 1997). Livestock in Sudan is characterized by diversity, the wide range of breeds and types of farm animals found in Sudan, in one sense reflect the great heterogeneity of the natural environment in which animal production take place, and the continuing efforts of the producer to obtain a type best suited to own environmental circumstances. Productivity in livestock can be determined using some phenotypic measurements. Using body measurements can be useful in defining performance in many cases. In literature, there are reports showing relationships between body measurements and performance traits (Sieber et al., 1988, and Yanar et al., 2000). Kenana cattle is considered one of the promising dual purpose animal, yet information on their linear body measurements and their relation with performance traits such as milk yield are limited. Hence, this study was conducted to provide essential information on some of these linear body measurements.

MATERIALS AND METHODS

Location of study

The data in this study was collected from Kenana cattle herd at Um-Benein Research Station and villages around it, they were located in Sinnar state on the western bank of the Blue Nile river about 360 km south of

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Khartoum and 9 km south of Singa. It lies between latitude 13° 04 N and longitude 33° 56 E and is 435 meter above sea level. There are three distinct seasons in the year based on rain fall and temperature: Winter (November-February), hot summer (March-June); and wet summer (July-October) with some showers in May and June. In addition to some herds were studied in the Gezira State.

Animals and their management

A total number of 239 Kenana cattle populations were randomly sampled from different areas, including Um-Benein and villages around, in addition to some herds in Gezira State. All the animals were housed in pens fenced by wood materials, steel pipes and sheds of local materials and corrugated zinc sheets. Water was available all the time in steel troughs.

Data collection and Statistical analysis

Data were collected on the following traits: Daily milk yield (DMY) in kilograms, lactation length (Days in milk) and linear body measurements (LBMs) namely, Heart girth circumference (HGC), Abdominal girth circumference (ABGC), Body length (Bl) and Height at withers (HTWs). The linear measurements were measured in centimeters with a Dalton's weighing band. The HGC was measured as the minimal circumference around the body immediately behind the front shoulder; the ABGC was measured as the minimal girth around the body immediately around the abdomen; Bl was the distance from the point of the shoulder to the ischium; HTWs was the widest point at the center of the stifle. The data were compiled according to the age groups (1 to 5) and lactation number (1 to 7). The collected data was subjected to statistical analysis program in the SPSS (1983), using least squares analysis of variance fixed model procedure(Harvey, 1979) model one to find-out the effect of lactation number on milk yield, to find-out a formula for linear regression of linear body measurements (LBMs) namely, Heart girth circumference (HGC), Abdominal girth circumference (ABGC), Body length (Bl) and Height at withers (HTWs) on daily milk yield (kg) and to find-out the persons correlation between linear body measurements and daily milk yield with the ultimate goal to securing a valid indicator of potential of the Kenana cattle.

The residual mean square was used as the random error term to test the significance of differences among groups.

The general model fits the data was: $Y_{ijkl} = \mu + A_j + L_k + H_l + e_{ijkl}$

Where:

Y_{ijkl} = The trait studied (Daily milk yield).
μ = The overall mean underlying the trait.
A_j = The effect of j^{th} age (for j = 1...5).
L_k = The effect of k^{th} lactation number (for k = 1...7)
H_l = The effect l^{th} of herd (for l = 1...3).
e_{ijkl} =The random error term (All factors considered fixed except for the random error term).

RESULTS AND DISCUSSION

Significances of body weight, milk yield and body measurements in dairy cattle breeds have been studied by a number of researchers. Most of the investigators reported that larger and longer cows produced higher amount of milk (Harville and Henderson, 1983; Kerr et al., 1985; Sieber et al., 1988; Glunski and Litwinczuk, 1999; Yanar et al., 2000).

Also genetic and phenotypic relationships among body weight, body measurements and milk production have been investigated by several authors (Baginda et al., 1985; Moore et al., 1991; Akbulut et al., 1998), but results have been inconsistent.

The effect of age on Kenana cattle breed was also observed. Age was found to have a high significant differences ($P<0.05$) on daily milk yield and lactation length of the animals.

Means and standard error of daily milk yield and lactation length are presented in Table 1. The daily milk yield in this study was 4.30 ± 0.38 the lactation length was 249.98 ± 2.97 days which was lower than that reported by Abdalla et al. (1990) 283.00 ± 40.00 days for the same breed at Um-Benein livestock Research Station.In general, daily milk yield and lactation length incraeased as age advanced and then decreased for animals in age group >10yrs. The effect of herd on kenana cattle was also observed. Herd was found to have a significant differences ($P<0.05$) on daily milk yield and lactation length. The values are shown in Table1. Means and standard errors for daily milk yield and lactation length by two methods were tabulated in Table 2. The values were not statistically significant ($P<0.05$). Table.3 contains least square means of estimated daily milk yield according to lactation numbers (1^{st} to$>6^{th}$), showed that the peak daily milk yield was reached in third lactation (5.75 kg) which was similar to that reported by Osman, 1970; Elkhidir et al., 1979, this results was higher than that reported by Osman (1972) for Northern Zebu cattle in range and lower than the reported one by Osman (1970) for the same cattle breed. Differences among means while the mean multiple comparison was performed using Duncan multiple range test for daily milk yield according to lactation numbers were statistically significant ($P<0.05$).

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Table 1 - Least square means (means±SE) of Some productive traits of Kenana cattle according to age groups and herds

Factor	NO	Daily milk(kg)	Lactation length(days)
Overall	239	4.30±0.38	249.98±2.97
Age (yrs.):			
3-4 yrs.	02	2.76±1.67	210.00±31.30
5-7 yrs.	52	4.91±0.34	238.57±6.88
8-10 yrs.	82	5.71±0.26	255.36±5.29
>10 yrs.	103	3.47±0.70	248.25±19.43
Herds:			
Um-Benein	156	3.22±0.36	248.67±3.54
El-Managil	46	7.47±0.50	260.22±6.61
Wad-Medani	37	6.01±0.35	241.00±8.19

Table 2 - Least square means (means±SE) of some productive traits of Kenana cattle using equation and scale

Factor	NO	Daily milk (kg)	Lactation length (days)
Overall	62	5.09±0.70	238.6.60±6.50
Equation	31	5.17±0.99	238.9.66±9.66
Scale	31	5.01±0.95	238.25±9.25

Table 3 - Least square means (means±SE) of milk yield of Kenana cattle by lactation numbers

Factor	NO	Daily milk(kg)
Lactations		
1th	22	3.78±0.52abc
2th	43	4.78±0.37a
3th	54	5.75±0.33abc
4th	56	4.76±0.32bcd
5th	32	4.50±0.43de
6th	22	3.59±0.52de
>6th	10	3.69±1.73cd
Overall	239	4.19±0.43

Means with the same letter not significantly different (P>0.05). Different letters denote significant difference at (P<0.05).

Phenotypic correlation coefficients between linear body measurements and daily milk yield are presented in Table 4. Generally, there were positive correlation between milk yield and all linear body measurements. Correlation values between all linear body measurements and daily milk yield were statistically significant (P<0.01). The results indicated that phenotypicaly longer cows had higher milk yield, and the results was similar to previous reports (Moore et al., 1991; Glunski and Litwnczuk, 1999). Also the longer cows tend to be efficient as smaller ones. The results were in accordance with findings of Hooven et al. (1968), Dickinson et al. (1969) and Sieber et al. (1988).

Table 4 - Phenotypic correlation coefficient between daily milk yield and linear body measurements of Kenana cattle breed.

Parameters	Heart Girth (cm)	Abdominal Girth (cm)	Body length (cm)	Height at withers (cm)
Daily milk yield (kg)	0.36**	0.22**	0.54**	0.28**

** Correlation is significant at the (0.01) level (2- tailed).

Table 5 presents the results of regression analysis, in which linear expression of all body measurements were used in all age groups to predict contemporary daily milk yield. The predicting relationship of daily milk yield and linear body measurements was determinate by regressing daily milk yield of the animal on linear body measurements of Heart girth, abdominal girth, Body length and Height at withers. There were highly and significant (P<0.05) regression coefficients between these body measurements and daily milk yield for the lactation studied. The relationships were further ranked according to t- values, Table 5.

The best relationship with daily milk yield in Kenana cattle is body length (t=7.67) followed by heart girth (t=1.85), abdominal girth (t=0.72) and height at withers (t=0.124). Regression equation was also derived to predict daily milk yield in different lactation in Kenana cattle breed. The relatively high accuracy of prediction equation obtained in this study suggested that regression equation was sufficient to use in prediction of daily milk yield from

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linear body measurements in Kenana cattle breed. However, more studies are needed to emphasis this statement. This is advantageous especially in Sudan.

Table 5 - Coefficients associated with regression of daily milk yield (kg) on linear body measurements (cm) of Kenana cattle breed

Model	Beta	SE	t value	sig.
1 (constant)	-18.526	3.720	- 4.976	0.000
Abdominal girth (cm)	0.00	0.012	0.724	0.470
Height at withers (cm)	0.004	0.033	0.124	0.901
Body length (cm)	0.171	0.022	7.670	0.000
Heart girth (cm)	0.042	0.023	1.850	0.060

Predicted equation: $\hat{Y}$ = -18.526 + 0.009 (ABG) – 0.004 (HTWs) + 0.171 (Bl) + 0.043 (HG), (R^2 = 0.52)

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, findings in this study shows that Body length (cm) can best be indicator to predict daily milk yield of Kenana cattle breed using regression equation. Also, Age played a major role on animal performance. Also found those lactation numbers have effect on daily milk yield of animal as it tends to increase in advanced with lactations. It also concludes and recommends that linear body measurements should be necessary to consider their contribution to cattle performance prediction in improvement programs for commercial production.

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IMPACT OF SEASON, SEX, AGE, AND AGRO-ECOLOGY ON THE PREVALENCE OF FASCIOLIASIS IN BUFFALOS OF LADAKH

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ABSTRACT: *Studies on fascioliasis of buffalos were undertaken at slaughter houses, household and livestock farms under different climatic conditions existing in Ladakh region of Jammu and Kashmir State in order to find out the various associated factors and their impact on the prevalence of fascioliasis. The study revealed that the infection rate was 62.05%, 34.37%, and 27.77% respectively in slaughtered, livestock farm and household buffalos with an overall prevalence of 42.59%. Significant variations were observed in the prevalence with respect to various factors of the host as well as the study area; of which the most important one was the climate. Overall highest (48.14%) seasonal prevalence in all types of buffalos was recorded during wet season while as only (37.03%) was recorded during the dry season. It was noticed that a higher (45.83%) infection rate was recorded in younger (>3 years) buffalos than in adult ones (40.00%). Sex of the host was also found having an impact on the prevalence wherein females were more infected (46.42%) than males (38.46%). It was also observed that the infection rate was high (44.62%) in comparatively low land areas as compared to high altitudes (40.38%). Therefore it was concluded that the prevalence of fascioliasis is very high in buffalos of this region and season and locality of the region as well as sex and age of the host species plays an important role in the prevalence of fascioliasis and it is a hope that this study will provide necessary information regarding fascioliasis in buffalos of Ladakh (where livestock rearing is one of the important sources of livelihood) for their effective management and hence for a better production which will benefit the resource poor people of this region.*

Keywords: *Prevalence, Fascioliasis, buffalos, Ladakh*

ORIGINAL ARTICLE

INTRODUCTION

Fascioliasis is a wide spread helminthiasis responsible for immense economic loses in buffalos in terms of livers, decreased milk and meat production, loss of weight and poor caracass quality. Fascioliasis is characterized by sudden death with bloodstained froth at the natural orifices in acute cases. Diarrhea, jaundice and bottle jaw are predominant features in chronic cases. This disease entity causes losses in terms of morbidity and mortality in flukey areas. Surveys in some Asian countries have shown that amongst domestic animals, buffalos suffer more from Fascioliasis.

In developed countries data on various aspects of helminthiasis are published in an efficient manner as an aid to combat infection more effectively. In contrast, in developing countries little published information exists on the epidemiological aspect of helminthic infections, particularly on fascioliasis. Although some work has been carried out from Jammu and Kashmir region but no work has been done on fascioliasis of buffalos in this region which is largely dependent on domestic ruminants including buffalos. Surveys in some Asian countries have shown that among domestic animals, buffaloes are the most suffering animals from fascioliasis (Sandra et al., 2003). The prevalence is high in areas surrounding dams or large ponds in which Lymnaea auricularia rubiginosa, the intermediate host of *F. gigantica* is found. An epidemiological study revealed that the disease has a seasonal pattern from which the following conclusion for control of the disease can be drawn. Strategic liver fluke treatment of all cattle and buffaloes which are older than 8 months should be carried out once a year. In addition, animals in poor condition should be treated to prevent severe losses, especially in high prevalence areas or where strategic treatment was missed. Problems of liver fluke control include the lack of knowledge about the parasite at farmers level and the lack of availability of drug supplies at the village level, both of which are important to allow strategic treatment of animals (Srihakim et al., 1991). In the present study an attempt was made to find out the impact of season, sex, age, and agro-ecology on the prevalence of fascioliasis in buffalos of Ladakh to provide a base line data and it was observed that all these factors are associated with prevalence of fascioliasis. This the reason for

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this paper, which records the prevalence of fascioliasis in buffalos in the Ladakh (J&K) in relation to climatological factors, host age, sex and agro ecology of the region and is an attempt to bridge the gap in knowledge of these aspects.

MATERIALS AND METHODS

Survey of fascioliasis in slaughter houses

To record the prevalence a systematic survey of various slaughter houses was carried by visiting the abattoirs at weekly intervals during the study. Post-mortem examinations of slaughtered animals were carried out and livers were checked out for the presence of flukes. The date, age, sex and locality were recorded. The number of total and infected animals was also recorded in order to determine the disease prevalence.

Fascioliasis in live animals

Epidemiological and helminthological studies were performed at livestock farms and on household buffalo in both the districts of the study area followed by standard methods of (Urquhart et al., 1988). During the studies the seasonal prevalence was recorded. For this purpose the year was divided into two seasons as follows: wet season and dry season. The prevalence in relation to age, sex and agro-ecology was also defined.

Parasitological techniques

Flukes recovered from each of the livers during the survey in slaughter houses were counted and morphologically identified as *F. hepatica* and *F. gigantica*. Faecal samples were examined by direct smear, flotation and sedimentation techniques for the presence of fluke eggs (Urquhart et al., 1988). The counting of eggs was performed by McMaster egg counting technique (Urquhart et al., 1988). Identification of adult flukes as well as eggs was done on the basis of morphology (Soulsby, 1982).

Meterological data

The climatological data was provided by government meteorological department Ladakh.

RESULTS

During the study year 40 buffalos at slaughterhouses,32 household and 36 livestock farm buffalos were examined of which 25 (62.5%) slaughtered, 11 (34.37%) at livestock farms and 10 (27.77%) household buffalos were found infected with either of the two species of *F. viz*; *F. hepatica* or *F. gigantica* or sometimes with both of these two species. It was also noticed that *F. gigantica* was predominant over *F. hepatica*. Overall infection rate was 46 (42.59%). It was noticed that prevalence was higher in buffalos at slaughterhouses (62.07%) followed by livestock farms (33.20%) and household buffalos (25.65%) respectively (Table1).

Table 1. Over all Prevalence of Fascioliasis in buffalos

Buffalo	Number Examined	Number Positive	Percentage
Slaughtered	40	25	62.5
Livestock	32	11	34.37
Household	36	10	27.77
Total	108	46	42.59

In all the buffalos overall prevalence recorded was higher during wet season (48.14%) as compared to the dry season (37.03%) (Table 2). A positive correlation of disease prevalence to rainfall, morning and evening humidity and minimum temperature has been recorded. Correlation between disease prevalence and other meteorological factors was not significant.

Table 2. Seasonal prevalence (%) of Fascioliasis in buffalos

Season	Number Examined	Number Positive	Percentage
Wet	54	26	48.14
Dry	54	20	37.03

Table 3. Age wise prevalence (%) of Fascioliasis in buffalos

Age group	Number Examined	Number Positive	Percentage
Young (>3 Years)	48	22	45.83
Adult (<3 Years)	60	24	40.00

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The occurrence of fascioliasis was more frequently recorded in younger buffalos (45.83%) than in adult ones (40.00%) which were above two years of age (Table 3). Similarly differences were found in infection rate with regard to the sex of the host wherein females were more infected (46.42%) as compared to their counter partners (38.46%) (Table 4).

Table 4. Age wise prevalence (%) of Fascioliasis in buffalos

Sex	Number Examined	Number Positive	Percentage
Males	52	20	38.46
Females	56	26	46.42

Furthermore the present study also revealed a correlation of disease prevalence to agro-ecology of the study area; the prevalence was high (44.62%) in low land areas (Kargil) as compared to a comparatively high altitude (Leh), (40.38%) (Table 5).

Table 5. Prevalence on the basis of Agro-ecology

Agro-ecology	Number Examined	Number Positive	Percentage
Low-land (Kargil)	56	25	44.62
High-altitude (Leh)	52	21	40.38

DISCUSSION

The occurrence of fascioliasis in an area is influenced by a multifactorial system which comprises hosts, parasite, management, and environmental effects. In the natural foci of fascioliasis, The *Fasciola* and their immediate and final host form an association posing a potential epidemiological threat and it is important that the existence and localization of such an association should be recognized beforehand so that the situation can be brought under control.

In the present study, epidemiological data on fascioliasis were collected from buffalos in slaughterhouses, livestock and household of Kargil and Leh districts of Ladakh. When the data on seasonal prevalence in all the three groups of buffalos were analyzed it was observed that a higher prevalence of fascioliasis occurred during wet season as compared to dry season. The higher prevalence in wet season than dry season is in agreement with many reports around the world, (Gupta et al., 1986; Al-Khafaji et al., 2003; Yadav et al., 2007; Firreria, et al., 1981; Maqbool et al., 1994). This could be due to the existence of a direct relationship between prevalence with the rainfall, humidity and temperature. In this study, the presence of sufficient rainfall and moisture during the wet season favored the survival of infective larvae in the pasture, emergence of cercaria from snails which results in higher probability of uptake of the infective larvae leading to higher prevalence rate (Sissay et al., 2007). Also during the wet season the snails which usually remain under the mud get exposed by rain and float along with the water and are being eaten by the animals along with water which also increase the infection rate.

The study further reveals that sex of the animals showed an association with the prevalence of the parasites, it was observed that females were more infected than their counter partners this statement is in consistent with Dhar et al. (1988) and Dutt et al. (1995). This could be due to some physiological peculiarities of the female animals, which usually constitute stress factors thus, reducing their immunity to infections, and for being lactating mothers, females happen to be weak/malnourished, as a result of which they are more susceptible to the infections besides some other reasons (Blood and Radostists, 2000).

Similarly, the higher prevalence recorded in younger animals as compared to the adult ones is in agreement with Firreria et al., 1981; Shah-Fischer and Say, 1989; Nganga et al., 2004, from different corners of the world. The reason for which could be the fact that younger animals are more susceptible to infections than adults. Adult animals may acquire immunity to the parasites through frequent challenge and expel the ingested parasite before they establish infection, (Dunn, 1978; Shah-Fischer and Say, 1989).

The study also shows higher prevalence in Kargil district which is comparatively lowland as compared to Leh (high altitudes) this statement is in line with reports from many parts of world (Teklye, 1991; Yildirim et al., 2000; Fikru et al., 2006). These low lands are characterized by a comparatively hot humid environmental situation that is favorable for the survival of the infective larval stage of these parasites. One another possible reason for higher prevalence in Kargil district as compared Leh could be that the water bodies (from where the animals drink water) of Kargil district are comparatively more polluted which leads higher pick up of parasites and therefore high prevalence.

CONCLUSION

Therefore it is evident from the present study that fascioliasis in buffalos of Ladakh is very high and several factors have been found to be associated with it is the need of the present hour to take more steps to gather more

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and more information regarding various aspects of helminthoses in this region and it is believed that the present study will provide some sort of help in the same direction.

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ANALYZING OF QUAIL EGGS HATCHABILITY, QUALITY, EMBRYONIC MORTALITY AND MALPOSITIONS IN RELATION TO THEIR SHELL COLORS

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ABSTRACT: *A total 2400 hatching eggs were obtained from Japanese quails breeders ranged from 100 to 150 days of age used to analyze the effect of shell color on fertility, hatchability, embryonic mortality and malposition as well as internal and external egg quality. Results revealed that shell color had significant effect on fertility and scientific hatchability while it doesn't affect commercial hatchability percentage. Moreover, there were significant effects for shell colors on early and late embryonic mortalities but not for mid embryonic mortalities. In addition, egg shell color represented some differences for embryonic malposition. Results also showed that egg shell color had significant effect on egg weight, length, width, volume, haugh unit, shell thickness and egg weight loss. But doesn't affect shape index, yolk index, yolk percentage, albumen percentage, shell weight and shell percentage. We recommended that spotted and white shelled eggs should be excluded from hatching procedures and used for another purpose because they recorded the lowest scientific and commercial hatchability percentages, highest early embryonic mortalities, the lowest egg volume and shell thickness as well as the highest values for egg weight loss during egg storage.*

ORIGINAL ARTICLE

Keywords: *Quail egg colors, fertility, hatchability, embryonic mortality and malposition, egg quality*

INTRODUCTION

Japanese quail lays eggs with colorful and patterned shells which make the eggshell color difficult to classify. Quail eggs are graded as white, sandy-spotted, little-spotted, high-spotted and/or medium-spotted (Okumus and Durmus, 1998), while eggshell color of the wild quail is white, flesh-tint, light brown or speckled blue and/or brown. Moreover, these differences in egg color have been proposed as a means of identifying hens (Mizutani, 2003). Also, (Sezer and Tekelioglu, 2009) concluded that quail eggshell color varies from white to blue and green. Additionally, quail eggs have brown or reddish-brown patterned areas on a light background. This colorful quail eggs provides more opportunities to study a wide variety of questions, such as the metabolism of pigment deposition and its relationship to overall bird physiology, egg quality and sexual behaviors.

Hulet et al. (1985) documented that fertility was not significantly affected by shell color. However, eggs with blue or tan colored shells tended to have a significantly lower hatchability in Pheasant. McDaniel et al. (1979) and Bennett (1992) concluded that thinner eggshells are associated with lowering in hatchability percentage, while thick-shelled eggs showed an increased hatchability as a result of greater fertility and lower intermediate and late embryonic mortalities (Roque and Soares, 1995). There are variations of the normal embryonic positions that are considered to not be detrimental to successful hatching. However, there are many positions that are associated with difficulty in hatching or are found in increased incidence in cases of poor hatchability (Wilson et al., 2003). It should be noted that there were significant correlations between shell color and shell strength, thickness, and shell weight. While there were no distinct correlations between shell color and egg weight, albumen weight, yolk weight, haugh unit, yolk color of the Yangzhou chicken (Yang et al., 2009), in addition, they demonstrated that some egg quality traits such as shell strength, shell thickness, shell weight and shell ultra-structure could be assessed through the shell color.

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The objectives of this study were to investigate the effect of eggshell color on fertility, hatchability, embryonic mortality and malposition as well as egg quality traits.

MATERIALS AND METHODS

This study was carried out on 2400 hatching eggs obtained from Japanese quails breeders ranged from 100 to 150 days of age at the Department of Animal Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, Alexandria University, Egypt.

Eggs

Collected daily from battery cages that contain quail breeders each cage contains 2 males and 6 females with sex ratio (1: 3). Eggs then arranged into five different color groups based up on pigment found on the surface of egg shell (Figure 1). Group (I) Brown pigmentation, group (II) grayish white egg shell pigmented with various sizes of black pigments (Black stained); group (III) non-pigmented egg shell (white), group (IV) small black pin dots on grayish brown shell (Spotted) and group (V) slightly blue pigments

(I) (II) (III) (IV) (V)

Fig. 1 - different shell color groups of Japanese quail eggs

Management of eggs

Eggs were collected and stored for seven days in the storage room at 18oC and 75% relative humidity. Cracked eggs, thin shells, dirty eggs and abnormal in size or shape, were eliminated. Eggs were fumigated using formaldehyde gas (Mixing of 40 ml formalin 40% and 20 g Potassium permanganate, KMNO4)/three cubic meters of cabinet area for about 20 minutes then the gas expelled). Eggs were set vertically with broad end up in the setting trays according to their color groups. Incubation temperature was 37.5^{o}C and relative humidity was 65% which kept all over the period of optimum hatchability. Eggs were turned automatically six times daily from second day of setting until the 14th day of incubation with turning angle was ±45 degree from vertical position. Eggs were transferred to Hatcher at 14th day of incubation were there was no turning occur. On hatching day the hatched chicks were removed to rearing house while non-hatched eggs were broken and examined for fertility, hatchability and mortality percentages.

Studied traits

Fertility percentage (No. of fertile eggs/Total number of eggs set)*100, scientific hatchability percentage (No. of hatched eggs/Total number of fertile eggs)*100, commercial hatchability percentage (No. of hatched eggs/Total number of eggs set)*100, embryonic mortalities (early embryonic mortality from zero to seven days of incubation, mid embryonic mortality from eight to 14th days of incubation and late embryonic mortality from 15th to 17th days of incubation), embryonic malposition (head toward narrow end (HTNE), head over right wing (HORW), head over left wing (HOLW), head under left wing (HULW) and head between two shanks (HBTS)).

Egg quality traits

1 - External egg quality (egg weight in grams, length and width in centimeters, egg shape index calculated according to (Carter, 1968) equation as follows: *I* = [Breadth/Length] x 100, Egg volume according to Narushin (1997) depending on egg length (L) and maximum breadth (B) as follow: E vol Narushin = 0.496 x L x B^2, shell percentage, as well as shell thickness of egg in millimeters by using digital caliber.

2 - Internal egg quality (yolk index, yolk percentages, albumen percentages as well as haugh unit index). The haugh unit was calculated according to the following formula:

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$$HU = 100 * \log (H - 1.7W^{0.37} + 7.6)$$

Where,

HU = Haugh unit

H = observed height of the albumen in millimeters

W = weight of egg in grams

3 - Weight loss (in grams and as a percentage) during 12 days of storage at room temperature 18°C and 70% relative humidity divided into four periods 3 days each.

Statistical analysis

Least-square analysis for the obtained data was done by the aid of SAS software (2004) according to following model. $Xik = \mu + Gi + eik$

Where: Xik = the Xth observation of the i th group

μ = overall mean

Gi = effect of the ith group of eggshell color (i = 1, 2, 3, 4 and 5)

eik = random error.

RESULTS AND DISCUSSION

Effect of shell color on fertility, scientific and commercial hatchability

Fertility, scientific hatchability and commercial hatchability percentages of different shell colors of Japanese quail eggs are presented in (Table, 1). Higher non-significant differences for fertility percentages were observed among colored verities of quail eggs, except for spotted shell of eggs, where blue stained eggs showed higher non-significant percentages for fertility (86.26%) followed by black stained eggs (85.02%) then brown and white eggs (83.99 and 83.30%). But spotted eggs expressed the lowest percentages ($P<0.05$) for fertility than other colors (67.50%). Hulet et al. (1985) found that fertility was not significantly affected by shell color. On the other hand Krystianiak et al. (2005) found that fertilization rate was lower in blue than in eggs of remaining colors. It was clear that scientific hatchability was significantly higher in blue, brown and black stained eggs (83.05, 81.47 and 80.13, respectively). While significantly lower scientific hatchability was recorded for spotted and white shelled quail eggs (55.77 and 55.33 %) comparable to the previous colors of shell. Hulet et al. (1985) reported that eggs with blue or tan colored shells tended to have a significantly lower hatchability in pheasant. In addition, (Anonymous, 1993) found an association between hatchability and shell color. Also, (Krystianiak et al., 2005) found that blue-shelled eggs were characterized by lower hatchability from fertilized eggs compared to the other egg color groups. Although there were non-significant differences for commercial hatchability among different egg shell colors of quail eggs but there were numerical increase in commercial hatchability percentages were recorded for blue, black and brown stained eggs (71.96, 68.39 and 63.35%, respectively) over spotted and white egg shell colors (53.05 and 48.30%). These results disagreed with those obtained by (Soliman et al., 2000) who found significant relationship between the percentages of commercial hatchability of four groups of quail eggshell colors.

Table 1 - Means ± standard errors (MSE) for fertility, scientific hatchability and commercial hatchability percentages of different shell colors of Japanese quail eggs

Parameter / Color	Fertility	Scientific hatchability	Commercial hatchability
Black	85.02±4.68^{ab}	80.13±4.50^{a}	68.39±5.02^{a}
Blue	86.26±5.36^{a}	83.05±3.37^{a}	71.96±7.18^{a}
Brown	83.99±1.44^{ab}	81.47±2.79^{a}	68.35±1.39^{a}
Spotted	67.50±8.88^{b}	55.77±10.66^{b}	53.05±12.34^{a}
White	83.30±2.53^{ab}	55.33±2.95^{b}	48.30±4.22^{a}

Means within the same column with different litters are significantly different at ($P<0.05$).

Effect of Shell color on embryonic mortality

Early, mid and late embryonic mortality percentages of different shell colors of Japanese quail eggs are presented in (Table, 2). White and spotted eggshell colors showed higher significant differences for early embryonic mortality percentages (57.32 and 55.00%) than blue, black and brown stained eggs (35.13, 34.27 and 32.18%; respectively). On the other hand non-significant differences were recorded for mid embryonic mortalities. on the contrary late embryonic mortality recorded higher significant percentages for black, brown and blue stained egg shell colors (52.34, 40.30 and 35.65%; respectively) than spotted and white shell eggs (27.22 and 27.28%).The same results were recorded by (Soliman et al., 2000) who reported that violet eggs had the highest early dead percentages, while the light brown eggs had the highest late dead percentages among all color groups. Also

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significant differences for embryonic mortalities among five color groups of quail eggs were recorded by (Darwish et al., 1997).

Table 2 - Means ± standard errors (MSE) for early embryonic mortality, mid embryonic mortality and late embryonic mortality percentages of different shell colors of Japanese quail eggs.

Parameter / Color	Early embryonic mortality	Mid embryonic mortality	Late embryonic mortality
Black	34.27±6.83^{b}	13.39±4.10^{a}	52.34±6.23^{a}
Blue	35.13±0.92^{b}	29.22±11.81^{a}	35.65±10.94^{ab}
Brown	32.18±5.80^{b}	27.52±4.26^{a}	40.30±2.08^{ab}
Spotted	55.00±2.52^{a}	17.78±1.11^{a}	27.22±3.62^{b}
White	57.32±3.36^{a}	15.40±1.14^{a}	27.28±3.56^{b}

Means within the same column with different litters are significantly different at (P<0.05).

Effect of Shell color on embryonic malposition

Embryonic malposition of quail embryos of different egg shell colors (Table, 3) showed that brown eggs recorded higher and significant differences for HTNE than that black and white colors (9.00%), but not significant for blue and spotted shell colors, while black spotted eggs showed higher and significant differences for HORW (53.95%) compared to brown eggs, but not-significant for the other eggshell colors, on the other hand no differences were observed among different egg shell colors for HOLW, but spotted eggs recorded the highest significant differences for HULW (39.33%) compared to the other colors of shell, in addition higher non-significant differences were recorded for white and blue egg shell colors for HBTS (26.10 and 24.4%, respectively). But the lowest significant malposition of HBTS was recorded for spotted eggshell color (8.33%) compared to the other shell colors. Butcher et al. (2009) recorded that the most commonly reported malposition are head between thighs, head in the small end of egg, head under left wing, head not directed toward air cell, feet over head, beak above right wing.

Table 3 - Means ± standard errors (MSE) for embryonic malposition percentages of different shell colors of Japanese quail eggs.

Parameter / Color	HTNE	HORW	HOLW	HULW	HBTS
Black	1.67±1.67^{b}	53.93±7.68^{a}	11.17±1.97^{a}	15.00±5.29^{b}	19.9±2.58^{ab}
Blue	3.33±3.33^{ab}	45.77±7.76^{ab}	14.73±2.64^{a}	15.10±4.10^{b}	24.40±5.20^{a}
Brown	9.00±2.18^{a}	31.34±2.86^{b}	17.44±4.33^{a}	24.43±3.49^{b}	17.78±1.82^{ab}
Spotted	3.33±1.67^{ab}	40.00±2.89^{ab}	9.00±2.08^{a}	39.33±5.67^{a}	8.33±3.33^{b}
White	1.52±1.73^{b}	48.33±6.01^{ab}	14.73±2.15^{a}	10.83±3.47^{b}	26.10±4.61^{a}

Means within the same column with different litters are significantly different at (P<0.05). HTNE=Head toward narrow end, HORW=Head over right wing, HOLW=Head over left wing, HULW=Head under left wing, HBTS=Head between two shanks.

Effect of shell color on egg quality traits

External and internal egg quality parameters of different shell colors of Japanese quail eggs are shown in (Table, 4). Difference in egg weight among different colors of quail eggs revealed higher significant differences for black, blue, brown stained and white egg shell over spotted quail egg shell (11.88, 11.61, 11.64 and 11.70 versus 11.02 g). Significant differences for egg weight among different egg shell colors were recorded by (Kirikci et al., 2005 And Krystianiak et al., 2005). But non-significant differences between different quail egg colors were recorded by (Soliman et al., 2000). Also disagreed with (Yang et al., 2009) found that no distinct correlations between shell.

The longest egg was brown stained eggs (3.24 cm) while the shortest one was spotted eggs (3.10 cm). The same pattern was recorded for egg width where brown stained eggs were wider than other color groups (2.62 cm) while the narrowest one also was spotted eggs. It was noticed that there were non-significant differences recorded for other three colors (black, blue stained and white egg shell) for length and width of the eggs. Although there were significant differences in egg length and width among colored verities of quail eggshell, egg shape index did not expressed any significant differences between different colors and ranged from (79.72 to 81.11) for blue and brown stained eggs. These results agreed with those obtained by (Choprakarn and Salangam, 1998) who found significant differences between egg sizes, length and width but not in egg shape index. Soliman et al. (2000) did not found any significant differences for egg shape between four eggshell colors of Japanese quails. But (Kirikci et al., 2005) found significant differences for egg shape index where white shell color eggs expressed lower significance shape index than blue, olive and brown egg shell colors. Significant differences among different egg shell colors for shape index also recorded by (Yang et al., 2009).

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Egg volume not well studied among different colored eggs so in our study we recorded that brown stained eggshell colors showed the highest significant egg volume (11.05) followed by black and blue stained eggs while the lowest egg volume recorded for spotted eggshell (9.48). Yolk index (Y.I) doesn't affected by eggshell color although there was numerical increases in brown eggshell color (0.75) while the lowest Y.I was recorded for blue eggshell color (0.46). The same results were recorded by (Kirikci et al., 2005) who found no significant variations for Y.I among white, blue, brown and olive egg shell colors of Pheasant. But disagreed with those obtained by (Soliman et al., 2000) who assessed Y.I for four color groups of quail eggs. Moreover, yolk percentage didn't varies among different eggshell color ranged from (31.75 to 33.86) for white and blue eggshell color; respectively. Yang et al., (2009) found that no distinct correlations between shell color and yolk weight in Yangzhou chicken. But disagreed with those obtained by (Soliman et al., 2000) who found significant differences for yolk percentage between four color groups of quail eggs.

White eggshell color recorded the highest significant values (0.95) for HU (measures of albumen quality) followed by brown eggshell color (0.92), while the same value was recorded for black, blue and spotted eggshell colors (0.91) the results disagreed with those obtained by (Yang et al., 2009) who found no distinct correlations between shell color and haugh unit in Yangzhou chicken. Also, (Kirikci et al., 2005) found no significant variations for HU among white, blue, brown and olive egg shell colors of Pheasant. On the other hand, Albumen percentage did not exhibit any significant differences among different egg shell colors of quail eggs and these results disagreed with those obtained by (Kirikci et al., 2005).

Non-significant values were recorded for eggshell weight and shell percentage between different eggshell colors. While, Kirikci et al. (2005) found significant differences among different eggshell colors for shell weight but no significance differences were recorded for shell percentage. On the other shell thickness varies significantly between different eggshell colors were black spotted and blue eggs shell showed the highest thickness (0.23 mm) over brown, white and spotted eggshell colors (0.19, 0.17 and 0.15 mm). These results disagreed with those obtained by (Joseph et al., 1999) who reported that the link between shell color and shell quality is still unclear, as no definitive conclusions have yet been reached concerning this relationship. While significant correlations between shell color and shell thickness were recorded by (Yang et al., 2009). In addition (Krystianiak et al., 2005) reported that shells of blue-shelled pheasant eggs were thinner. Our results indicated that shell thickness was positively correlated with higher egg quality and higher hatchability. The same results were recorded by (McDaniel et al., 1979) who reported that thinner eggshells are associated with lowering in hatchability percentage. Also (Roque and Soares, 1995) found that thick-shelled eggs showed an increased hatchability as a result of greater fertility and lower intermediate and late embryonic mortalities. On the other hand (Ingram et al., 2008) concluded that eggshell color was found to be lowly correlated to shell thickness.

Table 4 - Means ± standard errors (MSE) for egg weight in grams, external and internal egg quality parameters of different shell colors of Japanese quail eggs.

Parameter / Color	Black	Blue	Brown	Spotted	White
Egg weight	11.88±0.11^{a}	11.61±0.12^{a}	11.64±0.10^{a}	11.02±0.16^{b}	11.70±0.12^{a}
Length	3.21±0.03^{ab}	3.21±0.04^{ab}	3.24±0.04^{a}	3.10±0.05^{b}	3.17±0.02^{ab}
Width	2.59±0.03^{ab}	2.55±0.02^{b}	2.62±0.02^{a}	2.47±0.03^{c}	2.54±0.02^{b}
Egg shape index	80.84±0.67^{a}	79.72±0.89^{a}	81.11±1.03^{a}	79.85±0.67^{a}	80.11±0.65^{a}
Egg volume	10.72±0.30^{ab}	10.39±0.21^{ab}	11.05± 0.25^{a}	9.48±0.35^{c}	10.17±0.21^{bc}
YI	0.48±0.01^{a}	0.46±0.01^{a}	0.75±0.28^{a}	0.49±0.01^{a}	0.51±0.02^{a}
Yolk %	32.82±0.86^{a}	33.86±0.53^{a}	32.88±0.67^{a}	33.09±0.91^{a}	31.75±0.59^{a}
HU	0.91±0.01^{b}	0.91±0.01^{b}	0.92±0.01^{ab}	0.91±0.01^{b}	0.95±0.01^{a}
Albumen %	52.92±0.75^{a}	51.62±0.71^{a}	53.38±0.77^{a}	52.64±1.08^{a}	55.29±2.12^{a}
Shell weight (g)	1.67±0.08^{a}	1.74±0.10^{a}	1.67±0.11^{a}	1.49±0.12^{a}	1.57±0.05^{a}
Shell %	14.26±0.74^{a}	14.52±0.77^{a}	13.74±0.89^{a}	14.27±1.13^{a}	13.72±0.43^{a}
Shell thickness	0.23±0.02^{a}	0.23±0.02^{a}	0.19±0.01^{ab}	0.15±0.01^{c}	0.17±0.01^{bc}

Means within the same row with different litters are significantly different at ($P<0.05$).

Effect of shell color on weight loss during storage

Egg weight loss due to water loss and evaporation from eggs depends upon shell quality, our study confirmed this statement. Table (5) showed that egg weight loss from different eggshell colors was recorded for four different period each was three days and the total weight loss from the first day up to the end of twelfth day of egg storage. It was observed that spotted eggs recorded the highest egg weight loss and percentage of weight loss during 0-3, 3-6, 6-9, 9-12 and 0-12 days of storage (0.25, 23, 25, 27 and 1.00 g) and (2.39, 2.26, 2.61, 2.85 and 9.71%); respectively followed by white eggshell color, on the other hand the lowest egg weight loss and percentage was recorded for blue stained egg shell color during 0-3, 3-6, 9-12 and 0-12 days (0.06, 0.11, 0.12 and 0.42 g) and (0.51, 1.00, 1.07 and 3.70%) but black spotted eggshell color recorded the lowest egg weight and percentage during 3-6 days (0.13 g and 1.18%; respectively) these results indicated that there were negative correlation

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between eggshell thickness and weight loss; thus by increasing shell thickness the weight loss decreased. AR et al., (1974) found that egg weight loss in Japanese quail eggs was 3.09 mg /day but (Romanoff and Romanoff 1949) describe the daily water loss of 10-100 g eggs under constant conditions (not specified) as a linear function of the initial egg weight.

Table 5 - Means ± standard errors (MSE) for weight loss in grams and percentage of weight loss of different shell colors of Japanese quail eggs.

Parameter / Color		Black	Blue	Brown	Spotted	White
0-3 day	(g)	0.11±0.02^{cb}	0.06 ±0.02^{c}	0.13 ±0.02^{b}	0.25 ±0.03^{a}	0.17 ±0.01^{b}
	(%)	0.92 ±0.17^{cb}	0.51 ±0.19^{c}	1.16 ±0.20^{b}	2.39 ±0.27^{a}	1.42 ±0.11^{b}
3-6 day	(g)	0.15 ±0.02^{b}	0.11 ±0.02^{b}	0.15 ±0.03^{b}	0.23 ±0.03^{a}	0.17 ±0.03^{ab}
	(%)	1.22 ±0.18^{b}	1.00 ±0.15^{b}	1.36 ±0.28^{b}	2.26 ±0.26^{a}	1.43 ±0.22^{b}
6-9 day	(g)	0.11 ±0.02^{b}	0.13 ±0.04^{b}	0.15 ±0.04^{b}	0.25 ±0.03^{a}	0.16 ±0.02^{b}
	(%)	0.95 ±0.16^{b}	1.18 ±0.33^{b}	1.37 ±0. 38^{b}	2.61 ±0.31^{a}	1.39 ±0.20^{b}
9-12 day	(g)	0.19 ±0.05^{ab}	0.12 ±0.01^{b}	0.16 ±0.03^{b}	0.27 ±0.02^{a}	0.20 ±0.03^{ab}
	(%)	1.63 ±0.44^{b}	1.07 ±0.14^{b}	1.53 ±0.33^{b}	2.85 ±0.28^{a}	1.72 ±0.25^{b}
Overall	(g)	0.56 ±0.09^{cb}	0.42 ±0.05^{c}	0.60 ±0.11^{cb}	1.00 ±0.07^{a}	0.70 ±0.07^{b}
	(%)	4.61 ±0.74^{b}	3.70 ±0.48^{b}	5.27 ±1.03^{b}	9.71 ±0.72^{a}	5.82 ±0.56^{b}

Means within the same row with different litters are significantly different at (P<0.05).

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PERFORMANCE OF KENANA × FRIESIAN CROSS-BRED CATTLE IN CENTRAL SUDAN

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ABSTRACT: *A study to evaluate performance of Friesian crosses with Sudanese (Kenana × Friesian) dairy cattle was carried out in central Sudan conditions in tow herds at tow dairy farms (Kenana company, and ELbshaier dairy farms). A sample of 128 records (90+38 from Kenana and Elbashaier dairy farms respectively) were studied for the performance of different blood levels on milk production, days in milk, calving interval, age at lactation and lactation number. Analysis of variance, correlations, regressions and mean separation utilizing "Duncan" were done in version 9 (SPSS) computer program. The results showed that the overall mean lactation yield (kg), days in milk and calving interval were: 3603.4±127 kg, 317.3±8 days and 420.3±8 days respectively. Mean lactation milk yield was highest in 75% blood level (4724.1 kg).On the other hand, Mean milk yield for: 25%, 37.5%, 50%, 62.5%, 75%, 87.5% and 100% were: 2497.7, 3302.0, 3508.4, 2657.0, 4724.0, 4362.3 and 3507.5 kg respectively. There were significant (P≤0.01) differences between means of milk yield, days in milk, and calving interval in the tow farms Kenana and Elbashaier respectively. Blood level, herd, lactations and their interactions had a significant (P≤0.05) effect on milk production. Also blood level had a significant (P≤0.01) effect on days in milk, and the mean days in milk for 25%, 37.5%, 50%, 62.5%, 75%, 87.5%, and 100% were: 354.0, 291.0, 307.0, 298.6, 339.9, 302.5, and 377.0 days respectively. Milk yield was affected by: herd, lactation and blood level, but there was a positive significant (P≤0.05) correlation between milk yield and blood level. Mean calving interval for 25%, 37.5%, 50%, 62.5%, 75%, 87.5%, and 100% were: 466.0, 454.0, 395.7, 382.9, 445.7, 401.0, and 416.8 (days) respectively.*

Keywords: *Performance, Friesian crosses, central Sudan*

ORIGINAL ARTICLE

INTRODUCTION

Sudan is the home of large numbers of domestic animals. The total number of the cattle in 2001 was 38.325 million heads (Medani, 2003). In spite of this large number of cattle, there was a shortage in milk and milk products in many parts of the country, particularly in urban areas. The productivity of the Sudanese dairy cattle was generally low and the average annual milk yield did not exceed 2000 kg, (Osman and Ruseell, 1974). The best milk producing breeds in Sudan are Kenana and Butana, and they had shown production estimated to be about 1872 kg and 2254 kg per lactation respectively (Fangaly, 1980) On the other hand, Hamide (2004) reported that judged by international standards milk production potential of most indigenous Sudanese cattle was sub-optimal. Generally milk production in Sudan tends to be highly seasonal, and most production occurs during the rainy seasons at the time of relatively plentiful grass and other forages. This availability of feed continues into the winter season when agricultural byproducts are available. (Mohamed, 1987).Currently the demand for milk exceeds supply. To satisfy this shortage the government policy was to increase milk production by improvement of the genetic makeup of cattle by crossing with foreign blood. Cattle in the tropics have, on average, lower milk yield and shorter lactations than cattle in temperate zone countries. The difference is caused by both genetic and non-genetic factors. The level of foreign blood is one factor that affects milk yield and composition.

The main objectives of this study were to:

-Determine the effect of foreign blood levels on milk yield and the dairy characteristics.

-Determine the optimum foreign blood level that results in optimum performance

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MATERIALS AND METHODS

Data collection

Total sample of 128 (90+38 animal records from Kenana and El Bashaier dairy farms, respectively) were taken. All cows were (Kenana × Friesian) crosses at different foreign blood percentages (25 to 100%). Complete records representing, the period 1989 – 2005 were taken and analyzed.

Historical background

Kenana dairy farm was established in 1985.The farm was situated at Kenana Town on the Eastern bank of the White Nile, 300 km south Khartoum, latitude 13˚–10˚ N and longitude 32˚–40˚ East, in a heavy clay soil. The climate is hot, semi-arid with mean maximum temperature of 36.4˚C and corresponding mean minimum temperature of 20.2˚C and the mean annual rainfall of 278 mm for the period 1977 to 2002. The foundation stock of Kenana farm consisted of Kenana cattle type and some of the cows were crosses (Kenana × Friesian) from University of Gezira Research Farm, and Kafoury Dairy Farm (Khatroum North). Cross breeding was started in 1985 at Kenana Dairy Farm.

El Bashaier dairy farm is a private small scale dairy farm, located at Elshokaba 10 km south of Wad Medani Town (Gezira Steate). The farm was established in 1990 as a dairy production enterprise. At El Bashaier farm, the foundation stock was (Kenana × Friesian) crosses with different foreign blood levels.

Herd management

Animals were housed in open fenced pens in Kenana farm. There were three large units, A, B and C, with total capacity of 2200 heads of different ages (64x220) meters for every unit. Every unit was divided into many pens i.e (a1, a2, a3 … ect.) with total capacity of 85heads/pen. Also there were 16 sections for calf housing with 900 heads/unit. The total animal number of Kenana farm herd was about 900 heads, with (4–7) breeding bulls. Lactating cows were around 500 cows throughout the year. Artificial insemination (AI) system was used many years ago by using 100% Friesian semen. Cows were machine milked in two parlours with full capacity of 32 cows. Cattle feed was offered in the pens, consisting of: (Dolecus, lablab), Clitoria, Rhodes grass (Glories, gayana), Maize and Abu 70 (sorghum spp) and other grasses, concentrate feed was composed of groundnut cakes, wheat bran, and Maize forage, while molasses was fed adlib, cows were grouped into: three feeding groups according to the level of production (high, medium and low, yielders), dry cows and young stock. Calves were also kept in three separate units. Cows were milked twice a day and the total weekly milk yield for each cow was entered into a computer recording program.

In El Bashaier farm, cows were housed in open system, and partially grazed on Abu 70 (sorghum spp.) during the day. Concentrate was composed of sorghum, groundnut cakes, wheat bran and molasses, offered during milking. Dairy cows were supplemented with minerals and they were hand – milked twice a day and the daily milk yield was recorded for each cow.

Statistical analysis

The data extracted from the record sheets were transferred to a computer coding sheets prepared for statistical analysis in version 9 (SPSS). According to Harvey (1977). Means and standard deviations for: overall milk yield (kg), days in milk and mean calving interval (days) were computed. Mean separation utilizing Duncan's multiple range test (DMRT) was used to compare the different means. Milk performance was studied to determine any significant effect of factors affecting milk yield to compare the performance of different crosses together. And the mathematical model used was:

$$Yijklmnopq = \mu + Ai + Bj + HL + ABm + BHo + eijklmnopq$$

Where:

Yijklmnopq= Milk yield of nth cow of i^{th} age, and j^{th} blood level, on L^{th} herd, of m^{th} age x blood interaction, of o^{th} blood×herd interactions.

μ = Overall mean of lactation milk yield, days in milk and calving interval.

Ai = Effect of animal age.

Bj = Effect of blood level (j x 1, 2 … 7 groups).

HL = Effect of herd (1, 2).

ABm = Interaction of J^{th} age with j^{th} blood level (1 …7).

BHo = Interaction of j^{th} blood (1, 2…7) with herd (1, 2).

Eijklmnopq = (ijklmnopq) the random error term.

Regression was obtained on blood level groups for total lactation milk yield, days in milk, herd and age at lactation. Correlation of milk yield with blood level, age, herd, lactations and blood with, herd age and lactations were also computed.

RESULTS and DISCUSSION:

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Level of foreign blood and milk yield

A comparison of milk yield between the different levles of foreign blood groups was presented in Table 2 There were significant (P<0.01) differences between different foreign blood level groups(25, 37.5, 50, 62.5, 75, 87.5, and 100 %).Cows with 75% foreign blood produced the highest milk yield (4724.1 kg) followed by 87.5% (4362.3 kg) ,while there was no significant (P<0.01) difference between pure Friesian and 50% crosses in milk production (3507.5and 3508.4 kg); However, the lowest milk yield was obtained from 25% (2497.7 kg). The reason why 100% and 50% blood group cows produced the same volume of milk per lactation might be attributed to the very harsh environmental temperature that cows with this blood could not tolerate. Normally pure temperate zone cattle reared in the tropics show decreased production due to decreased feed intake, low energy metabolism and at the same time direct most of the energy intake to vaporization of sweat to keep the body cool. The highest milk production obtained from the 75% blood level might be due to acclimatization process gained during upgrading. While the lowest milk production obtained from 25%, foreign blood level cows might be due to the low performance cams from there high local blood level. This result was closely similar to that reported by Osman (1970) who found that total milk yield increased with the increasing percentage of foreign blood to a maximum at 75%; and also it was in agreement with Ageeb and Hillers (1991) who found that more the Kenana blood in the crossbreed the lower the yields. The current result for milk yield was also closely similar to that reported by El-Faki (1988) who revealed that cows with more than 50% foreign blood gave significantly higher daily milk yield as compared with those with less than 50% foreign blood. This however, was not in agreement with Kale et al. (1984) who concluded that there was no significant advantage in increasing the Holstein-Friesian inheritance more than 50%. Differences in milk yield between results obtained by different authors might be attributed to years and location effects. On the other hand, the mean milk yield of 37.5, 50, 75 and 100% foreign blood (3181.2+211.2, 2400.4+108.8, 4109.8+271.6 and 3548.4+506.7 respectively) was not in agreement with that obtained by Ibrahim (1983) who reported that milk yield of 37.5, 50 and 75% was 2324, 2347 and 2457 kg respectively, these differences may be due to age and locations. The low production in milk yield from the 62.5% foreign blood level was not expected. This was in contrast with most studies. Mc Dowell (1985) reported that crossbred with 62.5% European inheritance had performed well. Also Chacko and George (1984) reported same results for 62.5% Friesian X Sahiwal. Ali, et al. (1988) found that the average milk yield was better at 62.5% (5733 lb) and lower at 50% (4136 lb) in Sudan for crossbred dairy cattle.

This study indicated that, the Interaction between: (lactation xHerd), (Herd x lactation x blood level) and (lactation x blood level) had a significant effect on milk yield (Appendix II).

Lactation period (days in milk)

Dairy cows need to express good production characteristics by producing more milk and prolonging their productive period. Table 3 shows that blood level had significant (P<0.01) effect on days in milk. Pure Friesian cows were milked for longer period (377 days) followed by 25% (354 days), then 75%, while there was no significant difference between 50%, 62.5 and 87.5%. Shorter days in milk was obtained at 37.5% foreign blood level (291 days); there was a moderate correlation (r=0.57) between milk yield and days in milk (Table 1).

The difference between days in milk and calving intervals obtained between different blood levels may be due to management variation (i.e.) reproductive disorders, health control and environmental stress. This result was different from the Findings of Ali et al. (1988), Kale et al. (1984) Ibrahim (1983) and Khalifa (1964). The lowest milk production from 25% blood level was attributed to the low performance due to the high percent of the local blood, though they were adapted to the environmental stresses; this may be explained by longer productive period (354 days). Pure Friesian cows and those with 87.5 % blood level, lost their high genetic potentials by the interaction with the environment, although they produced for longer periods (377, 339.9 days respectively). The current result was similar to the findings of Ali, et al. (1988) who reported 306 days for 50% crossbred in Sudan, and also similar to that obtained by Madalena et al. (1990) for 50, and 75% foreign blood level. But their finding for 62.5% (191) was less than in this study. On the other hand Fadlelmoula (1989) revealed different result, indicating that lactation length was similar in cows with 37.5 and 50% foreign blood levels.

Table (4) shows the results concerning the data of the two farms, Kenana and El Bashaier. There was a significant ($P \leq 0.01$) difference between the two farms in means of milk yield (3147.8, 3805.4), days in milk (296.9, 346.6), and calving interval (429.1, 407.8) respectively. Overall mean of total milk yield (kg), calving interval (day), and days in milk were: (3603.4$\pm$127.3, 420.4$\pm$8 and 317.3$\pm$8) for Kenana and El Bashaier respectively. The herd had also significant ($P \leq 0.05$) effect on days in milk (296.9$\pm$9, and 346.6$\pm$14.5) for Kenana and Elbashaier respectively.

It was obvious from Table (1), that there was a positive significant ($P \leq 0.01$) correlation between: milk yield x days in milk (r=0.10), and milk yield x Herd, (r=0.15); but no significant correlation between milk yield x calving interval (r=0.03). Correlation between milk yield x Age of the animal (r=0.10). Blood level had a positive significant ($P \leq 0.05$) correlation for milk yield (r=0.08), and significant ($P \leq 0.01$) correlation for herd (r=0.20) and days in milk (r=0.01); But negative significant ($P \leq 0.01$) correlation (r=-0.20) with lactation (year). Regression of blood level, age at lactation (year), herd and lactations on milk production (kg) were presented on (Appendix III). According to (t) value milk yield was dependant upon herd (1.87) followed by lactation (1.52) and then blood level (0.82).

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Table 1 - Correlation between age at lactation groups, blood level, calving interval, days in milk, herd, lactation, and milk yield

	Age at lactation (year)	Blood %	Calving interval (days)	Days in milk	Herd	Lactations	Milk yield (kg/Lactation)
Age at lactation	1.0	- 0.007	-0.139	- 0.005	-0. 56**	0.088**	0.122
N	218	218	128	155	217	218	155
Blood %		1.0	- 0.034	0.0134**	0.241**	- 0.16**	0.084*
N		706	544	621	705	706	619
Calving inter (days)			1.0	0.041	- 0.060	- 0.035	0.034
N			544	467	544	544	465
Days in milk				1.0	0.025*	- 0.059	0.567**
N				621	620	621	619
Herd					1.0	- 0.060	0.146**
N					705	705	618
Lactations (kg)						1.0	0.101*
N						706	619
Milk yield (kg/Lac)							1.0
N							619

*Correlation is significant at the (0.05) level, **Correlation is significant at the (0.01) level, N = Number of observations.

Table 2 - Milk yield (kg/lactations) of different blood level groups

Blood %	Mean milk yield (kg)	SE ±	N
25	2497.667^{f}	893.60	4
37.5	3302.122^{d}	259.035	74
50	3508.413^{c}	114.919	334
62.5	2656.994^{e}	293.771	93
75	4724.069^{a}	321.338	92
87.5	4362.250^{b}	947.848	10
100	3507.500^{c}	557.282	11

Means with different letters differ significantly ($P \leq 0.01$). N=Number of lactations.

Table 3 - Days in milk of different blood level groups

Blood %	Mean days in milk	SE +
25	354.00^{b}	56.70
37.5	291.04^{e}	16.43
50	307.25^{d}	7.29
62.5	298.62^{d}	18.63
75	339.89^{c}	20.38
87.5	302.50^{de}	60.12
100	377.00^{a}	35.35

Means with different letters differ significantly ($P \leq 0.01$).

Calving interval

Breeding efficiency of the dairy cows is dependent upon the good management in reproductive program, by reducing calving interval, and other reproductive problems. Results of calving intervals (days) are illustrated in Table 5 from this Table it could be seen that, there was a significant ($P<0.01$) difference between blood level groups. Highest interval was found in cows with 25 % foreign blood (466 days) followed by 37.5% (454 days) and then 75% (445 days). While shorter calving interval was obtained at 62.5 % (382.9 days). There was a positive correlation ($r=0.03$) between milk yield and calving interval (Table 3.1). Calving interval had no significant effect on milk yield (Appendix I). Overall mean calving interval in this study was 420.4+84 days which had no significant effect on milk yield. This result was closely similar to that obtained by Mohammed (1995) who reported 411 days for calving intervals for (Friesian x local Zebu breeds) in Sudan. However longer interval (than 420.4 days) was obtained by Magzoub (1993) who found overall calving interval of the first four calvings was 450 days in Sudanese crossbred cows. The longer interval at 25 % foreign blood level may be due to the high local blood level.Reducing calving interval is needed to increase the productive life of the cow, since the local dairy cattle are characterized by longer calving interval as it was reported by Saeed et al. (1987) with average calving interval of 485+5 days for Kenana type at Um Banien animal production research Farm. On studying the Sudanese dairy cattle, Osman (1971) reported 441+8 days which was higher than the overall mean calving interval in the present study (420.4+8) (Table 5).This indicated that there was a reduction in calving interval (day) by upgrading the local dairy breeds and it had a significant effect on milk yield. Calving interval tended to decrease by increasing the foreign blood up to 75% and it

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was negatively correlated with, blood level (r=-0.034) and negatively with herd (r=-0.06) (Table 1). This means that there was no direct relation between the two herds.

Table 4 - Means of milk yield, days in milk, and calving interval in Kenana and EL Bashaier dairy farms

Factor	Milk yield (kg/lactation)		Days in milk		Calving interval	
	Mean	SE ±	Mean	SE ±	Mean	SE ±
Overall	3603.40	127.30	317.30	8.08	420.40	8.40
Herd						
Kenana	3147.76 a	136.70	296.90 a	9.20	429.10a	9.60
El Bashaier	3805.38 b	201.42	346.60 b	14.50	407.80b	15.10

Means with different letters differ significantly (P≤ 0.01).

Table 5 - Calving intervals (days) of different blood level groups

Blood %	N	Means of calving Interval	SE ±
25	4	466.00[a]	58.74
37.5	74	454.10[b]	17.03
50	334	395.69[f]	7.55
62.5	93	382.94[g]	19.31
75	92	445.68[c]	21.12
87.5	10	401.00[e]	62.30
100	11	416.83[d]	36.63

Means with different letters differ significantly (P≤ 0.01). N=Number of observations.

CONCLUSION

The effect of foreign blood level, herd, lactations, and there interaction had significant (P<0.05) effect on milk production. The compartmental performance at the crossbred cows with different blood level showed that the overall mean: lactation milk yield (kg), days in milk and calving interval were 3603.4 kg, 317.3 days, and 420.4 days respectively. While the mean lactation milk yield for different blood levels 25, 37.5, 50, 62.5, 75, 86.5 and 100% were 2497.7, 3302.1, 3508.4, 2656.9, 4727.1, 4362.3 and 3507.5 kg respectively. Highest milk was reached at the 7th lactation. Mean days in milk for different blood levels 25, 37.5, 50, 62.5, 75, 86.5 and 100% were: 354.0, 291.0, 307.0, 298.6, 339.9, 302.5, and 377.0 days respectively. Mean calving interval (day) for different blood levels 25, 37.5, 50, 62.5, 75, 86.5 and 100% were: 466.0, 454.0, 395.7, 382.9, 445.8, 401.0 and, 416.0 respectively.

RECOMMENDATION

1) From this study, it has been established that dairy cattle managers at Kenana and El Bashaier dairy farms, should be advised to keep crossbred dairy cows of the intermediate exotic blood (62.5–75%, Friesian inheritance) for higher production.

2) From this study it could finally recommended that management improvement is a target and a decisive factor for any production system in dairy cattle.

3) More work in evaluation crosses with the intermediate blood level with large number of records and for longer period was so needed at the two farms.

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GROWTH AND DEVELOPMENT OF MUSCLES, BONES AND FAT OF DOMESTIC FOWL (*GALLUS GALLUS*)

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ABSTRACT: *This study was conducted to evaluate the growth pattern of muscles, bones and fat of domestic fowl. Eighteen day old chicks were reared for 22 weeks and serial slaughters were done every four weeks for evaluation. Results showed that the feed conversion ratio was 1:4, highest feed intake at 22 weeks of age and highest weight gain at 15 weeks. Carcass yield was 60%. The great mass of muscle was found in the thorax and hind limb, highest bone percentage was found in the pelvis and wing and the flank had high percentage of muscle and connective tissues and all regions had the same percentage of fat. Thorax and hind limb had high growth rate when compared with pelvis, wing, neck and flank.*

Keywords: *Carcass yield, body regions, serial slaughter*

ORIGINAL ARTICLE

INTRODUCTION

Growth is often measured as live weight gain per unit time, (Berg and Butterfield, 1976). Live weight could be a useful measure of growth as it is highly predictive of the amount of desirable edible products such as muscles. Carcass weight is more useful than live weight and the components of the carcass when measured, give a true picture of the benefit from the animal. Carcass composition is measured by the proportion of components, muscles, bones, fat and connective tissues.

Factors that affect carcass composition are slaughter weight; breed or genetic differences, sex and plane of nutrition, Nheta et al. (1997) said that sex has no effect on the growth rate of birds. The carcass is the most important unit in meat studies, since it finally settles the value of the meat animal, both for the farmer and the butcher, (Callow, 1948). The muscle is the most important tissue in the animal; because it is most desired by the consumers and superior carcasses have a maximum yield of muscle, minimum of bone and an optimum amount of fat (Berg and Butterfield, 1976). Hammond (1932) stated that during their lives animals have two sets of muscles; early developing and late developing ones. So there must be causes for the changes in the proportion of individual muscles as animals grow. The growth of muscles can be measured by comparison of weights of the individual muscles on serial animal slaughters, and dissected throughout the lifespan of homogenous animals (weight, breed and sex) raised on a similar plane of nutrition. This method compares the percentage values of weight of individual muscles or muscle groups relative to total muscle weight at various stages of development (Berg and Butterfield, 1976). The growth patterns of the tissues show that the bones growing at a steady, but slow rate, the muscle grow relatively fast, so that the ratio of muscle to bone increases. In poultry the first ossification takes place 12–24 hours later in the form of laminae of bone which eventually fuse to form a thin, compact cylinder which is the periosteal bone collar (Hall, 1987). Long bone growth is a complex process which takes place in the growth plates located at the end of these bones; it consists of cartilage cells which form a template over which bone is laid. Fat is the most variable tissue in the carcass and it varies even in its partitioning among various depots and alters markedly throughout growth; therefore it has the greatest influence on both the amount of each of the other tissues in the carcass at any particular weight and the proportionate size of cuts. Fat comprises a relatively small amount of the carcass at birth and then increases so that it approaches and occasionally in very fat animals surpasses muscle tissues in absolute amount, (Berg and Butterfield, 1976).

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The domestic fowl appears to have been known to man from the very early times. It has been generally supposed that the domestic fowl owes its origin to the great jungle of India, (Richardson, 1956). The domestic fowl appears to have been known to man from the very early times. It has been generally supposed that the domestic fowl owes its origin to the great jungle of India, (Richardson, 1956). Noy and Sklan (1997) studied the post-hatch development in poultry and concluded that the earlier access to feed the better the growth through marketing and the body weight. Iheukwumere et al. (2007) evaluated the growth of control broilers fed cassava leaf meal and found that daily feed intake was 0.143 kg, body weight gain 0.040 kg and the feed conversion ratio was 3.53. Jayalakshmi et al. (2006) studied the production performance of broilers fed sunflower acid oil and found that the weight gains during the first, second, third, fourth, fifth and sixth week of breeding were 0.095, 0.285, 0.610, 0.112, 0.146, and 0.186 kg and the feed conversion ratios during these weeks were 1.14, 1.35, 1.49, 1.56, 1.87 and 2.03. Daria and Bochno (2007) compared the slaughter quality of layer-type cockerels and broilers and found that the day-old cockerel chicks were lighter than broilers by 7 g. they concluded that layer-type cockerels as compared to broilers are characterized by lower body weight, lower carcass weight, lower dressing percentage, lower breast muscles and high bone contents. Lubritz (1997) studied the effect of sex on the growth, and found that males yielded a higher ratio of white meat to live weight than females. Calistar and Aydin (2006) studied the effect of animal bone fat on body performance and carcass characteristics in broilers. They found that animal bone and fat were significantly influenced by the live weight gain, feed efficiency, cold carcass weight and abdominal fat level. Iheukwumere et al. (2007) evaluated the carcass yield of broilers under different levels of cassava feeding and found that when the live weight was 1.43 kg under zero level of cassava feeding the dressing percentage was 79% and thigh and shank, neck, wings, back and breast muscle weights were 0.118, 0.032, 0.075, 0.108 and 0.154 kg respectively. Esen et al. (2006) examined the growth and carcass characteristics of Rock Partridges (*A. graeca*) and found that when the average value of the bird weight was 0.481 kg, the dressing percentage was 72.11%, wing weight was 0.033 kg and the leg weight was 0.146 kg. Fasuyi (2007) examined a protein supplement in broiler finisher diets and found that when the live weight was 1.250 kg, the dressed weight percentage was 82% thigh, drumstick, shank, back, wing and neck weights were 0.047, 0.102, 0.030, 0.081, 0.039 and 0.063 kg respectively. Akinfala et al. (2007) found the slaughter weight of cockerels to be 1161.15 gram; the dressed weight was 574.50 gram with percentage 49.48%. They found that at this slaughter weight the weights of the neck and shank were 14.42 and 26.84 gram.

Comparing the slaughter quality of layer-type cockerels versus broilers, Daria and Bochno (2007) found that at six weeks of age, the body weights and carcass weights were 0.665 kg versus 2.577 kg and 0.412 kg versus 1.897 kg respectively. Ugwu and Onyimonyi (2008) found the final body weight at 45 weeks of age was 1.723 kg and the carcass weight was 1.163 of spent layer fowl and the thigh, breast, head and neck weights were 0.326, 0.253 and 0.100 kg, respectively.

Koster and Webb (2000) compared the carcass characteristics of South African native chicken lines that include Koekoek, Newhampshire, Naked-neck, Lebowa-Venda, Ovambo and Cobb and found that the highest dressing percentage was in Ovambo line, the percentage of muscle, fat and bone ranges between 55-51%, 6.5-1.2% and 36.2-24.1% respectively for all lines.

MATERIALS AND METHODS

A total of 72 Hisex day-old chicks were brought to the Extension and Rural Development Centre, Faculty of Animal Production–Elmanagil, University of Gezira. The birds were lodged in a pen of dimensions 1.5×2.0×2.0 m. divided equally to three compartments. The birds were divided to three groups each of 14 birds to ease management. The pen sides were guarded by a mesh-wire of fine openings set over a half-meter brick wall up to the roof which was made of corrugated zinc sheets. The ground was concrete with sand bedding. The pen was equipped with chick and then poultry feeders and waterers. The birds were phase-fed. For two weeks as an adaptation period with starter broiler ration (CP 20%, ME 11.65 M j/kg); phase after the grower ration (CP 17.11%, ME 8.58M j/ kg), was fed for 16 weeks of age. A finisher ration (CP 16%, ME 6.01 m j/kg) was fed for four weeks till the experimental feeding was concluded. Feed offer frequency and intake records followed that of the first experiment. Weekly body weights were recorded to the nearest 0.5 g at 7:00 is before feeding, using a small pressure balance. One bird from each of the three groups was selected for slaughter every four weeks for further carcass analysis and muscle groups study. The bird was controlled by tying its legs. The slaughter procedure followed the Muslim practice using a sharp knife to cut the right and left jugular veins and carotid arteries. The blood was collected and weighed after the bleeding was complete. After immersion in tapid water, the feathers were plucked and the skin was removed. The head was removed at its articulation. The abdomen was eviscerated and thorax was opened, (Griffiths and Purcell, 2008). Carcass data was taken. The hot carcass was divided into right and left halves and the left side was divided into six regions (hind limb, pelvis, flank, thorax, neck and wing) and their muscles were separated.

RESULTS AND DISCUSSION

Average performance values of domestic fowl raised to 22 weeks of age are shown in Table (1). Final weight was 1.33±0.11 kg and the feed conversion ratio was approximately 1: 4.

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Table 1 - Average performance values of domestic fowl raised to 22 weeks of age	
Item	**Value**
Initial weight (kg)	0.310±0.002
Final weight (kg)	1.327±0.108
Daily weight gain (kg)	0.009±0.005
Daily feed intake (kg)	0.040±0.008
Feed conversion ratio	1: 4.40

It is clearly illustrate in Figure 1 that average values of feed intake and weight gain (kg) of the domestic fowl raised to 22 weeks of age. The highest feed intake was at week 22 (0.34 kg). The highest gain in weight (0.11 kg) was during the 15th week of age and the lowest gain was during the first two weeks of age. Feed intake of the domestic fowl was high during 22 weeks of age (0.343 kg). The lower feed intake occurred during the first week of age which was 0.11 kg. Iheukwumere et al. (2007) evaluated the growth of broilers fed cassava leaf meal and found the feed intake to be 0.143 kg. Noy and Sklan (1997) concluded that the earlier access to feed the better the growth rate. In this study the weight gain of the domestic fowl was high during the 15th week of age (0.112 kg). Iheukwumere et al. (2007) evaluated the growth of broilers fed cassava leaf meal and found that the body weight gain was 0.040 kg, but Jayalakshmi et al. (2006) studied the production performance of broilers fed with sunflower acid oil and found that the weight gain in second, third, fourth, fifth and sixth week of breeding were 0.095, 0.285, 0.610, 0.112, 0.146 and 0.186 kg. In our study the weight gain during the sixth week of age was 0.071 kg. Differences here may be attributed to difference in breeds. Feed conversion ratio was found to be averaged 4.4 during 22 weeks of age. This result was near to that obtained by Iheukwumere et al. (2007) which was 3.53.

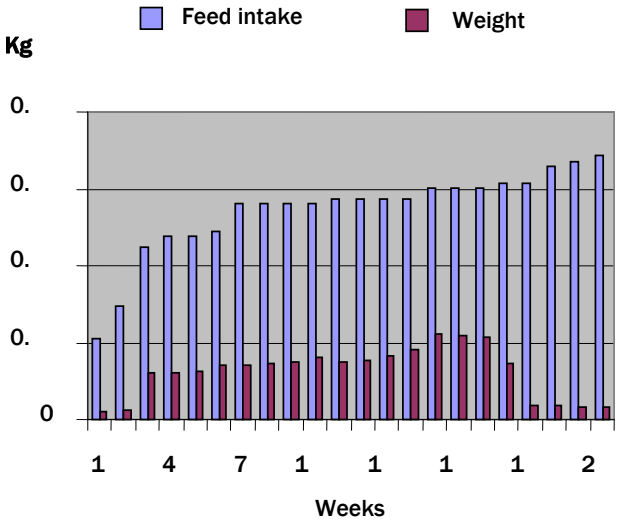

Figure 1 - Average values of feed intake and weight gain (kg) of the domestic fowl raised to 22 weeks of age

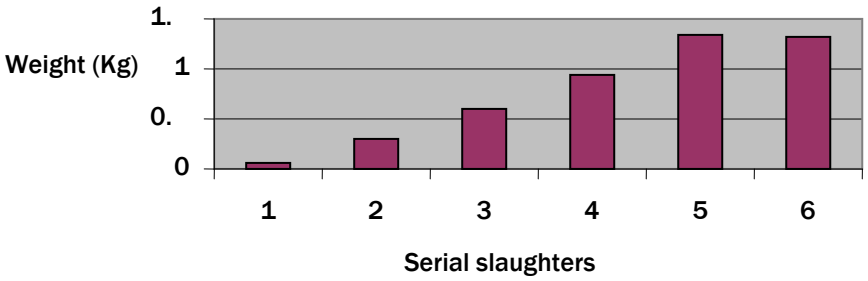

Figure 2 - The slaughter weights (kg) of the six serial slaughters of the domestic fowl

Figure 3 shows the hot carcass weight (kg) of the six serial slaughters of the domestic fowl. The hot carcass weights of the six serial slaughters were 0.017±0.005, 0.140±0.004, 0.281±0.006, 0.488±0.044, 0.624±0.076 and 0.793±0.120 kg. The weight of the carcass of the domestic fowl was 0.793 kg when the live weight was 1.377 kg and the dressing percentage was 60% at 22nd week of age. Iheukwumere et al. (2007) studied the growth and carcass yield of broilers and found that when the live weight was 1.430 kg, the dressing percentage was 79%. Such

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differences are due to breed and management practices specially feeding, beside the environmental conditions prevailing when running the experiment. They found that weight of the shank and thigh that comprise the hind limb was 0.118 kg, the neck 0.032 kg, wings 0.075 Kg, thorax 0.154 kg and the back 0.108 kg. In this study the weights of the hind limb, neck, wings, thorax and pelvis (back) were 0.131, 0.047, 0.084, 0.141 and 0.030 kg respectively. Fasuyi (2007) who examined a protein supplement in broiler finisher diets found that when the live weight was 1.250 kg, the dressing percentage was 82% the weights of thigh, drumstick, shank (hind limb), back, wing and neck were 0.047, 0.102, 0.030, 0.081, 0.039 and 0.063 kg. The difference in weights of the above mentioned regions occurred due to the variations in body weights and breeds used in this study.

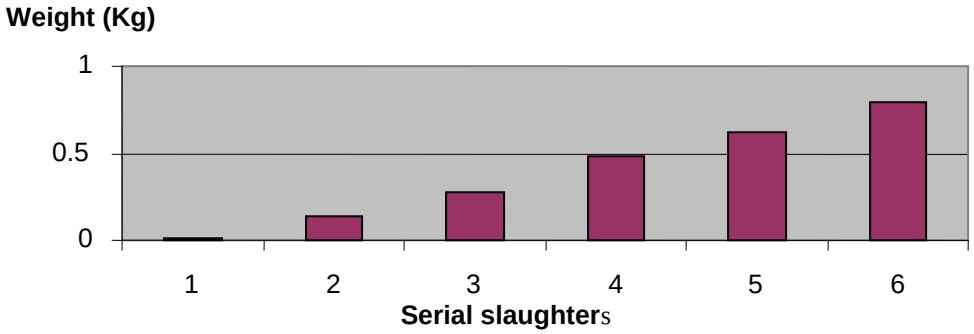

Figure 3 - The hot carcass weight (kg) of the six serial slaughters of the domestic fowl

Table 2 - Average body regions absolute weights (kg) and their percentages from the left side weight and body region tissues percent of the left side region weight at terminal slaughter

Region	Weight	Percentage	Muscle %	Bone %	Connective tissues %	Fat %
Pelvis	0.030±0.005	8	49	41	7	3
Thorax	0.141±0.002	36	79	17	2	2
Flank	0.005±0.001	1	56	0	44	0
Hind limb	0.131±0.020	33	78	19	1	2
Wing	0.042±0.004	10	56	39	4	2
Neck	0.047±0.002	12	47	47	4	2

Average values (kg) of different body region weights of domestic fowls raised to 22 weeks of age are shown in Figure 4.12. The highest regional growth rate occurred in the thorax and hind limb. All other regions are much lower in value

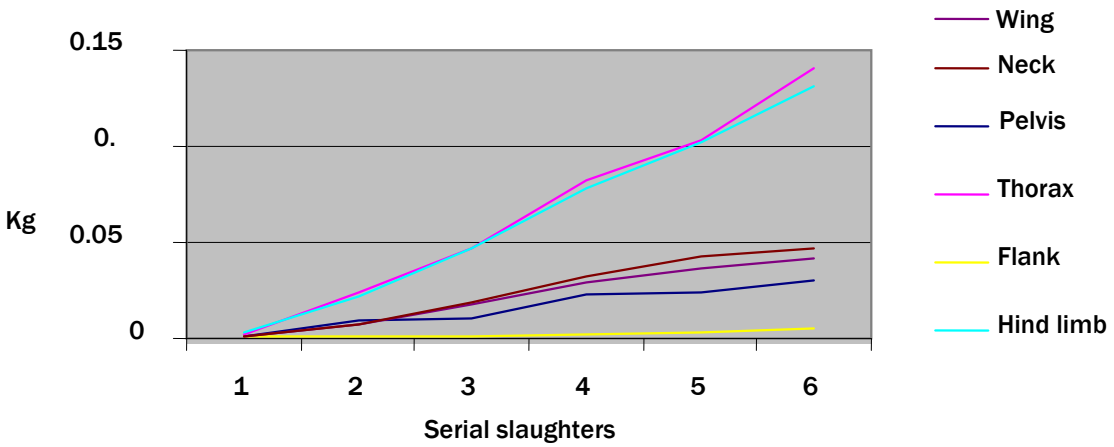

Figure 4 - Average values (kg) of different body region weights of domestic fowls raised to 22 weeks of age

Table 2 shows average body regions absolute weights (kg) and their percentages from the left side weight and body region tissues percent of the left side region weight at terminal slaughter. The thorax comprised the highest percentage from the left side of the carcass (36%) and next to is the hind limb (33%). The flank had the lower percentage (1%). The thorax and hind limb had the greater mass of muscle (79 and 78% respectively). The highest bone percentage obtained was from the pelvis and the wing (41 and 39% respectively). The flank had no

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bones or fat but high percentage of muscle and connective tissues (56 and 44% respectively). All regions had the same percentage of fat (2%) or no fat except for the pelvis (3%).

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POULTRY WASTE MANAGEMENT IN BOTSWANA: A REVIEW

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REVIEW ARTICLE

ABSTRACT: *A literature review was conducted to identify methods that are used to dispose of poultry waste in Botswana. It appears that the predominant methods of poultry waste disposal in Botswana are direct disposal at the landfills, application as a fertilizer in gardens or farms, burning and compositing. The use of poultry manure and/or litter to raise fertility status of the soil appears to be appropriate given that soils in Botswana are generally poor in plant nutrients, especially phosphorus. Given the high feed costs in Botswana it is suggested that the use of poultry manure and/or litter as livestock feed should be considered in areas where foot and mouth disease (FMD) is endemic such as Chobe and North West Districts, as meat from these districts does not enter the European Union market.*

Keywords: *Beef, calcium, litter, manure, phosphorus, pollution, potassium*

INTRODUCTION

Worldwide, the poultry industry is growing rapidly and contributes towards addressing key national development goals, as well as, in improving the standard of living of people through poverty alleviation and creating employment opportunities (Agblevor et al., 2010). Roeper et al. (2005) contended that the problem coming along with the poultry production is the manure that needs to be taken care of, as a non-appropriate treatment or disposal can become risky for environment and humans. For instance, manure can support the spread of diseases and may pollute soil and groundwater resources if not properly handled.

Waste is defined as anything that is no longer useful and needs to be disposed of. Furthermore, waste may be defined by the type and place in which it is produced, such as agricultural, household, industrial and mining (Ministry of Local Government, Lands and Housing, 1998).

The poultry industry produces large amounts of waste that include solid waste and wastewater. The solid waste consists of bedding material, excreta (manure), feed, feathers, hatchery waste (empty shells, infertile eggs, dead embryos and late hatchlings), shells, sludge, abattoir waste (offals, blood, feathers and condemned carcasses) and mortality. The wastewater results from washing and disinfection of chicken houses and abattoirs. Dong and Tollner (2003) stated that poultry densities on farms continue to increase and have caused manure related problems which are water, air and land pollution.

Livestock manure can be either a valuable resource or an environmental pollutant. Generally, manure refers to faeces and urine produced by animals, and it contains organic matter and nutrients, that has fertilizer value when applied on the land and used by crops. The proper handling and management of manure can augment or replace purchased commercial fertilizers (Tao and Mancl, 2008). On the other hand, poultry litter is a mixture of poultry droppings and bedding materials, such as wood shavings and rice or peanut hulls. In Botswana, ashes, which result from using coal for brooding, are also produced in large quantities on farms, especially in medium and large-scale broiler operations as waste, and these need to be disposed of.

In general, broiler or turkey litters have higher dry matter content (60%) than layer manure (35%), although all manure types had similar concentrations of nutrients (*e.g.*, sodium, potassium, phosphorus, magnesium and sulphur) on a dry weight basis. Typically, sodium: phosphorus: potassium ratio is 6:2:2 for layer manures and 6:2:3 for broiler or turkey litters. The readily plant available nitrogen content of the poultry manures is approximately 30 – 50% of the total nitrogen (Nicholson et al., 1996).

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Poultry wastes pose serious environmental pollution problems through offensive odours and promotion of fly and rodent breeding (Adeoye et al., 1994). Several poultry waste management methods can be employed to reduce the negative impact of poultry waste on the environment. Given the large volume of poultry waste that is produced on farms and that needs disposal, a review was undertaken to identify methods of disposing poultry waste in Botswana.

Poultry liiter and manure production

Tao and Mancl (2008) estimated daily manure production by a broiler and laying hen to be 0.09 kg and 0.18 kg, respectively. Factors that influence manure production include type of chicken, age and breed, stocking density, feed conversion, kind and amount of feed type and amount of litter, moisture content of litter, type of floor, and even climatic conditions during accumulation (Perkins et al. 1964). On the other hand, factors affecting composition of litter/manure are type of birds, feed nutrient density, bedding material and amount, time in use and other management factors (Ritz and Merka, 2009).

The properties of manure depend on several factors including animal species; feed ration digestibility; protein and fibre content; animal age and productivity; manure management and handling; and the environment (Tao and Mancl, 2008). According to Faridullah et al. (2009), ashing poultry manure can improve its nutrient content depending on the temperature of ashing and source of the poultry waste. Chicken litter ash contains more phosphorus and potassium than duck litter ash but the latter contains more calcium and magnesium.

POULTRY WASTE DISPOSAL METHODS

The disposal of poultry carcasses presents significant environmental, biological, and financial problems for the poultry industry (Cai et al., 1994). Worldwide, there are several ways of disposing of poultry waste including burial, rendering, incineration, compositing, feed for livestock, fertilizer or source of energy. Each disposal option has advantages and disadvantages.

Malone (2004) estimated that in the United States (US), 40% of meat-type mortalities are composted, ~20% incinerated, ~20% rendered and ~20% buried. For layers, rendering and incineration are predominant and composting is the least used disposal option. In Botswana, spent hens are sold alive or are slaughtered for meat that is regarded as a delicacy. Malone (2005) and Council for Agricultural Science and Technology (CAST) (2008) identified mass disposal methods to include burial, landfills, incineration, composting, and rendering. The most predominant waste disposal methods in Botswana appear to be burial in the landfills, burning, incineration and use as a fertiliser in gardens and arable lands. A brief description of each disposal method is given in the sections below.

Application to arable lands

Poultry manure has long been recognized as perhaps the most desirable of all animal manures (fertilizers) because of its high nitrogen content (Sloan et al., 2003). As a result, direct land application of poultry litter from broiler operations is the most widely used and cost effective disposal method. Olexa and Goldfarb (2008) argued that if waste must be transported to a disposal site, it must be placed in sealed containers to prevent spillage. Globally, an excess of 90% poultry waste is spread on land close to the poultry farms (Moore et al., 1995). For some poultry producing regions, the spreading of poultry waste has become less cost effective mainly because of restrictions on land availability. Excess nitrogen and phosphorus have been noted in soils applied with poultry manure because of lack of soil analyses to determine the mineral content of the soil. Coote and Zwerman (1975) pointed out that the risk of nutrients, organic material, and pathogens contaminating water bodies and public water supplies will greatly increase if manure is spread adjacent to streams, waterways, and lakes.

Generally, soils in Botswana are poor in phosphorus; hence application of poultry manure or litter in the farm lands appears to be the most ideal method of disposal. A recent study of Dikinya and Mufwanzala (2010) in Botswana revealed that chicken manure is a potential source of nutrients and chemical conditioner. The investigators reported increased electrical conductivity together with exchangeable bases with increased application rates of chicken manure in all soil types, indicating positive effects on soils.

Manure can be applied directly to the soil or it can be pelleted before application. Pelleting manure converts a wet heterogeneous material which is difficult to apply on the land uniformly into a uniformed matter which is easy to handle and transport to areas where there are infertile soils to reduce the excess of nutrients in soils and water in poultry producing regions (Hamilton and Sims, 1995). Also, pelleting can allow for low quality manure to be fortified with inorganic fertilisers. Previous study of Roeper et al. (2005) reported that pelleting results in approximately 75% of the total nitrogen remaining in the pellets.

Poultry waste in livestock feeding

Poultry litter has been used in diets for poultry, swine, lambs, ewes, lactating cows, wintering cattle and brood cows. Poultry litter and/or manure are used as livestock feed in most countries (Smith and Wheeler, 1979) including Israel and some states in the US. Poultry waste used for animal feeding is obtained primarily from laying hens (caged and not caged) as well as broiler operations. Poultry litter is also used to feed livestock. Cage layer

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waste can be used by ruminants as a source of supplemental protein. Chaudhry et al. (1997) stated that amino acid nitrogen of cage layer waste ranges from 37 to 40% of total nitrogen and that about 40 to 60% of total nitrogen in poultry excreta is present in the form of non-protein nitrogen (NPN). Uric acid, the major NPN source in poultry is degraded to ammonia by rumen microbes.

According to National Research Council (NRC) (1984), the maximum inclusion rate for poultry waste in ruminant feeds is 20%. Crickenberger and Goode (1996) suggested that adding broiler litter to beef cattle rations at a level of 20% or higher (as fed basis) generally meets the animal's needs for crude protein, calcium and phosphorus. The investigators reported beneficial effects of feeding corn silage to which poultry litter has been added at a level of 30%. Furthermore, Muller (1980) observed that poultry waste fed at levels above 35% usually covers almost the total protein requirement of sheep, and contributes substantially to the energy of the total ration. The investigator noted that the only problem encountered in feeding processed poultry waste to sheep is the toxicity derived from the high copper level in poultry diets. Additionally, Chaudhry et al. (1997) argued that the danger of feeding poultry waste to livestock includes health hazards like pathogens and residues of pesticides. As a result, the investigators suggested that ensiling poultry waste, i.e. slaughterhouse wastes with molasses and lactobacilli improves NPN and reduces pathogens.

Dried poultry waste contains 28% protein and 30% ash and is also an excellent source of calcium, phosphorus, potassium, iron and zinc (NRC, 1984) which are useful in supplementation of sheep in winter. Jordon et al. (2002) measured body conditions of sheep fed dried poultry waste, soybean or urea as winter supplements and concluded that feeding a supplement containing dried poultry waste resulted in performance similar to that of conventional supplements containing soya bean meal. In Nigeria, Owen et al. (2008) investigated the nutrient quality of heat treated poultry litter and obtained dry matter (DM), crude protein, energy, crude fibre, ether extract and ash values of 87%, 20%, 621.41 kcal/kg, 10.40%, 2.2% and 18.50%, respectively. In addition, phosphorus, calcium, sodium, potassium and magnesium values in the litter were 4.50%, 2.00%, 0.10%, 2.05 and 0.48%, respectively. The investigators concluded that poultry litter could be incorporated into animal feeds.

In Botswana, the use of poultry waste as cattle feed is prohibited according to Statutory Instrument No. 126 (2004). This is because beef that is processed in the local export abattoirs is exported mainly to the EU, which prohibits the use of poultry waste as a feed ingredient for fear of transmission of Bovine Spongiform Encephalopathy (BSE). This is consistent with Olexa and Goldfarb (2008) from the University of Florida in the US who reported that animal feed that reuses poultry waste as an ingredient may not be fed to ruminant animals due to disease concerns. In addition, Statutory Instrument No. 126 (2004) prohibits application of fertilizers containing ruminant protein on pastures accessed by livestock (cattle, camels, equines, pigs, sheep and goats) and also to dispose of any substance including poultry waste in places where livestock has access to grazing. Although Makobo and Mosimanyana (1985) reported that Botswana does not use chicken litter for livestock feeding but occasionally as a fertilizer, poultry litter or manure has been used by some farmers as a feed resource prior to 2004, especially during the drought periods. In addition, mortality from some large-scale broiler operations is used as feed for the crocodile industry.

Burial

Besides burning and rendering, the carcasses of dead domestic animals may be disposed of by burial. The carcasses may not be disposed of by dumping on any public road or right-of-way left where they may be consumed by animals (Olexa and Goldfarb, 2008). According to Malone (2005), on-farm burial has been the predominant disposal option for many catastrophic mortality events such as avian influenza outbreaks. Anon (2005) mentioned that for mass disposal of certain production animals (poultry, swine, and calves) burial pits may be used if they are designed, constructed, maintained, and used in a manner to prevent the spread of diseases.

Burial is one of the simplest and most cost-effective methods employed to deal with many types of mass mortality losses. However, burial of dead birds in a pit can lead to ground water contamination (Cai et al., 1994) and public perception concerns if not properly managed. Payne mentioned that when proper guidelines are followed, burial is a safe option but that poor site selection, such as sandy soils or areas with high water tables, may pose a threat to groundwater.

Previous work (Payne) indicated that burial of mortality requires the construction of a pit, which must be located at least 91.44 m away from any wells, waters of the state, neighboring residences, public areas or property lines. The bottom of the burial pit must be at least 30.48 cm above any floodplain level and at least 60.96 cm above the seasonal-high water table. On the other hand, Anon (2005) indicated that mortality to be buried must be located more than 30.48 m away from any existing or proposed wells, water supply lines, or seasonable high water table of any water source, and 4.57 m horizontal away from the edge of any embankment. Additionally, burial sites must not be in areas with gullies, ravines, dry streambeds, natural or man-made drainage ways or sinkholes. Payne stated that if there is bedrock in the area, the bottom of the pit must be at least 60.96 cm above the bedrock. In addition, carcasses must be covered with a minimum of 76.2 cm of top soil after placement in the pit. Anon (2005) stated that mortality must be buried at least 0.91 m below ground level but no more than 2.44 m deep. Animals may be buried in mass burial pits or in approved landfills. The soil for a burial site must be of moderate or slow permeability and must be at least one 30.48 cm above the seasonal high groundwater elevation.

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Burning

This is one of the common methods of disposing of mortalities in Botswana, especially among small-scale farmers. In this disposal method, mortalities are fully burned at relatively high temperatures using fuels such as wood, tyres or diesel. However, this waste disposal method may lead to atmospheric pollution in the event of catastrophic mortalities resulting from outbreaks of highly infectious diseases such as Newcastle disease and avian influenza. Anon (2005) argued that burning is not a preferred method of disposal because of the resulting air pollutants.

According to Anon (2005), mass cremation of mortality should be performed in a flat area that is easily accessible to heavy vehicles for transporting the carcasses and away from public view. The site must be located away from buildings, public roads, and overhead electric and telephone lines, underground utility wires, and shallow underground pipes or gas lines.

Incineration

Incineration is recognized as one of the biologically safest methods of disposal, eliminating the threat of disease (Blake et al., 2008). Mortalities and condemned carcasses from the slaughter facilities are burned at high temperatures in a purpose-built incinerator, usually in the abattoirs. Incinerating poultry and small animals is biologically the safest disposal method. The residue from properly incinerated mortality is largely harmless and does not attract rodents or insects. Payne stated that incineration eliminates all pathogens but high operational costs and incineration's potential to contribute to air pollution (if not properly maintained and operated) decreases its usefulness for widespread use as a mortality carcass disposal option.

Malone (2005) argued that the incineration process is slow, loading decomposed carcass poses a problem and it will require disposal of 0.3 tonnes of ash per tonne of carcass. Without the proper sources of fuel and supervision of the process, smoke and odour can create nuisance complaints. Cai et al. (1994) observed that incineration is expensive and can potentially pollute the air. Therefore, this makes incineration not recommended for large-scale poultry operations that produce large amounts of mortalities but mainly for poultry slaughter facilities.

Compositing

Composting is a natural, biological process by which organic material is broken down and decomposed (Malone, 2004). It is also the manipulation of the natural aerobic process of biological decomposition of organic materials to increase the decomposition rate. This process is carried out by successive microbial populations which function under increasing temperatures to break down organic materials into carbon dioxide, water, minerals, and stabilized organic matter (Evanylo et al., 2009). Composting of waste is viewed as a viable means of reducing litter needs by recycling and reusing litter. Additionally, composting results in a product that is much more environmentally acceptable than raw litter for land application. It is a biological process in which organic wastes are stabilized and converted into a product to be used as a soil conditioner and organic fertilizer (Brake, 1992). According to Anon (2002), composting provides an inexpensive alternative for disposal of animal-based wastes and other biological residuals. Properly composted material is environmentally safe and a valuable soil amendment for growing certain crops.

The basic objective in composting is to maximize microbial activity at the expense of the waste material. To achieve this, maximum metabolic heat output by thermophilic bacteria must be attained (Drake, 1992). According to Malone (2005), microorganisms will rapidly compost carcasses in the presence of oxygen (>5%), moisture (40-60%), and a proper carbon to nitrogen ratio (20:1 to 35:1). This process produces carbon dioxide, water vapour, heat and compost. Under proper conditions, thermophilic organisms will cause the compost to heat to temperatures ranging from 57 to 63 ^{o}C. Evanylo et al. (2009) stated that mesophilic bacteria thrive at temperatures of 25° to 42 °C, but they can survive at higher temperatures. Mesophilic bacteria feed on the most readily available carbohydrates and proteins. Their metabolic activity raises the temperature of the windrow sufficiently to allow the takeover by thermophilic bacteria which perform best at temperatures ranging from 50° to 60 °C. If the temperature rises much above 66 °C, the majority of the bacterial population and many other living organisms will die. Anon (2002) stated that it takes 2 to 6 months for the animal to decompose.

The benefits of compositing are manifold. Compositing has the ability to reduce poultry litter, dispose of carcasses, stabilise trace minerals and reduce odours (Turnell et al., 2007; Bonhotal et al., 2008). Also, compositing can kill pathogens and help control disease outbreaks; it can be done any time of the year and can be done with equipment available on farms; hence it is economical (Bonhotal et al., 2008). The most efficient temperature range for composting is between 40 ^{o}C and 60 ^{o}C. However, compost pile temperatures are dependent on the amount of heat produced by the microorganisms that is lost through aeration or surface cooling. In the opinion of Turnell et al. (2007), the immobilisation of nitrogen and phosphorus during compositing reduces the risk of these nutrients entering the water systems. Imbeah (1998) stated that the decomposition process kills pathogens, converts ammonia nitrogen to organic nitrogen and reduces waste volume. Furthermore, compositing reduces the pathogenic organisms due to the high heat produced during the process of compositing. Das et al. (2002) reported that hatchery waste compositing reduces E. coli and salmonella by 99.9% and 100%, respectively.

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Composting of poultry litter offers a convenient and environmentally acceptable method of its disposal (Chaudhry et al., 2007).

The disadvantages of compositing are loss of some nutrients including nitrogen, the land area required for the compositing and odour problems (Glatz et al., 2011). A potential problem with compositing is the emission of greenhouse gases such as methane and nitrous oxide, which are efficient in absorbing infra-red radiation resulting in global warming and acid rain. Animal production contributes 7% of greenhouse emissions worldwide through the decomposition and degradation of manure (Hao et al., 2004).

Rendering

Rendering is a process of using high temperature and pressure to convert whole animal and poultry carcasses or their by-products with little or no value to a safe, nutritionally and economically valuable feed ingredient. It combines blending, cooking, pressurizing, fat melting, water evaporation, and microbial inactivation (CAST 2008). Rendering process cooks the product while killing pathogenic agents and converting the product into a value-added product which can be used as pet feed ingredients or livestock feed ingredients. Although rendering is an effective method, only few poultry operations in Botswana use it probably due to high operational costs. CAST (2008) argued that rendering is only feasible if there is a local rendering plant close enough for convenient pickup.

Rendered products are used in feed production. In India, Santhi et al. (2011) reported significantly ($P<0.05$) higher body weight, as well as, better feed conversion ratios in poults fed diets with 25% poultry waste carcass meal crude protein replacement compared with diets containing only fishmeal as a protein source. The investigators concluded that levels of poultry waste carcass meal replacing the crude protein from fishmeal up to 25% appeared acceptable based upon eighth week body weight and feed efficiency.

Other Waste Disposal Methods

Waste disposal methods presented in the sections below are currently not practised in Botswana but are likely to be employed in the future.

Conversion of poultry waste to energy

Poultry litter has been shown to be a viable, renewable biomass fuel. This conversion of poultry litter to energy furnace provides a high value alternative to land application and helps to control rising energy costs (Habetz and Echols, 2006).

Anaerobic digestion and direct combustion are technologies that can be used to convert poultry waste material to energy. Methane gas produced during anaerobic digestion can be gas cleaned and used as a renewable energy in households for cooking and heating (Collins et al., 2002). A recent study of Phanthavogs et al. (2011) in Laos Peoples Democratic Republic showed that biogas generated from pig manure reduced the amount of fuel wood and charcoal usage by 69.30% and 47.32%, respectively. Biogas production appears to be an attractive technology for Botswana given high energy costs, as well as, frequent power outages. Other benefits to using biogas include less odours and lower fly populations, as well as, reductions in greenhouse gas emissions (Phanthavongs et al., 2011).

Heat and electricity can be generated from manure combustion as renewable sources of energy. Habetz and Echols (2006) noted that because of the controlled combustion process, the resultant ash is converted to a concentrated fertilizer or fertilizer amendment, high in phosphorous, potassium, calcium, magnesium and other valuable micronutrients. However, concerns have been raised due to the gas emission into the air. As a consequence, it is necessary that technologies such as gas cleaning are employed to reduce the impact of these emissions.

Poultry litters from broiler chicken and turkey houses, as well as, bedding material can also be converted into biocrude oil in a fast pyrolysis fluidized bed reactor which is a source of renewable energy. The biocrude oil yield depends on the source, age and bedding material content of the litter. The hardwood shavings give a biocrude oil yield of 63%. The viscosity of the oils is a function of both the source of litter and the pyrolysis temperature (Agblevor et al., 2010).

Use of poultry waste for treatment of heavy metal contaminated water

Utilization of poultry litter as a precursor material to manufacture activated carbon for treating heavy metal-contaminated water is a value-added strategy for recycling the organic waste (Guo et al., 2010). Poultry litter-based activated carbon possesses a significantly higher adsorption affinity and capacity for heavy metals than commercial activated carbons derived from bituminous coal and coconut shell and does not pose secondary water contamination risks.

CONCLUSION

Direct disposal of poultry waste (mortality and abattoir condemnations) at the landfills, application on farm lands as a fertilizer, burning and compositing are the most commonly practised methods of poultry waste disposal in Botswana. These methods are challenged by issues of environmental pollution and restricted land to use. As Botswana is prone to droughts, it is probably high time that poultry manure and/or litter is considered as livestock

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feed in areas where FMD is endemic such as Chobe and North West Districts because beef from FMD zones is not exported to the European Union or sold outside the boarders of these districts.

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THE EFFECT OF FREE OR RESTRICTED ACCESS TO ARTIFICIAL SHADE ON RESPIRATION RATE, BEHAVIOUR AND PERFORMANCE OF GRAZING STEERS

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ABSTRACT: *The effect of access to artificial shade on respiration rate, performance and behaviour of grazing steers was determined during summer. Forty-two yearling steers were randomly assigned to 3 treatments without replication: 1) no shade, 2) free access to shade, and 3) restricted access to shade. Animals with restricted shade were daily removed from the grazing paddocks and enclosured in a resting area with shade and water between 10.00 and 16.00 h while animals of group 2 had both shade and water available ad-libitum in the grazing area. The respiration rate of control steers (69 breaths/min) was significantly higher than that of shade steers without differences between free and restricted access to shade (58 and 56 breaths/min, respectively). Total grazing time during daylight hours was not affected by shade availability (515 min). Between shaded treatments, animals with restricted access to shade spent significantly (P< 0.05) more time grazing during the morning than animals with free access to shade to compensate the lack of grazing between 10.00 and 16.00 h (241 and 168 min, respectively). The amount of time steers with free access to shade spent in the shade structure was strongly related to air temperature (R^2=0.85). When air temperature averaged 23.1°C between 06.00 and 20.30 h steers spent on average 50 min in shade; while when temperature averaged 29.6°C steers spent 422 min in shade. No significant difference was found in overall average daily gain among treatments (538 g/a/day). The provision of shade either ad-libitum or restricted reduced respiration rate of steers without affecting diurnal grazing time and animal performance.*

Keywords: *Cattle, behaviour, respiration rate, shade*

ORIGINAL ARTICLE

INTRODUCTION

There has been a trend towards more intensive forage-based beef production units in Uruguay. Cattle are managed in rotational grazing systems all year around, even during summer when combinations of temperature and humidity can result in conditions that present considerable challenged to farmed livestock. Increase animal productivity may also increase the susceptibility to heat stress and the response to mitigation strategies. One of the first steps that should be taken to moderate the stressful effect of a hot climate is to protect cattle from solar radiation. Mature trees are the more convenient and simplest way of providing shade to grazing animals. However, trees are not often conveniently placed for rotational grazing systems as often some paddocks have shade while others do not (Turner, 2000) and trees can be killed by high cattle density (West, 2003). To overcome those issues, the provision of artificial shade is the most cost-effective way of alleviating cattle heat stress by changing the radiation balance of the animal (Ames and Ray, 1983; Mader et al., 1999; West, 2003).

Research has extensively addressed the issue of shade and heat stress mainly on feedlot cattle (Gaughan et al., 2004; Mader et al., 1999, 2002 and 2006; Mitlöhner et al., 2001). The response in pastoral systems may be different as cattle are not confined which increase air circulation and ventilation. Although studies have been conducted overseas examining the effect of shade on pastoral systems many of these have been conducted in dairy cattle (Tucker et al., 2008; Schütz et al., 2009, Schütz et al., 2010) which is known to be more susceptible to heat stress. Growing and fattening steers would have lower heat production and usually higher thermal insulation being less influenced by a hot climate (Vandenheede et al., 1995).

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Ideally, the shade structure should be moveable in grazing systems but in practice is difficult to provide portable shades to meet the desired amount of shade for adult cattle in large herds on pastures (Turner, 2000). A practical approach is to build a permanent shade structure in a resting area and to move cattle from the grazing paddock to the shaded area during the warmest hours. However, as animals are kept under zero-grazing conditions in the resting area the benefits of providing shade could be offset by a decrease in animal performance. On the other hand, there is the perception among producers that providing shade *ad-libitum* in the grazing area may reduce the time that cattle spend grazing affecting pasture intake and animal performance. The objective of this experiment were to evaluate the effect of restricted or un-restricted access to artificial shade on respiration rate, behaviour and performance of grazing steers during summer and to discuss the overall cost-benefit of implementing a shade structure.

MATERIALS AND METHODS

This study was carried out from January 4th to March 12th 2007 at the INIA-Treinta y Tres Research Station (latitude: 33° 14' S, longitude: 54° 15' W) in Uruguay. Forty two growing 15-month-old Angus x Hereford steers (average initial weight ± standard deviation (SD): 278±26 kg) were randomly assigned to 3 treatments of 14 animals each without replication: 1) no shade, 2) free access to shade, and 3) restricted access shade. Each treatment group was kept separately in 2 hectares of Sudangrass (*Sorghum sudanense*) sub-divided into 3 paddocks of 0.67 ha which were rotationally grazed changing the grazing area based on forage allowance. The artificial shade structure consisted of a black woven polypropylene cloth occluding 80% of the incoming radiation mounted on 3.0-m-high eucalyptus posts with the long axis north/south. The length and width of the cloth were 12.0 and 4.0 m (48 m^2) corresponding an average space of 3.4 m^2 of shade per animal. Shade in the free access treatment was available 24-h per day in the grazing area. Animals with restricted access to shade were daily removed from the un-shaded paddocks at 10.00 h and taken to a zero-grazing resting area with a shade structure until 16.00 h when they returned to the grazing paddock.

Dry bulb temperature (°C) and relative humidity (%) were recorded each day hourly during 24 hours placing automatic weather stations (HOBO Pro Series Model) exposed to sun and under the shade structure at a height of 2.0 m above ground level. A Temperature-Humidity Index (THI) was calculated hourly to characterize the climatic heat load experienced by the animals based on the equation developed by Thorn (1959): [(0.8 x temperature) + (relative humidity/100) x (temperature-14.4) + 46.4]. Pasture allowance was estimated before and after grazing each paddock by cutting ten 0.125 m^2 quadrants. Respiration rate (breath/min) was measured weekly by counting the flank movements in 60 seconds in four steers randomly selected per treatment in 9 different days 5 times per day (10.00, 12.00, 14.00, 16.00, and 18.00 h) as practical indicator of heat stress risk (Silanikove, 200). Steers were weighed on days 1, 20, 35, 55 and 67. Animal behaviours (grazing, standing, lying, walking and head in the water trough) were measured in five days by live observations of all animals per treatment every 15 minutes from 06.30 to 20.30 h.

Statistical analyses were performed using the SAS System v. 6.12 (SAS Inst. Inc., Cary, NC). The main effect of shade on climatic, pasture and animal-related variables was analysed using the PROC GLM procedure. In all the variables, where the *F*-test was significant ($P<0.05$) the differences between treatments were determined using Tukey's test.

RESULTS AND DISCUSSION

Climatic variables

The provision of shade did not affect climatic variables registered by automatic sensors (Table 1). Mean THI was in the category of "no stress" according to the five comfort zones for milking cows reported by Wiersama (2005) to assign the risk of environmental heat stress (no stress THI<72; mild stress 72≤THI≤78; severe stress 79≤THI≤89; very severe stress 90≤THI≤98; risk of death THI>98). According to the THI value recorded hourly during the experimental period cattle were exposed to no stress, mild and severe risk of heat stress during 51, 36, and 13% of the time, respectively.

Table 1 - Climatic conditions during the study (mean±SD)

	Sun	Shade
Average air temperature, °C	23.0±5.8	23.1±6.0
Minimum air temperature, °C	16.2±3.8	16.4±3.7
Maximum air temperature, °C	31.5±3.5	30.7±3.7
Relative humidity, %	77±27.0	76±25.0
Temperature-Humidity Index	70±8.0	70±7.0

Row means with different superscripts differ significantly at P <0.05.

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Pasture characteristics

Shade had no effect either on herbage mass or plant height (P>0.05) (Table 2). Numerically, herbage utilization was greater in shaded treatment than in the control group (55% and 40%, respectively). Averaging over treatments, values of organic matter digestibility (59.3%), crude protein (7.65%), acid detergent fibre (44.3%), neutral detergent fibre (68.5%), and ashes (7.95%) of Sudangrass reflected the excessive accumulation of herbage mass which affected its nutritional value.

Table 2 - Mean (± SD) herbage mass and plant height for each treatment before and after grazing

	Treatment		
	No shade	**Restricted shade**	**Free shade**
Before grazing			
Herbage mass (DM kg/ha)	5199±418	5478±1629	5473±1696
Plant height (cm)	137±29	134±29	134 ±32
After grazing			
Herbage mass (DM kg/ha)	3116±1146	2424±1315	2539±1159
Plant height (cm)	84±16	77±19	80±14
Herbage utilization, %	40	56	54

Row means with different superscripts differ significantly at P<0.05.

Respiration rate

Shaded animals had lower (P<0.05) overall mean respiration rate (RR) than un-shaded animals averaged over day of evaluation (57 and 69 breaths/min, respectively) (Figure 1). This is consistent with several studies that have also found that average RR was lower in shaded animals than in animals with no shade availability (Mitlöhner et al., 2002; Gaughan et al., 2004; Eigenberg et al., 2005).The differences in RR were significant throughout the day except in the first measure at 10.00 h which averaged 54 breaths/min over treatments (P>0.05) indicating that climatic conditions registered during the night were cool enough to allow animal recovery from the heat load encountered during the day (Igono et al., 1992; Muller et al., 1994a; Silanikove, 2000). Between shaded treatments, shade-restricted animals had a significant higher RR than animals with free access to shade only at 14.00 h (P<0.05). Maximum RR rate was registered at 14.00 h (61 breaths/min) and 16.00 h (77 breaths/min) for shaded and un-shaded treatments, respectively.

Only in 2 out of the 9 days in which RR was evaluated there was no significant difference (P >0.05) in RR among treatments. In those days, the average air temperature was 26.5ºC between 10.00 and 18.00 h compared with an average of 29.7ºC registered in the days with significant differences in RR. This is consistent with results reported by Muller et al. (1994b) and Eigenberg et al. (2005) who found that the provision of shade had no effect on RR on days when the ambient temperature was less or around 25ºC.

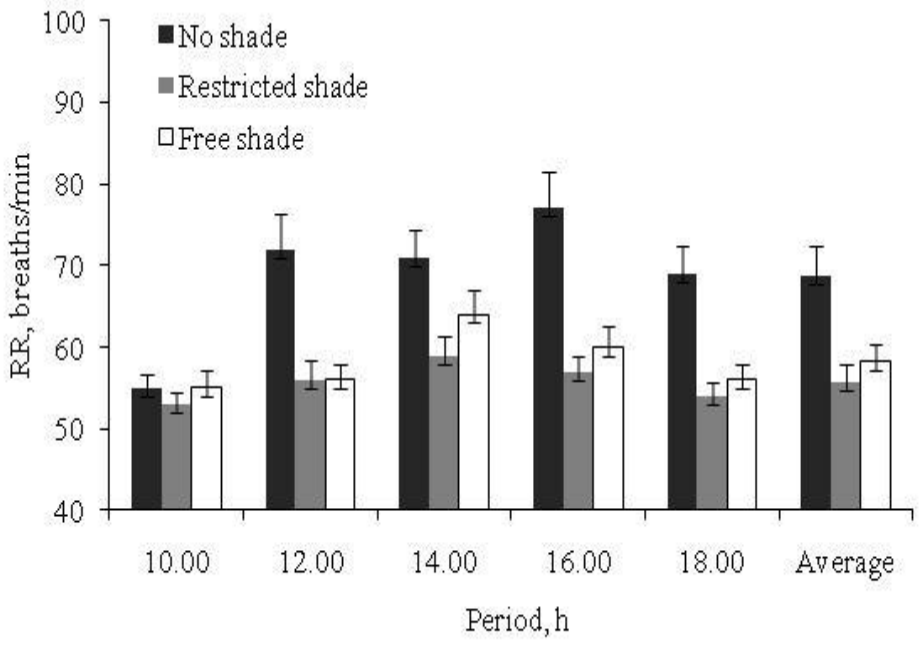

Figure 1 - Mean (± SEM) respiration rate (breaths/min) of steers per treatment and period of day.

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Animal behaviour

The provision of shade did not affect diurnal grazing time (P>0.05) (Table 3). Between shaded treatments, grazing activity of restricted steers was increased during the morning (+43%) and evening (+20%) hours compare with those with free access to shade. This was a mechanism to compensate the lack of grazing between 11.00 and 16.00 h when animals were taken to the resting area. In recent studies, it has been reported that cattle can react to a time constraint at grazing through an increase in the proportion of time spent grazing and in pasture intake rate (Perez-Ramirez et al., 2008; Kennedy et al., 2009). In addition, the grazing behaviour of steers was not registered during the night (20.30–06.00 h) being recognized that a decrease in dry matter intake during the hottest hours of the day can be compensated for longer grazing periods at night when climatic conditions are cooler (Igono et al., 1992).

Table 3 - Mean (± SD) behaviour of steers (min) between 0600 and 2000 h

	Treatment		
	No shade	Restricted shade	Free shade
Total grazing time	524±60[a]	528±39[a]	478±109[a]
06.00-11.00 h	225±28[a]	241±39	168±31[a]
11.00-16.00 h	117±17[a]	43±21[b]	106±22[a]
16.00-20.00 h	182±53[a]	245±44[b]	204±40[a]
Standing	120±75[a]	90±16[a]	99±56[a]
Lying	138±45[a]	198±26[a]	230±85[a]
Walking	17±07[a]	15±21[a]	21±17[b]
Head in the water trough	25±21[a]	9±05[a]	13±10[a]
Total use of shade	-	130±111[a]	199±206[a]
Standing	-	43±25[a]	72±62[a]
Lying	-	87±88[a]	126±148[a]

[ab] Row means with different superscripts differ significantly at P <0.05.

Free-shaded animals decreased their grazing time and spent more time in the shade during the morning and afternoon hours compared with un-shaded steers. The preference for steers to lie as opposed to stand in shaded areas in the present experiment is consistent with results reported by Muller et al. (1994c) and Rovira and Velazco (2010) but contrary with other observations (Mitlöhner et al., 2001; Kendall et al., 2006). When increased standing behaviour is observed during summer it is likely an effort to maximise the animal surface area exposed to the environment to regulate body temperature in extreme environments (Kendall et al., 2006). Drinking, walking, lying and standing behaviours did not differ among treatments (P>0.05).

Animal performance

Average daily gain (0.538±0.138 kg/a/day) and final body weight (314±28 kg) were not affected by treatment (P>0.05) even though restricted and free shaded animals showed an average daily gain 8% and 14% greater than un-shaded steers, respectively. The moderate rate of growth of animals could decrease the sensitivity to heat stress as the comfort line depends on the level of production being more sensitive animals presenting higher level of production as dairy cows and feedlot cattle (Berman, 2005). The difference in body weight between shaded and un-shaded animals was maximum between d 34 and d 51 (9 kg) (Figure 2). In the last period (51 day to finish) compensation through increased daily gain by cattle provided no shade tended to be evident and is generally expected to occur after periods of heat stress in cattle (Mader et al., 1999; Mitlöhner et al., 2001).

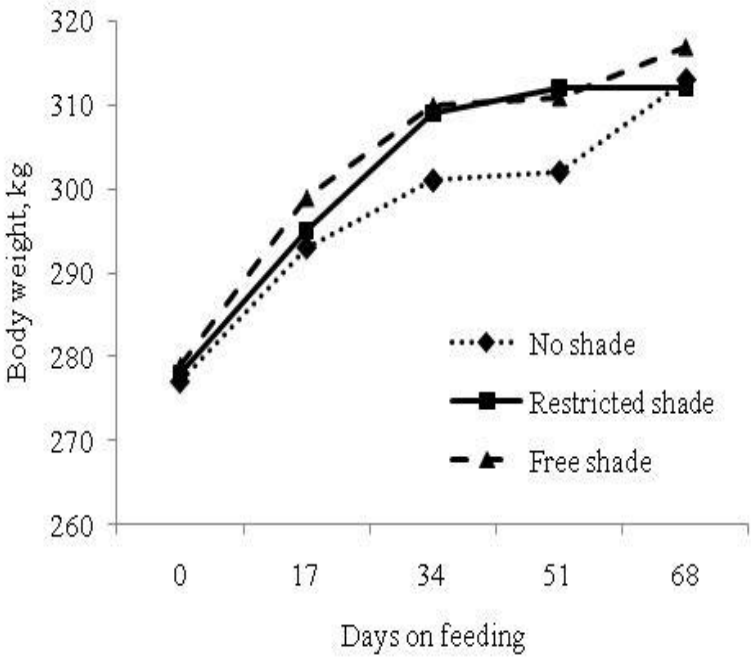

Figure 2 - Means of body weight (kg) of steers during the 68-day grazing period

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CONCLUSION

The results of the present study support the use of shade either *ad-libitum* or restricted during summer to decrease animal respiration rate reducing the risk of heat stress in grazing cattle without compromising productivity.

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MORPHOLOGICAL CHARACTERISTICS OF FARTA SHEEP IN AMHARA REGION, ETHIOPIA

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ABSTRACT: *A study to describe the physical body characteristics of Farta sheep was undertaken in south Gonder zone of the Amhara Regional State, Ethiopia. Three districts (Estie, Farta and Lai-Gaint) were selected purposively based on sheep population and accessibility. Both qualitative and quantitative measurement data was collected on 1050 (878 Female and 172 male) sheep. Three coat patterns - plain (54.9%), spotted (29.5%) and patchy (15.6%) were observed. Farta sheep have many color types to which white coat color was relatively frequent (35.3%; 40.4% for males and 34.3% for females) in both males and females and black was the next dominant coat color only for males. Almost all sheep had coarse fleece (96.6%) and horizontal ear form (99.7%). Farta sheep is short fat tailed. 67% of males and 10% of females were horned. The overall mean body weight, wither height, heart girth, body length and pelvic width obtained were 25.8±0.26 kg, 63.6±0.31 cm, 70.4±0.38 cm, 55.4±0.30 cm and 12.7±0.11 cm, respectively. Fixed effects age and sex had affected all the traits considered. Male and older age sheep were consistently larger (P<0.01) for all the traits over female and younger sheep respectively. Generally, it is possible to conclude that Farta sheep is relatively of smaller body size as compared to other breeds of the country. Efforts to improve the performances of Farta sheep should consider the harsh environmental condition to which the breed is maintained.*

ORIGINAL ARTICLE

Keywords: *Body weight, Farta sheep, linear body measurements, phenotypic characterization*

INTRODUCTION

Ethiopia has a large number of sheep estimated at 25.9 million (CSA, 2010) with more than 18 populations and nine breeds (Gizaw et al., 2007) which are found distributed in different agro-ecological zones and different production systems of the country. A molecular characterization work by Gizaw et al. (2007), indicate that Farta sheep is among the sheep breeds found distributed in the central highlands of Ethiopia. Farta sheep is said to be hardy which can produce and reproduce under feed shortage conditions and are resistant to some internal and external parasites, small in size with mature body weight of 25.4 kg (Gizaw et al., 2007; Shigdaf et al., 2010).

Identification and characterization of indigenous breeds of animals which are thought to have some valuable attributes that could be used at present or sometime in the future is a fundamental component of livestock improvement and conservation programs. With this respect detailed morphological description is required to physically identify, describe and recognize distinct animal populations. Therefore, the objective of this study was to analyze and describe the phenotypic characteristics of Farta sheep in south Gonder zone of Amhara Region.

MATERIALS AND METHODS

Site selection and description of the study area

The study was conducted in south Gondar zone of the Amhara region, where Farta sheep is widely distributed. The area is characterized by scarce vegetation cover, serious natural resource degradation, erratic rainfall and recurrent drought (Sisay, 2009; Shigdaf et al., 2010).

Three districts known to rear this breed of sheep were purposively selected based on their high number of sheep population and road accessibility. The first district, Farta district, is located about 100 km north-east of Bahir Dar, capital of the Amhara National Regional State. Farta district lies within an altitude range of 1920-4135 m a.s.l.

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The district receives an average annual rain fall of 900-1099 mm and a mean-range temperature of 9-25 C^o (Farta District OoARD, annual report). The second district, Lai-Gaint district, is located 175 km from Bahir Dar and lies between an altitude ranges 1300-3500 m.a.s.l. Lai-Gaint receives an annual average rain fall of 600-1100 mm and mean minimum and mean maximum temperature of 9 and 19 C^o, respectively. The third district, Esite district, is located 157 km North West of Bahir Dar city having an altitude range of 1500-4000 m.a.s.l. The minimum and maximum mean annual rainfall of the area is 1307-1500 mm and the mean annual minimum and maximum temperature is 8.3^0C - 25^0C (ENMA, unpublished).

Data collection

Data were collected on 1050 sheep of all age and sex groups in the flock. Data collected on physical body characteristics include linear body measurements on body form and size, live body weight and qualitative morphological traits as per the descriptor lists recommended by FAO (1986). Dentition was used to estimate/classify sheep in to age groups.

Qualitative characters collected were coat color, coat color pattern, head profile, presence or absence of wattle, presence or absence horn, presence or absence beard, tail type and presence or absence ruff. Linear body measurements such as: Chest Girth (CG) - the circumference of the chest posterior to the forelegs at right angles to the body axis; Body Length (BL)–horizontal length from the point of shoulder to the pin bone; Height at Wither (HW)–the highest point measured as the vertical distance from the top of the shoulder to the ground (bottom of forelegs); Ear Length (EL)–length of the external ear from its root to the tip; Tail Length (TL)-from the point of attachment to the tip; and Horn Length - from the base of the horn at the skull along the dorsal surface to the tip of the horn were also measured using flexible metal tape (3 meter length) to the nearest 0.5 cm after restraining and holding the animals in an unforced position. Body weight was taken using suspended Salter balance (50 kg capacity with 200 gram precision).

Data Analysis

The data collected from the field were entered, cleaned, managed and analyzed using Statistical Program for Social Sciences version 12.0 (SPSS Software, 2003) descriptive statistics and General Linear Model (GLM) procedures. Sex and dentition were considered as fixed effects for the analysis of quantitative traits. For the analysis of traits that can be manifested at later ages (e.g., presence or absence of horn and other horn traits, and linear body measurements), sheep with age of about nine months and above were used (sheep with spread apart milk teeth.

Dention was classified as: 0 pairs of permanent incisors (PPI) - these are sheep with no permanent incisors but approximately of yearling age; 1 PPI – sheep with one PPI; 2 PPI – sheep with two PPI; ≥3 PPI – sheep with three PPI and above.

The model used to analyze body measurements was;

$$Y_{ijk} = \mu + S_i + T_j + (ST)_{ij} + e_{ijk}$$

Where

Y_{ijk} = The observation on body weight and other linear body measurements;

μ = Overall mean;

S_i = Fixed effect of sex (i = Female, Male);

T_j = Fixed effect of dentition (j = 0, 1, 2, ≥3);

$(ST)_{ij}$ = the interaction effect of sex with dentition;

e_{ijk} = effect of random error

RESULTS AND DISCUSSION

Qualitative physical characteristics

The physical body characteristics for Farta sheep obtained in the present study are presented in Table 1. Figures 1 and 2 shows flock of sheep with typical color characteristics. Most (54.1%; 53.8 for males and 54.2% for females) of the Farta sheep had plain coat color pattern followed by spotted (30.6%). There were different coat color types in Farta sheep populations to which white coat color was relatively frequent (35.3%; 40.4% for males and 34.3% for females) in both males and females and black was the next dominate coat color only for males. Almost all sheep had coarse fleece (96.6%) and horizontal ear form (99.7%). Farta sheep is short fat tailed with curled (57.8%) and twisted (32%) shape. Toggle is not a characteristic of Farta sheep, only 2% had toggle. Horn described from sheep of about yearling age was a characteristics of male Farta sheep (67%) while only ten percent of the females had horn. Most of the horn shape was curved and backward oriented. On average, the morphological characteristics obtained in this study agree with the report of Sisay (2009) for the same breed.

Body weight and linear body measurements

The least squares mean ± standard errors of body weight and linear body measurements of Farta sheep are shown in Table 2.

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The overall least squares mean body weight obtained in the present study (25.8 kg) was similar with the values reported by Gizaw et al. (2007) for a similar breed of sheep and Tesfaye et al. (2009) for Menz and Afar sheep. However, it is lower than the values reported for Washera (Mengistie et al., 2010), Horro and Bonga sheep (Zewdu et al., 200). The smaller size might be because; Farta sheep is developed under harsh environmental conditions of the highlands of Amhara region. Animal sex and dentition exerted a significant (P<0.001) effect on body weight of Farta sheep. Males were heavier than their female counterparts. Body weight has significantly (P<0.001) increased from milk teeth to the fourth dentition group (≥3PPI). The growth curve for Farta sheep (Figure 3) indicates that the weight of Farta sheep increases up to the age when they produce the third pair of permanent incisor and declines after the fourth pairs of permanent incisor. The effect of sex and dentition on body weight of sheep is well stated in the literature (Tibbo et al., 2004; Mengistie et al., 2010; Tesfaye et al., 2009; Zewdu et al., 2009).

Table 1 - Qualitative physical body characteristics of Farta sheep

Variable	Trait	Male		Female		Total	
		N	%	N	%	N	%
Coat color pattern	Patchy	32	18.70	128	14.60	160	15.30
	Plain	92	53.80	476	54.20	568	54.10
	Spotted	47	27.50	274	31.20	321	30.60
	Total	171	100.00	878	100.00	1049	100.00
Coat color	Black	4	23.00	35	4.00	39	3.70
	Black and White	10	5.80	89	10.10	99	9.40
	Black, White, Brown	20	11.70	96	10.90	116	11.10
	Brown	21	12.30	129	14.70	150	14.30
	Brown and Black	27	15.80	157	17.90	184	17.50
	Brown and White	20	11.70	71	8.10	91	8.70
	White	69	40.40	301	34.30	370	35.30
	Total	171	100.00	878	100.00	1049	100.00
Hair type	Coarse	165	96.50	849	96.60	1014	96.60
	Smooth	6	3.50	30	3.40	36	3.40
	Total	171	100.00	879	100.00	1050	100.00
Head Profile	Concave	0	0.00	3	0.40	3	0.30
	Convex	28	24.30	144	18.60	172	19.30
	Slightly convex	6	5.20	52	6.70	58	6.50
	Straight	81	70.40	576	74.30	657	73.80
	Total	115	100.00	775	100.00	890	100.00
Ear form	Horizontal	171	100.00	876	99.70	1047	99.70
	Rudimentary	0	0.00	3	0.30	3	0.30
	Total	171	100.00	879	100.00	1050	100.00
Presence/ absence of horn	Present	66	57.40	42	5.40	108	12.10
	Scur	11	9.60	39	5.00	50	5.60
	Absent	38	33.00	694	89.50	732	82.20
	Total	115	100.00	775	100.00	890	100.00
Horn shape	Curved	40	60.61	26	61.90	66	61.11
	Spiral	15	22.73	7	16.67	22	20.37
	Straight	11	16.67	9	21.43	20	18.52
	Total	66	100.00	42	100.00	108	100.00
Horn orientation	Back ward	48	72.73	26	61.90	74	68.52
	Lateral	18	27.27	16	38.10	34	31.48
	Total	66	100.00	42	100.00	108	100.00
Tail type	Short fat	169	100.00	879	100.00	1048	100.00
Tail shape	Curled	93	54.40	514	58.50	607	57.80
	Straight	10	5.80	97	11.00	107	10.20
	Twisted	68	39.80	268	30.50	336	32.00
	Total	171	100.00	879	100.00	1050	100.00
Presence/ absence of Toggle	Present	2	9.10	20	2.30	22	2.10
	Absent	169	98.90	859	97.70	1028	97.90
	Total	171	100.00	879	100.00	1050	100.00

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Figure1 - Flock of Farta sheep grazing on a communal grazing land

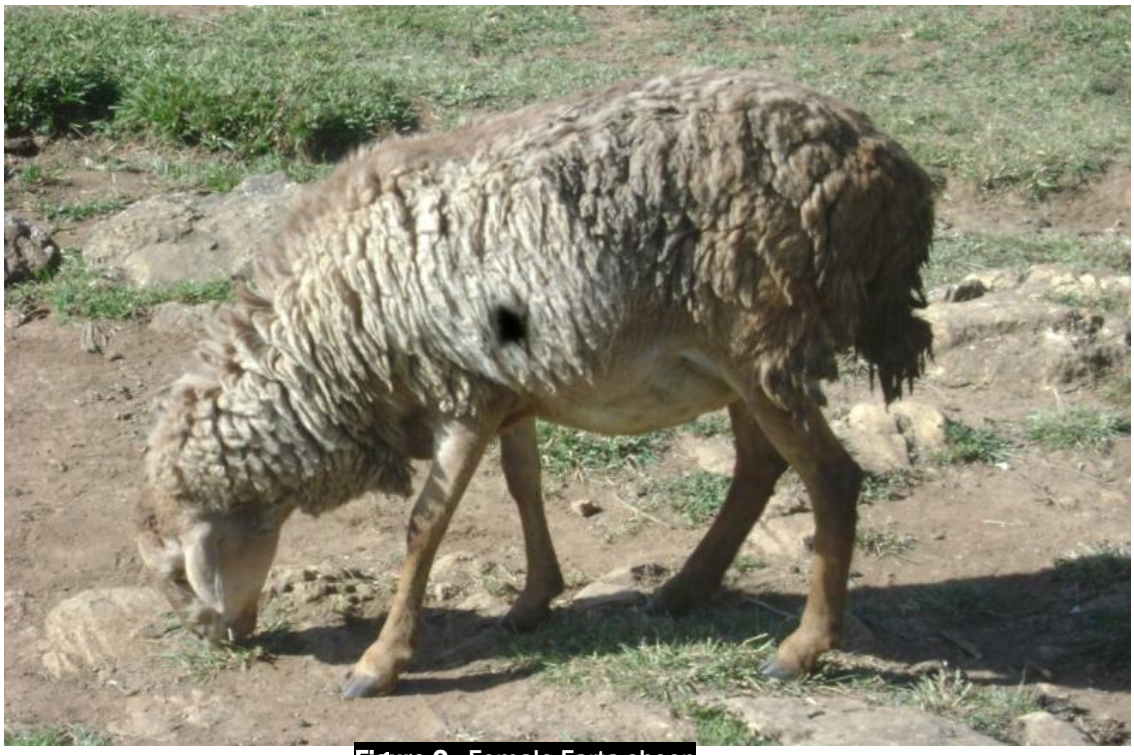

Figure 2 - Female Farta sheep

The least squares mean wither height obtained for Farta sheep in the current study (63.6±0.31 cm) was higher than the values reported for Menz and Afar sheep (Tesfaye et al., 2009), while it was lower than for Washera sheep reported by Mengistie et al. (2010). Males were taller than females (65.2±0.58 vs. 62.1±0.23; P<0.001). Dentition exerted a significant difference on wither height of Farta sheep that animals with dentition 0PPI were shorter, and those with ≥3PPI were taller (P<0.001) from the dentition groups which might be because animals with dentition group 0PPI are still growing and do not attain maturity. Different Scholars has reported the effect of sex and dentition on wither height (Mengistie et al., 2010; Tesfaye et al., 2009).

Body length (55.4±0.30 cm) was significantly affected by sex of animals; males had higher body length than female sheep (56.5±0.56 vs. 54.3±0.22; P<0.001). The effect of dentition was also significant (p<0.001). The body length of Farta sheep is lower than Washera, Bonga, Horro and Afar sheep (Mengistie et al., 2010; Tesfaye et al., 2009; Zewdu et al., 2009) while it is larger than Menz sheep (Tesfaye et al., 2009). The effect of sex and dentition was also reported in the literature for Washera, Menz and Afar sheep in Ethiopia (Mengistie et al., 2010; Tesfaye et al., 2009).

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Table 2 - Body weight and linear body measurements of Farta sheep

Variable	Body Weight kg		Wither Height cm		Body length cm		Heart Girth cm		Pelvic Wedth cm		Ear Length cm	
	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	865	25.8±0.26	886	63.6±0.31	892	55.4±0.30	892	70.4±0.38	892	12.7±0.11	890	9.3±0.11
Sex		***		***		***		**		NS		***
Male	115	28.0±0.51	113	65.2±0.58	115	56.5±0.56	115	71.4±0.71	115	12.5±0.20	115	8.9±0.21
Female	750	23.6±0.21	773	62.1±0.23	777	54.3±0.22	777	69.4±0.28	777	12.8±0.08	775	9.8±0.08
Dentition		***		***		***		***		***		NS
0 PPI	221	17.8±0.27^{a}	219	58.3±0.30^{a}	222	50.2±0.29^{a}	222	61.5±0.37^{a}	222	11.1±0.10^{a}	222	9.3±0.11
1 PPI	67	26.0±0.63^{b}	67	63.4±0.71^{b}	67	55.7±0.69^{b}	67	70.9±0.87^{b}	67	12.9±0.24^{b}	67	9.3±0.25
2 PPI	62	28.3±0.64^{c}	63	65.4±0.71^{bc}	64	56.3±0.69^{b}	64	73.1±0.88^{c}	64	12.8±0.24^{b}	64	9.5±0.26
≥3 PPI	515	31.1±0.58^{d}	537	67.5±0.65^{c}	539	59.4±0.64^{c}	539	76.1±0.81^{c}	539	13.9±0.22^{c}	537	9.3±0.23
Dent *Sex		***		***		***		NS		NS		NS
0 PPI*Male		18.2±0.42		58.9±0.48		50.3±0.46		61.7±0.59		11.1±0.16		9.1±0.17
0 PPI*Female		17.4±0.33		57.8±0.36		50.2±0.35		61.4±0.45		11.1±0.12		9.5±0.13
1 PPI*Male		28.5±1.15		64.4±1.30		57.3±1.26		72.2±1.60		13.0±0.44		8.9±0.46
1 PPI*Female		23.5±0.51		62.3±0.57		54.2±0.56		69.6±0.71		12.8±0.19		9.7±0.21
2 PPI*Male		30.9±1.15		67.4±1.29		57.0±1.26		74.0±1.60		12.2±0.44		9.0±0.46
2 PPI*Female		25.7±0.53		63.4±0.60		55.6±0.58		72.3±0.73		13.3±0.20		9.9±0.21
≥3 PPI*Male		34.3±1.15		70.2±1.29		61.5±1.26		77.9±1.60		13.9±0.44		8.8±0.46
≥3 PPI*Female		27.9±0.17		64.8±0.19		57.3±0.18		74.3±0.23		13.9±0.06		9.8±0.07

N = Number of observations; 0PPI – sheep with 0 pairs of permanent incisors (PPI); 1 PPI – sheep with one PPI; 2 PPI – sheep with two PPI; ≥3 PPI – sheep with three PPI and above. ^{a,b,c}Means in a column with different superscripts are significantly different; NS – Not significant (P>0.05); **P<0.01; ***P<0.001

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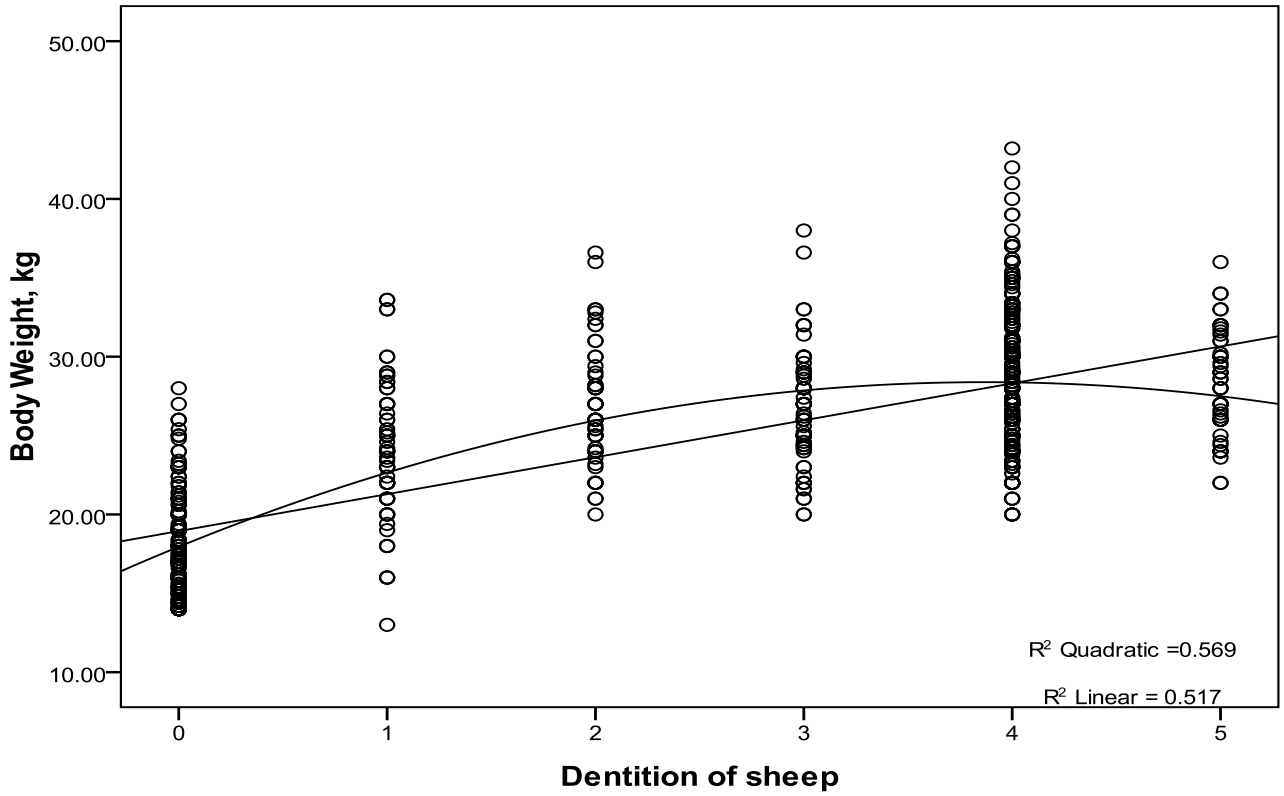
The least squares mean heart girth obtained was 63.6±0.31 cm. Farta sheep had lower chest girth than other indigenous sheep breeds of Ethiopia (Mengistie et al., 2010; Tesfaye et al., 2009; Zewdu et al., 2009). Male sheep and sheep with dentition ≥3 PPI had higher heart girth than female and lower dentiton groups, respectively. The result is in agreement with literature (Mengistie et al., 2010; Tesfaye et al., 2009; Zewdu et al., 2009).

The Pelvic width of farta sheep in the current study (12.7±0.11 kg) is lower than reported for other sheep in the country (Mengistie et al., 2010; Tesfaye et al., 2009; Zewdu et al., 2009). Older animals had wider pelvic ($P<0.01$) than younger sheep. However, unlike other findings (Mengistie et al., 2010; Tesfaye et al., 2009), sex didn't show significant difference ($P>0.05$) in pelvic width of Farta sheep.

Ear length of Farta sheep in the current study is similar with that of Washera sheep (Mengistie et al., 2010) while it is smaller than Bonga and Horro sheep reported by Zewdu et al. (2009). Female sheep had longer ear than male sheep.



Dentition: 0 - those of about yearling age before erupting their milk teeth; 1 - those with one pairs of permanent incosors (PPI); 2 - those with two PPI; 3 - those with three PPI; 4 - those with four PPI; 5 - sheep starting to drop their permanent incisors

Figure 3 - Growth curve of Farta sheep

CONCLUSIONS

Farta sheep one of the sheep breeds with its own physical characteristics. It is relatively of smaller body size from other indigenous sheep breeds of the country. Farta sheep is developed for the harsh environmental adaptation like feed shortage of the highlands of south Gonder zone. The fixed effects considered were a significant source of variation for almost all of the response variables (linear body measurements). Management practices which aim at developing and improving the productivity of Farta sheep breed should target in exploiting the hardy environmental adaptation of the breed.

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NUTRITIONAL EFFECTIVENESS OF WATER HYACINTH LEAVES COMBINED WITH WHEAT BRAN AND COTTON SEED CAKE ON THE PERFORMANCE OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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ABSTRACT: *The aim of this study to evaluate the different levels of water hyacinth plant leaves in the diet of Nile Tilapia and their effect on growth performance so as to eliminate the water hyacinth plant from the Nile and provide a cheap food for fish. In this experiment the dried water hyacinth leaves (Eicchornia crassipse), wheat bran and cotton seed cake were used in different ratio to formulate two experimental diets (A and B). Diet (A) contains 70% wheat bran, 20% cotton seed cake and 10% water hyacinth leaves, while diet (B) contains 65%, 20% cottons seed cake and 15% water hyacinth leaves. These diets were fed to studied fish with 5% per their body weight for 105 days. The results of this study revealed that the diet (A) has higher growth performance on studied fish than those fed on diet (B). The results of food conversion ratio (FCR, 4.04) in diet (A) and food conversion ratio (FCR, 5.73) in diet (B), and the increment of growth rate in fish fed with diet (A) more efficient on the growth performance of studied fish than diet (B) except in the case of protein efficiency rate (PER) it's found to be more in diet (A) than diet (B). It was concluded that the diet (A) had better growth performance than diet (B) on the feeding regime of Nile tilapia (Oreochromis niloticus).*

ORIGINAL ARTICLE

Keywords: *Nutritional effectiveness, water hyacinth leaves, wheat bran cotton seed cake, Nile tilapia*

INTRODUCTION

Africa has been a large potential for fish farming with 56–70% of its land having the highest yield potential for tilapia, catfish and common carp (Aguilar- Manjarrez and Nath, 1998). The farming of tilapia in Africa has been expanding slowly (about 2.5% per annum) over the past decade and production in 1996 was estimated at 39.348 metric ton (FAO, 1998).

During the same period, total aquaculture production in Africa increased at a rate of 11% per annum. Ponds remain the most common tilapia production system in Africa, contributing about 38–93% of total tilapia production from aquaculture in many Africa countries (FAO, 1995). Tilapia is a hardy prolific, fast growing tropical fish, and it can survive on a diversity of food. Algae is probably their most common food in the wild. On fish farms they are fed a high-protein pelleted feed. They can be fed by hand or with sprinkler mechanism, and generally fed twice per day (Fathia, 2010).

The Sudan has often been described as the largest country in Africa, at present the population is about 40 million people. The Sudanese consume a substantial amount of meat in their diet, but the country demand for fish is not yet satisfied the present per capita consumption at 1.38 kg/year (Yousif, 1988). This level is low when compared to the neighboring countries.

Aquaculture is the fastest growing sector of word human food production and has an annual increase of about 10% (FAO, 1997). To sustain such a high rate of growth a matching increase in fish feed production is imperative (AIFA, 2004).

The feed is the most expensive component in the intensive aquaculture where it represents over 50% of the operating cost, moreover protein itself represents about 50% of feed cost , therefore the selection of proper quality of dietary protein is a necessary tool for successful fish culture practices (El – Sayed, 2003) .

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Fish meal is considered the most desirable animal protein ingredient in aquaculture feeds because of its high protein content, balance amino acid profile, high digest ability and palatability, and as a source of essential fatty acid (Hardy and Tacon, 2002) .Therefore, fish nutritionists have made several attempts to partially or totally replace fish meal with less expensive and locally available protein sources.

In this aspect, a several feed ingredients have been investigated in an attempt to find substitutes for fish meal in the diets of tilapia.

These include animal protein sources such as, the fishery by- products, shrimps meal, and feather, bone meal and blood meal. Plant protein sources including soy bean meal cotton seed meal, ground nut meal, wheat bran meal, sunflower cake and water hyacinth plants (Ogunji, 2004; El–Sayed, 1999; El–Sayed and Tacon, 1997). Cottonseed, groundnut and sun flower cakes are one of the best plant protein sources for tilapia in developing countries due to its high availability, relatively low price, good protein content not less than 26.54% depending on processing methods and amino acid profile (FAO, 2004. Replacement of fishmeal by cheaper ingredients of either animal or vegetable origin in aquatic animal feed is necessary because of the rising cost and uncertain availability of fishmeal (Kaushik, 1995; Higgs et al., 1979). These feeds are not only considerably cheaper than fish meal but also enjoy high availability and accessibility in certain regions of the world. Soy bean meal and wheat bran meal has been used as a protein source in diets of various fish species (Jackson et al., 1982 and Xie et al., 2001).

The protein of plant leaves can be used after it has been extracted; water hyacinth is a warm water aquatic plant widespread in many countries, such as Sudan in Africa and other countries particularly during the summer months with its highest growth in July. Which was a very widely distributed weed in the River Nile, could double its population every seven days to yield an annual productivity of 930–2900 tons/hectares (Laro and Bressani, 1982). Water hyacinth has a multitude of direct and indirect effects on almost all aspects of human life once a water body on which man so much depends is invaded and covered by the weed mats (Schneider, 1996): fisheries; water supply; hydroelectric power generation; human health; agriculture; transport; biodiversity; evapo-transpiration and increased cost of water treatment are some of the adverse effects.

Hence, research in fish nutrition that will utilize locally available ingredients plant protein sources and fabricated equipment without reducing the quality of the feed is urgent and crucial to the overall success of aquaculture development, growth and expansion in Africa. The main aims of this study to study the different levels of water hyacinth plant leaves protein in the diets of Nile tilapia and their effect on growth performance so as to eliminate the water hyacinth plant from the Nile and provide a cheap food for fish.

MATERIALS AND METHODS

Diet formulation

Water hyacinth leaves (*Eichhornia crassipes*) weeds were collected from Blue Nile and White Nile near to Sennar and Juba cities (Sudan). The roots and stems of plant were removed and the rest of plants were washed with running tap water to minimize the adhesive materials, then dried under natural sunlight and stored at room temperature until used. The ground dried water hyacinth plant leaves, were added in to the diets by different ratio (in percentage) 10% and 15% in diet A and B respectively, to formulate two different experimental diets (A) and (B).

Scarified fish samples at the beginning and at the end of experiment from each groups randomly were selected and ground homogenously, in addition to samples of experimental diets (A and B) were taken both to Lab of Nutrition of Khartoum University, to determine the proximate analysis (Moisture, Dry Matter, Ash ,Fat, Crude Protein using the method of AOAC (1980). Nitrogen free energy (NFE) was determined according to Halver (1997) formula (NFE%= 100 - (Crude protein %+ fat %+ash % + moisture %)

Table 1 - Shows the proximate analysis of fish samples at the beginning of experiment and samples of experimental diets (A and B)

Parameters / Treatment	Moisture %	Dry matter %	Crude Protein %	Ash %	Fat %	NFE %
Initial fish flesh	67.2	32.80	20.41	7.07	0.28	39.42
Diet (A)	7.8	92.20	31.75	7.53	1.54	51.38
Diet (B)	5.63	94.37	29.40	7.06	1.56	56.35

NFE=Nitrogen free energy

Table 2 - Shows the levels of different ingredients of experimental diets (A) and (B)

Parameters	Diet (A)	Diet (B)
Water hyacinth leaves	10%	15%
Wheat bran meal	70%	65%
Cotton seed cake	20%	20%
Total	100%	100%

Experimental Trial

Total number of (150) fingerlings of Nile tilapia with an average initial body weight of (22.95 g), standard length (7.8 cm) and total length (13.12 cm) were collected from the fish farm of the department of fisheries and

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wildlife science, College of Veterinary Medicine and Animal production, Sudan University of Science and Technology using suitable gillnet and distributed in to experimental aquaria.

Aerators were used for aerating the water of experimental aquaria. The pH and temperature were recorded every day, using pH electronic meter (model, No. 201) and thermometer.

The fingerlings were acclimatized for ten days to the experimental aquaria conditions and feeding regime. Fish were daily offered the diets at a rate of 5% biomass per day for the studied period. Fish were weighed every fifteen days and the amount of feed for each aquarium was adjusted accordingly. The daily ration was introduced at 9 am and 3 pm. The water of aquaria was changing half of the water in each aquarium every day.

RESULTS AND DISCUSSION

The nutritional effectiveness of different levels of water hyacinth leaves (10% and 15%) combined with wheat bran meal in two experimental diets A and B on the performance of Nile tilapia (*Oreochromis niloticus*) were showed in the Tables 3 and 4.

The result of diets (A) on growth performance of studied fish was showed a better value than the diets (B) as recorded in Tables 3 and 4.

Table 3 - Shows chemical analysis of final fish flesh that fed on experimental different diets (A and B)

Experimental Diet	Proximate Parameters					
	DM	MO	ASH	CP	EE	NFE
Diet (A)	22.4	77.6	7.89	17.5	1.5	50.61
Diet(B)	20.9	79.1	6.90	14.0	1.90	56.3

Values are means of 14 fish for each group. DM= Dry matter. MO= Moisture content. CP = Crude protein. EE = either extract. NFE=Nitrogen free energy

Table 4 - Shows the average values of fish growth performance of the two fish groups fed with diets (A and B) during the experimental period

Parameters	Diet (A)	Diet (B)
Initial total length	10.9	10.9
Final total length	17.57	17.21
Increment in total length	7.67	7.31
Initial standard length	9.00	8.95
Final standard length	15.57	15.21
Increment in standard length	6.57	6.21
Initial weight	22.95	24.6
Final weight	135.57	133.14
Increment weight	112.62	108.54
Food conversion ratio	4.04	5.73
Food conversion efficiency	0.25	0.18
Specific growth rate	0.55	0.35
Protein efficiency rate	0.39	0.29
Daily weight gain	0.360	0.244

The study investigates the nutritional effectiveness of water hyacinth leaves combined with wheat bran meal on the performance of Nile tilapia (*Oreochromis niloticus*). The results of this study were analyzed as in Table 4.

The study revealed that the diet (A) with lower plant component have a better values performance on studied fish than the diet (B) which have higher plant content. This finding is in agreement with Lim and Doming, (1989) they reported that high levels of plant protein in fish diets in many cases resulted in reduced growth and poor efficiency, or decrease of palatability and pellet water stability value.

The diet (A) showed the highest values in weight increment, this indicated that the levels (10%) of water hyacinth were suitable for Nile tilapia fingerlings than the levels (15%). This might be in the line of (Lim and Doming, (1989).

In spite of high levels (15%) of water hyacinth leaves in diets (B), but the growth rate parameters showed lowest results than the levels (10%) of water hyacinth leaves in diets (A). Because the water hyacinth leaves has is consists of little protein levels.

That means the highest levels of water hyacinth leaves in fish diets it has negative result in the growth performance of fish. The present findings were in agreement with those reported by Muri *et al.* (2005), who found plant component has lower crude protein and ash and higher crude fibers contents.

The highest levels of water hyacinth leaves in diets of Nile tilapia may reduce the crude protein levels. So the food conversion efficiency (FCE), Specific growth rate (SGR), and Protein efficiency ratio (PER), (0.25, 0.18), (0.55, 0.35) and (0.39, 0.29) respectively values were recorded higher in studied fish group (A) than the group (B). It could

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be concluded that the leaves of water hyacinth could be tried as one of conventional feedstuff. Also the study suggested that, the usefulness of low water hyacinth leaves more than high quantity in the fish diet.

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ADAPTABILITY AND PRODUCTIVITY OF WASHERA RAMS AND ITS CROSSES WITH FARTA SHEEP IN SOUTH GONDER ZONE OF AMHARA REGION, ETHIOPIA

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ABSTRACT: *A rapid survey was conducted in south Gonder zone districts to collect information on the adaptability and productivity of distributed Washera rams and its crosses under smallholder farmer's management systems in the study areas. Pre-survey information was collected from zone agricultural office professionals and checklist was used to collect information from zone and district professionals, development agents and smallholder farmers. In addition, physical observation and body measurements were taken on rams and their progenies. Since the distribution has started in 2005, 1965 Washera rams were distributed in to nine districts by different organizations like Food for Hunger International, World Vision, Research and District Agricultural and Rural development office (WoARD) safety net program. According to the professionals and farmers judgments, Washera sheep has many economically important traits of which better growth rate, attractive coat color and big fat tail are the most important ones. Farmers recalled some adaptation problems as susceptibility to food shortage and disease, especially at their early age of arrival. The observed physical measurements depicted that these sheep are performing well. The body weight and other linear measurements obtained for rams were better than the values for the same breed of sheep at Adet and Quarit. Among the interviewed farmers (70%) preferred to rear Washera and its crosses while 8.7% of them preferred their locals (Farta). In general, most of the farmers (73.9%) have positive comment and suggestion on the distribution of Washera rams through which the performance of the locals could be improved. For future distribution, districts should consider when and where to buy and distribute the rams. In addition, for efficient use of the rams, the distribution should consider communal use of the rams in a common grazing land and it is better to distribute on recommended areas. Finally, in the context of animal genetic resource utilization and conservation, a strategy that would help to improve and conserve the Washera sheep at its belt should be designed.*

Keywords: *Adaptation, fat tailed sheep, growth performance, performance assessment*

ORIGINAL ARTICLE

INTRODUCTION

Sheep production is an important agricultural activity in the mixed crop livestock farming systems of the highlands of Ethiopia. They provide cash income from sale of live sheep, meat and skin, manure and social and cultural functions for the farm household. There are about 21 million heads (CSA, 2006) of sheep in Ethiopia of which 70% are found in the highlands of the country (Alemayehu, 2003). However, irrespective of high population numbers, the production and productivity of sheep and the contribution of this sub-sector to the farm economy is unsatisfactory. This is because, sheep are managed under traditional husbandry practices to which there are wide spread of animal diseases (including internal and external parasite), shortage and seasonal variation in feed availability and low productivity of local breeds.

In order to improve the productivity of indigenous breeds of sheep, improving the management (health, nutrition, housing, etc) aspects and the genotype (selection, crossing with better performing exotic/indigenous breeds) is of paramount importance. In Ethiopia, crossbreeding of sheep, with the aim of improving growth and

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wool of indigenous sheep, has been started in 1944 when the Merino breed was imported from Italy. Since then different exotic breeds (more than five) were introduced in to the highlands of the country (Tibbo, 2006; Beyene, 1989). Farmers in the highlands of Ethiopia, however, declined to accept the crossbreds due to their phenotypic unlikeness to the indigenous sheep. Consequently, due to assumed phenotypic similarity to the local sheep the Awassi breed was imported from Israel and still is in use in the cool highlands of central Ethiopia (Tibbo, 2006). However, due to different reasons, like the high cost and un-availability of Awassi x local crossbred rams to reach in to the farm households and bring an impact to the sector, the breeding program still has a limitation.

With regard to this, the Amhara national regional state bureau of agriculture and rural development has designed a strategy to distribute Washera sheep rams to different zones of the region where the local sheep are believed to be low performing (BoARD, 2004). The Washera sheep, found distributed in the western highlands of Amhara National regional state (E. Gojjam, W.Gojjam, Awi), is believed to be one of the promising sheep breeds of the country (Chipman, 2003; Mengistie, 2008). This breed of sheep is known by its fast growth, better reproductive performances and wide range of environmental adaptations as compared to other highland breeds of the region (Sisay, 2002). Accordingly, about 2000 Washera rams were purchased from the Washera area markets and distributed in to the traditional production systems of the south Gonder zone districts by different actors. And, therefore, this rapid survey was designed to assess the adaptability and performance of Washera rams and its crosses with Farta sheep in the south Gonder zone districts.

MATERIALS AND METHODS

Study area

The study was conducted in the eight districts of south Gonder zone during February 2009 in areas where Washera rams were distributed by different governmental and non-governmental organizations. The study area has an altitude range of 1300-4135 m a.s.l, mean range temperature of 9-19 C^{o} and mean range annual RF of 600-1100 mm (BoARD, 2004).

Data collection and analysis

Pre-survey information about districts where Washera rams have been distributed was obtained from the south Gonder Zone Bureau of Agriculture and Rural Development office. Within each district, sample peasant associations (PAs) were selected in consultation with district level extension staff (where the distribution is?) and based on road accessibility. However, due to lack of information about the exact time of distribution and for whom the rams were distributed, only flocks with Washera rams either intact or castrate and the neighbors who had Washera rams (as hear-say) were visited. Flocks/farms were identified and visited together with development agents from each PA. Information on adaptability and productivity of the rams was collected from 38 farm flocks of 13 PAs. Name of districts and PAs, and number of farms/flocks included in the study are shown in Table 1.

Table 1 - List of districts and PAs, and number of farms/flocks included in the survey

District	PAs	No. farms/flocks	No. Washera rams
Dera	Emashenkoro	2	-
Fogera	Alember	2	1
Libokemkem	Shamu	5	5
	kebele12	1	-
Ebinat	Debreabajale	4	4
Farta	Ata	2	1
	Awzet	6	6
L/Gaint	Damot	3	3
T/Gaint	Kebele 12	2	1
	Kebele 2	2	2
	Kotmender	2	2
Simada	Kebele15	6	6
	Kebele 12	1	1
Total	13	38	32

A Checklist focusing on the history of Washera ram distribution (number distributed, date of distribution, current inventory of the distributed rams and responsible bodies for the distribution) and performances of the distributed rams was used to collect information from zone/district/PA expertise and from farmers. Individual ram examination and progeny performance assessment was undertaken. Age was estimated by dentition for rams and by asking the owners on recall bases for the progenies. Weight - the live weight of an animal; was taken using the

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Salter scale (50 kg capacity with 200 gram precision). Other body measurements (heart girth, wither height, body length and scrotal circumference) were taken using flexible metal tape (3 meter length) to the nearest 0.5 cm after restraining and holding the animals in an unforced position. Body condition was scored 1-5 (1 for the worst and 5 for the best). The reference points for linear measurements taken were according to Sisay (2002). Heart girth - the circumference of the chest posterior to the forelegs at right angles to the body axis; Wither height - the highest point measured as the vertical distance from the top of the shoulder to the ground (bottom of forelegs); Body length - horizontal length from the point of shoulder to the pin bone. The data collected from the field was managed and analyzed using statistical package for social sciences (SPSS, 2006).

RESULTS AND DISCUSSION

The influence of the dietary protein level on feed intake, weight gain and feed efficiency is shown in Table 2. Feed intake increased with increasing protein levels of 16% and 18 % crude protein respectively. These results are in agreement with Kingori et al. (2003) who reported increased feed intake as protein was increased. In this study there was a general increase in body weight throughout the growing stage. Adeyemo et al. (2006) reported increased live body weight of guinea fowls fed different levels of crude protein. There was significant difference ($P<0.05$) in feed intake between the three treatments. This might be due to the differences in percentage crude protein content. This could also have been influenced by some ingredients in the diets to compel the birds to eat more to meet their body protein requirements. The weight gain increased significantly ($P<0.05$) between the treatments. Adeyemo et al. (2006) also reported significant difference of weight gain between birds fed 14 and 16% CP. Growth in animals is influence by genotype of birds, nutrition, hormones, tissue specific regulatory factors and other aspects of the bird's environment (Carlson, 1969). When birds consume below their protein requirement they do not improve protein utilization. The study showed that feed efficiency improved as protein was increased between 14, 16 and 18% crude protein (Table 2). Although slower growing than broiler chickens they are reported to out-perform replacement layer pullets in feed conversion efficiency (Olomu, 1983).

Ram distribution

Distribution of Washera rams in the districts of south Gonder zones were started since 2005. Since then, 1965 rams were distributed in to nine districts of the zone. From the visited 38 flocks, 18, 12, 4, 4 were provided for the farmers during the year 2008, 2007, 2006 and 2005 respectively. It was not possible to get data on the current inventory of the distributed rams due to lack of information (district/PA expertise lack follow up). Therefore, the indicated figures could not indicate the representative status of the distributed rams as died, sold, and in service. Different organizations like Food for Hunger International (FHI), World Vision (WV), Andassa livestock research center (ALRC) and district office of agriculture and rural development safety net program were participated in the distribution.

Performance assessment

Performance assessment by zone/district/PA expertise: According to the expertise from zone/district/PAs, Washera rams have better growth performance; they grow fast, they gain better when fed well. However, its reproductive performance is similar as compared to the local one. Washera rams are preferred by the producers and local markets due its attractive coat color and big fat tail character. Due to this all the districts where the survey was undertaken had planned to scale-up the distribution of Washera rams in the following budget years.

Performance assessment by farmers: Adaptation and productivity of Washera rams and its crosses with the local breed was assessed in a set out check list. As the result indicates (Table 2), from the total interviewed farmers (n=23), 78.3% and 74% responded that Washera rams and their crosses with Farta ewes have a characteristic of fast growth and better body conformation than the locals, respectively. Similarly, respondent farmers (34.8%) reveal interest on the colors of Washera rams and its cross with the local breed. Its color was plain red (15.9%), plain white (14.77%), red and white with white or red on the head and/or tail/leg (63.63%) and black and white (3.4%).

However, 56.6% of respondent farmers pointed out that Washera rams were susceptible to dry season feed shortage prevailing in the area, which might be because, the area where they came from is a better cropping area and then have better crop aftermath and crop residue. In addition, their body size is larger than the local and need more feed. About 52.2% of interviewees mentioned health problems like coughing and diarrhea and even death during early arrival period. The rams were very young and transported long distances (more than 300 km - in asphalt and gravel road) with in two-three days which could be a stress and may cause health complexity.

About 22% of interviewed farmers responded that big fat tail was one of the merits of the Washera sheep considered and was transferred to the crosses as a positively changed trait (30.4%). Washera sheep is characterized by large body size and wide fat tail usually curved up ward tip (Mengistie et al., 2009).

From the total interviewed farmers, 26.1% mentioned that Washera rams and its crosses attributed an increased market value due to its better body conformation (size, color, tail). Sheep price is affected by animal characteristics such as weight, sex, age, condition, and color (Beneberu et al., 2006). According to Chipman (2003), Washera breed of sheep has been found to be a relatively fast growing breed under harsh circumstances with good

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potential to aid producers and the economy of Ethiopia. In spite of this, 13% of interviewed farmers mentioned that Washera rams could not tolerate the dry season temperature, feed shortage and disease as a demerit of the breed. So it is important to improve animal management and infrastructure related to health services. This adaptation problem was lowered (4.3%) on the crosses. The Lion share (34.8%) of demerits of Washera rams and its crosses with Farta sheep as compared to Farta sheep lied on the absence of horn on the rams. According to the respondents, absence of horn has impact on local market preference and during mating time since it cannot resist competent local rams with horn.

Table 2 - Washera ram adaptation problems

Parameter for adaptation	N	Yes (%)	No (%)
Adaptation for disease problems	23	63.2	36.8
Adaptation for feed shortage	23	60.0	40.0
Walking ups and downs problems	23	22.2	77.8
Adaptation for cold	23	12.5	87.5

Even though farmers have their own Washera breeding rams, only 65% of them use controlled breeding with their Washera ram only while 30.4% of the farmers use random mating on the field. 52.2% of the rams of the respondent farmers serve the neighbors flocks from which 13% were controlled by bringing the ewes to the ram owner's house.

Due to their fast growth and high market values, 70% of the respondent farmers preferred to rear/keep Washera sheep and its crosses while 8.7% of them preferred locals. In general, most of the farmers (73.9%) have positive comment and suggestion on the distribution of Washera rams and local sheep breed improvement program.

Table 3 - Merits and demerits of Washera rams and its crosses with the local as compared to the local sheep breed

Parameters	Sheep breed		
	N	Washera	Washera × local
Merits	23		
Fast growth & better body conformation		78.3%	74.0%
Attractive color (Red and white)		34.8%	34.8%
Big fat tail		21.7%	30.4%
High market value (better price, demand)		26.1%	26.1%
Demerit	23		
Absence of horn		34.8%	34.8%
Susceptible to drought, feed shortage & disease		13.0%	4.3%

N: number of observations

Flock size and composition

The average flock size obtained from the study was 9.17 (4.19) with a range of 4-18 sheep. A similar flock size was reported for Washera sheep (Chipman, 2003; Mengistie, 2008). However, it is lower than the 16.02 sheep/household in Gumuz sheep (Solomon, 2007), and 24 sheep/household in Lallo Mama Midir in the central highland of Ethiopia (Abebe, 1999).

Flock composition in terms of sex and age classes has been taken as an indicator of the management system that reflects to some degree the management objective, flock productivity and constraints on the system (Ibrahim, 1998). From the total flock, the higher proportion (47.87%) were mature ewes followed by lambs less than 6 month age (27.50%). This indicates that more ewes were kept for breeding. The result is inconsistent with other studies in the highlands of the region (Mengistie, 2008; CSA, 2006). The mean number of rams (1.29), both Washera and locals, was more than what is needed and violates the 1:20-25 ram to breeding ewes ratio in year round mating. The higher proportion of rams in the flocks could be due to farmers offered the Washera rams in addition to their local ram before selling or castrating them.

The higher proportion of rams decreases the efficiency of the rams since it makes them idle; and the farmers knowingly or unknowingly castrates the rams after some crosses get born. This is because the farmers think that the rams replaced their progeny.

Table 4 - Average flock size and composition of the surveyed flock

Classification variable	N	Mean	Range	Composition
Flock sizes	23	9.17(4.19)	4-18	100.00

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Number of mature ewes	4.39(1.92)	2-10	47.87
Number of mature rams	1.29(0.47)	1-2	10.40
Number of ewe lambs (6-12 Months)	2.22(1.09)	1-4	9.47
Number of ram lambs (6-12 Months)	1.71(1.49)	1-5	5.68
Number of lambs (<6 Months)	2.90(1.65)	1-5	27.50

Growth performances

The age of sheep was estimated based on dentition classes. From the total observed Washera rams (31), only two of them were with 3 permanent incisors (PPI) and most of the distributed rams (12, 9 and 8) were with 0 PPL,1 PPL and 2 PPL respectively. They were distributed to the farmers when they were very young (with milk teeth).

The overall mean body weight (kg) of Washera rams obtained in the current study was 39.63±1.66 (Table 5). There was a significant difference (P<0.01) between dentition classes, that rams with 3PPI were heaviest and those with 0PPI were lowest in weight than other dentition classes. The overall mean wither height obtained was 71.38±1.20 cm and was significantly affected by age category. Rams with 1 and 2PPI were higher. Heart girth (80.49±1.40 cm) also was significantly affected by age; older rams had larger heart girth than those with 0PPI.

Scrotal circumference, measured for intact rams as the circumference of the scrotum at the wider area, was 25.17±0.34 cm. This figure is within the range of values reported for Menz and Horro rams at one to two years of age (Tibbo et al., 2004). It was significantly affected by age of the ram; rams with 0PPI had smaller scrotal circumference than older ones. Scrotal size could differ between breeds and even within breeds; there was significant difference between age groups and circumference increased with age (Girma, 2008).

The performance figures obtained in the current study were by far better than the performance observed for the same breed of rams at Adet and Quarit districts which is the home land of the breed (Mengistie et al., 2009). This difference might be because; the rams in the current study were managed in a better way than those in Quarit and Adet. Thinking of the rams need extra care, because farmers think these rams are improved, farmers gave better attention for the distributed rams. The other thing is, the rams were idle; the rams did not give the intended service since the number of ewes were so small. In addition some farmers castrated and fed fattening diet to their rams to fatten them.

Table 5 - Weight and body measurements (Mean±SE) of Washera rams under the farmer's management in the surveyed areas

Classification variable	N	Weight (kg)	Wither Height (cm)	Heart Girth (cm)	Body Length (cm)	Scrotal Circ. (cm)	Body Condition[1]
Overall	31	39.63±1.66	71.38±1.20	80.49±1.40	62.84±1.34	25.17±0.34	4.02±0.24
Agro-ecology		NS	NS	NS	NS	NS	NS
Dega	14	39.06±1.79	71.68±1.27	80.49±1.48	63.56±1.49	24.80±0.50	4.18±0.26
W/dega	17	40.19±1.71	71.09±1.48	80.49±1.73	62.11±1.73	25.53±0.46	3.86±0.31
Age category		**	**	*	NS	*	*
0 PPI	9	29.10±3.14^{d}	71±50±2.00^{bc}	73.42±2.34^{b}	60.45±2.35	23.00±0.52^{b}	3.13±0.46^{b}
1 PPI	12	33.89±3.06^{c}	75.45±1.95^{a}	77.81±2.28^{a}	62.63±2.28	25.30±0.60^{a}	3.61±0.44^{ab}
2 PPI	8	40.76±2.78^{b}	74.79±1.77^{ab}	82.36±2.07^{a}	63.13±2.07	27.20±0.64^{a}	4.17±0.40^{a}
3 PPI	2	54.76±4.49^{a}	63.79±3.64^{c}	88.36±4.25^{a}	65.13±4.26		5.00±0.65^{a}
Breeding status		NS	NS	NS	NS		NS
Castrate	3	40.43	73.30±2.64	82.13±3.08	63.99±3.09	-	3.69±0.59
Intact	28	38.82	69.45±1.32	78.84±1.54	61.68±1.55	-	4.35±0.27

[1]BC = Body condition score (1 to 5: 1= poor, 2= medium, 3= fair, 4= good & 5= very good); N: number of observations; NS=non-significant (p>0.05); *p<0.05; **p<0.01; ***p<0.001

Among the 31 physically assessed rams 28 (87.5%) were intact and were giving service while only 3 (9.4%) were castrated. According to the farmer's judgment, 71.43%, 14.28% and 7.14% of the breeding rams had good, fair and poor libido performance, respectively. The difference in libido performance between the rams might be because, the rams were purchased with no any selection criteria (eg. libido test), even some were with poor testicle condition (small and of un-equal size). Libido could be different between rams of different age, health status; body condition and even up to 15% of the rams are homo-sexual and will not mate with ewes (Girma, 2008).

Even though, distribution of Washera rams has been started since 2005, the numbers of crossbred sheep observed in the field were very small. This might be because, since the crosses could fetch better price, they are sold out without considering for replacement stock and the farmers castrated the rams before they give the intended service. In addition, the flock size in the surveyed areas is small.

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The mean weight and body measurements of Washera × Farta crossbred progenies are presented below (Table 8; Figure 1). The mean values obtained for different age groups in the present study were in comparison with the mean values of Washera sheep with comparable age groups (Mengistie et al., 2009) and were higher for Menz and Horro sheep (Tibbo et al., 2004).

Table 8 - Mean (SD) of weight and body measurements of Washera x local progenies under the traditional management in the surveyed areas

Classification variable	N	Weight	Height	Heart Girth	Body Length	Body Condition[1]
Age						
2-3 months	2	12.20 (3.11)	50.50(6.36)	49.50(10.61)	45.00(4.24)	2.50(0.71)
4-5 months	19	15.14(2.17)	57.68(2.63	58.00(3.32)	48.78(2.99)	3.00(0.47)
6-7 months	11	20.63(3.45)	60.91(5.43)	64.54(4.67)	53.63(2.36)	3.27(0.47)
8-9 months	4	22.37(5.34)	63.75(6.95)	67.00(2.94)	55.25(5.12)	3.33(0.57)
12-16 months	23	20.81(7.32)	61.60(6.79)	63.71(7.77)	53.35(6.82)	3.04(0.64)
Sex						
Female	22	19.42(6.37)	59.00(6.04)	61.91(6.99)	52.14(5.83)	3.04(0.50)
Male	37	18.31(5.54)	60.59(5.86)	61.73(6.93)	51.61(5.39)	3.08(0.59)

[1]BC = Body condition score (1 to 5); N: number of observations

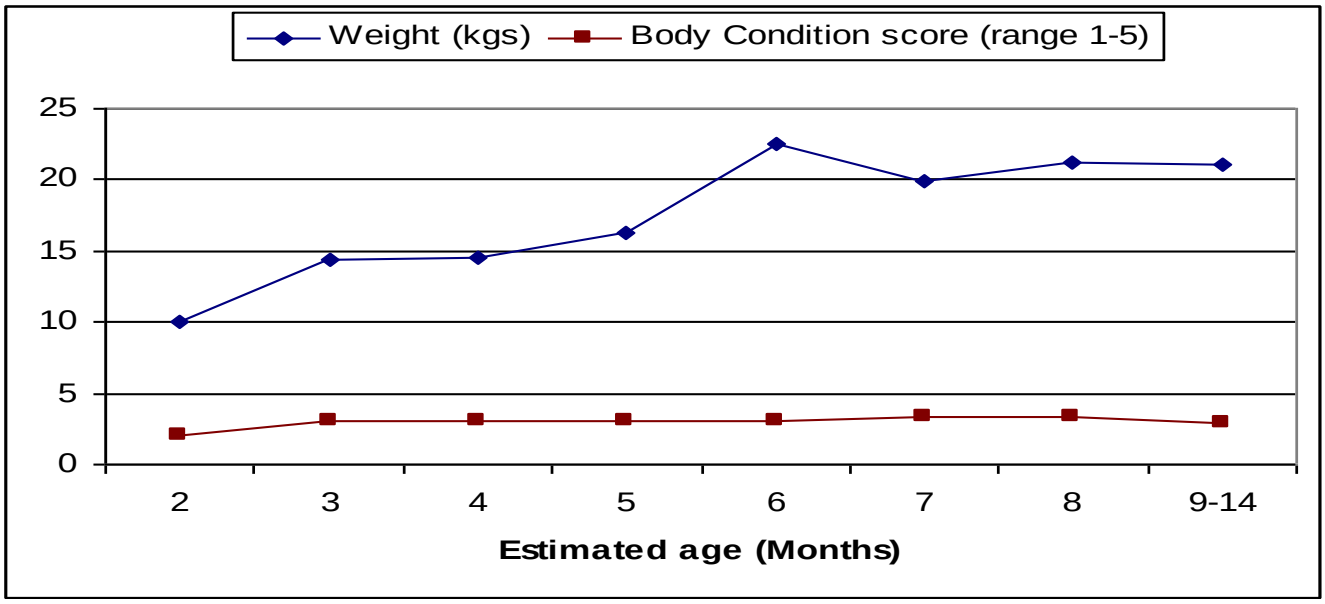

Figure 1. Growth of Washera × Farta crossbred sheep

CONCLUSIONS

The results obtained indicated that Washera breed of sheep is adaptive and productive in areas of south Gonder zones. To increase the reproductive performance of the rams, Washera rams should be bought with careful assessment including where and when to buy. Purchase should consider some criteria like age, conformation and condition. In order to make the distribution successful, a strategy that could make use the rams in a communal way should be designed. Rams could be offered for farmers with in a common grazing land by adjusting the number of breeding ewes and rams. Farmers in the targeted distribution area should be organized into village level community sheep improvement program involving integrated genetic and management improvement to increase sheep productivity. Training of farmers about breeding and management of sheep is needed. In addition, the distribution should be takes place on the recommended area that is suitable for adoption and diffusion of the technology. From the point of conserving and utilizing the animal genetic resources, a strategy to improve and conserve the Washera sheep from its belt needs to be designed.

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A COMPARATIVE STUDIES ON THE CHEMICAL AND PHYSICAL ATTRIBUTES OF WILD FARMED NILE TILAPIA (OREOCHROMIS NILOTICUS)

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ABSTRACT: *The research was directed towards the study of the fish species Orcochromis niloticus (Trewavas), formerly Tilapia nilotica (Linnaeus) in order to comparing the chemical composition and fish body weight characteristics of its farmed with their natural counterpart (collected from Nile River). Forty nine assorted fish species of each group (Tilapia noliticus) were randomly collected fresh from Sudan University Fish Farms and Nile River. For two groups the filleting yield (head, skin, viscera, fins and skeleton and fillet were taken) and chemical analysis were performed. The sequence percentage variation of fish body weight components in each fish was varied among studied species. Thus the order tend to decrease from fillet, head, fins and skeleton, viscera and skin in farmed fish and from fillet, head, fins and skeleton, skin and viscera in wild fish. Concerning the chemical analysis of major body constituents of studied fish whose main elements moisture, dry matter, ash, protein, fat and NFE were determined. Protein and fat content level was found to be significantly different (P<0.05) while moisture, dry matter, ash, NFE was insignificantly different (P>0.05) in the farmed and wild fish species.*

ORIGINAL ARTICLE

Keywords: *Chemical, physical attributes, wild, farmed Nile tilapia, Oreochromis niloticus*

INTRODUCTION

From nutritional point of view fish composite of very high nutritional quality, it is rich in most of vitamins, proteins, minerals, fats and essential amino-acid and a nutritious part of human diet an idea which had been justified by some biological experiments that it is nutritionally equivalent to those of meat, milk, eggs (FAO, 1995a). This properly placed fish in an especially important category of food.

The study of chemical composition of fish is an important aspect of fish flesh quality since it influence both keeping quality and the technological characteristics of the fish (Huss, 1988).

The state of world fisheries and aquaculture 2006, review total capture fisheries production globally in 2004 reached 95.0 million tones, an increase of 5% in composition with 2003, when total catch had declined to 90.5 million tones (Non, 2006).

Preliminary estimates for 2005 global capture production indicate that in land water catches have increased by almost 0.4 million tones and marine catches have decreases by over 1.5 million tones (Non, 2006). However, less than one third of the marine captured production last in 2005 in comparison with 2004 can be attributed to be high variability of Peruvian anchoveta, as total catches of all over marine species combined were reduced by about 1 million tones (Non, 2006).

Aquaculture production contribution to global supplies of fish, and other aquatic animals continued to grow, increasing from 3.9% of total production by weight in 1970 to 27.1% in 2000 and 32.4% in 2004 (Non, 2006). Africa and Asia continue to contribute about 90% of the world total and their shares are fairly stable (Non, 2006).

Fish production and management in Sudan fisheries resources is endowed with enormous aquatic and fisheries resources (Non, 2002). The fish potential in the Sudd Region has been estimated at 75000 year/tons while the reported landings have not exceeded 3000 tons per year (Non, 2002). Fresh water, fish culture started in Sudan in 1953, with the establishment of the experimental demonstration fish farm within the premise of the fisheries research centre in Khartoum production from these farms has been extremely low, with a maximum of

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1000 ton per year. Fresh water fish culture has not developed, due to serious handicaps including limited skilled personnel, inadequate research extension and infrastructure facilities and limited operational funds (Non 2002).

The variations in the chemical composition of fish are closely related to the environment of rearing in ponds or nature and completely depend on feed intake. During periods of heavy feeding, at first the protein content of the muscle tissue will decrease very slightly and then the lipid content will show a marked and rapid increase. Fish will have starvation periods for natural and physiological reasons (Bendall, 1962).

To compare the chemical analytic composition of farmed fish with their natural counter parts is complex study, should be emphasized with more specialized geographical influence with diet playing an important role (Malcolm, 1977) culture fish tend to be deficient in body protein and ash and that they almost always contain more lipid than do wild fish, such lipid being the more saturated. The chemical composition of fish varies greatly from species to one individual to another depending on age, sex, environment diet, and season.

Concerning comparison on the proximate chemical composition and physical characteristic and filleting yield between cultured and wild Nile Tilapia (*Oreochromis niltoicus*) little work has been carried out in Africa in general and almost nothing in Sudan in particular (FAO, 1992 and 1995a).

The man Objective of this study is to show a comparison on the chemical composition, physical attributes and filleting yield between cultured and wild Nile Tilapia (*Oreochromis niloticus)*.

MATERIALS AND METHODS

Locality

The study was conducted at Sudan University of Science and Technology college of Veterinary Medicine and Animal Production Department of Fisheries and wildlife science 10km east of Khartoum.

Samples and Experimental trial

A total of ninety nine of commercially fish (Wild) and farmed samples of (Trewavas, 1982), formerly *Tilapia nilotica* (Linnaeus, 1957) of Nile Tilapia (*Oreochromis niloticus)* belonging to family Cichlidae (Local name: Bulti), were selected for this study. Standard and total lengths of the each sample group were determined and recorded (in cm) using measuring board (100 cm in length) and total body weights were recorded in gam. Then, fishes were filleted, eviscerated, de-headed and skinned using sharpen knives. The weight of viscera, fillets (with ribs), head, skin, skeleton and fins (with some adhesive meat) weighed separately using weighing balance (10 kg).

The whole fish body each of each fish group of wild and farmed *Oreochromis niloticus* species were trimmed and ground homogenously using blending machine (Maframa) and placed in insulated plastic bags and chilled in refrigerator, then the samples were taken to laboratory of central veterinary research laboratories centre (Soba) South of Khartoum for proximate analysis following the procedure given by AOAC (1980).

Statistical analysis

The data of this study were analyzed statistically, using computer statistical package (SPSS version 10) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Tables 1 and 2 show summary of filleting yield, chemical composition and statistical analysis of wild and cultured Nile tilapia (*Oreochromis niloticus)*.

The finding of the present study showed some stark fact on the manifesto of the popular cultured fish emphasizing on chemical composition between wild and farmed *Oreochromis niloticus* which serves as the principle basis in evaluating the nutritional and economical value of the fish.

The proximate chemical composition analysis clearly revealed that, a distinct variation on the chemical composition of the studied fish. The protein and fat percentage level of *Oreochromis niloticus* from Nile river site was found to be 22.70 and 7.78 and from fish farms was 21.05 and 7.32. This agree with Agab and Babiker (1987), they reported that the range of protein and fat content level in fish flesh lies in between 18.12-28.5% for protein and 10.6–22.5% for fat, while Karrick et al. (1956) and Remijo (1992), they indicated that protein and fat was ranged between 6–28% and 0.1–67% as reported by El Taly (1994), Eyo (1991) and Mgawe (1991).

However these results were clearly revealed that wild fish had its better than farmed species in accordance with the percentage of protein and fat content, this might be, interpreted by the fact that since the fish collection took place during May (Autumn) the wild fish might has already stored body fats and protein during the its feeding period, whereby it tends to have higher protein and fat levels. Also this might be due to natural geographical distribution as the fish exclusively inhibit a wider range of ecosystems evolved as riverine fishes living in marginal waters, flood, plain, and pools and, they are adopted to Lacustrine conditions and different feeding habits and patterns as tilapia are generally herbirorous and omnivorous Pike and Brown (1967).

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Table 1 - Shows summary of mean yields of different body parts of Nile Tilapia (Oreochromis niloticus) collected from different sites

Parameter / Treatment	Total Weight (g)	Total Length (cm)	Standard Length (cm)	Head (%)	Skin (%)	Viscera (%)	Fins & Skeleton (%)	Fillet (%)	Inedible parts (%)	Edible parts (%)
Wild Fish	288.2±47.97	23.7±1.30	19.67±1.30	28.0	8.2	7.8	16.5	32.2	60.5	32.2
Cultured Fish	365±161.70	21.7±2.74	17.50±3.08	25.4	5.8	6.2	18.6	37.1	56.0	37.1

Values are the mean of 49 fish samples for each. SD=Standard Deviation

Table 2 - Shows summary of statistical analysis and chemical composition components of wild and cultured NileTilapia (Oreochromis niloticus) collected from different sites (mean±SD)

Parameter / Treatment	Total Weight (g)	Total Length (cm)	Standard Length (cm)	Moisture (%)	Dry Matter (%)	Ash (%)	Protein (%)	Fat (%)	NFE (%)
Wild Fish	288.2±47.97	23.7±1.30	19.67±1.30	72.5±4.35	26.7±5.14	2.80±0.26	22.70±82	7.78±0.12	28.96±4.18
Cultured Fish	365±161.70	21.7±2.74	17.50±3.08	74.08±3.08	25.96±3.11	2.98±0.36	21.05±64	7.32±0.17	32.70±2.87
Standard Error	24.53	0,48	0.42	0.77	0.85	6.58	0.22	5.68	0.82
Significance Level	-	-	-	N.S.	N.S.	N.S.	**	**	N.S.

Values are the mean of 12 fish samples for each. SD=Standard Deviation. NFE=Free nitrogen Electron

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The lower percentage level of fat and protein content in farmed fish might be due to insufficient and less nutritive value of the artificial supplement feeds, less digestibility, poor water quality and mis-management.

The chemical and biological characteristics of water in artificial aquaculture pond are extremely complex neither natural water. There is a close interaction between chemical equilibrium and various physical, biological and edaphic factors. These factors affects and are affected by changes in the chemical equilibria and the cycle in the pond which reflects in the fish species as described by Borgstrom (1962).

As demonstrated above, the proximate analysis data of the same fish species showed a significant variation. This is due to several environmental conditions, dietary and physiological factors, seasonal variation, sexual maturation, size, feeding cycle (Borgstrom, 1962). These factors are observed in wild, free-living fishes on the open sea and in inland waters. Fishes raised in aquaculture may also show variation in chemical composition, but in this case several factors are controlled, thus the chemical composition may be predicted. Factors such as feed composition, environment, fish size, and genetic traits all have an impact on the composition and quality of the aquaculture fish.

From ecological part, this fish species belong to the same trophic levels, *Oreochromis niloticus* is a vegetarian (Abu Gidiri 1982). The effects of environmental condition on fish major chemical constituents especially fat were to be more obvious in fishes feeding on lower trophic levels, as appeared in this study. The major physico-chemical and biological characteristics of each site starkly effective on the chemical composition and physical characteristics of each fish differently and indirect. The level of oxygen, together with temperature, consequently play a great role in the water quality and hence food consequently production. These factors could be played a major role in chemical constituent's variation in our studied species.

The dry matter showed a slight variation between the two treatment studies 26.7 and 25.9 as well as the nitrogen free electron (NFE) 28.9 and 32.7 respectively. Ash content was found to be of 2.8 and 2.9. In all the treatments the moisture percentage level increases while the percentage of total fat level decreases and vice versa. The protein percentage also increases with the decrease in fat percentage, and ash percentage show a little variation than the rest of the constituents of the fish flesh.

The proximate chemical composition results of body constituents were showed protein and fat were significantly different ($P<0.05$) while moisture, dry matter, ash and nitrogen free electron (NFE) were insignificantly different ($P>0.05$) between the studied species.

The fillet was found to be 32.3 and 37.1% in wild and farmed species respectively this was disagreed with the findings of Hassan (1996) who mentioned that the edible parts is ranged between 45–50% and percentage levels differ according to the shape and body size of fish. These findings in the line of Obanuand Ikeme (1988), and agrees with Omer (2000) who found that the fillet percentage ranged between 32.8%-42.92.

This lowest fillet yield might also be attributed to large head, viscera and method and techniques of filleting. Also the results showed a decreasing order of fillet, head, fins and skeleton, viscera and skin for cultured fish and decreasing order of fillet, head, fins and skeleton, skin, and viscera for wild fish respectively. This in agreement with the findings of Mac (1992) and Mac (1996) who carried out study on meat yield and nutrition value determination of Nile Tilapia (*Orechromis niloticus)* and *S. galilaenous* he found that the physical characteristics of the species has a decreasing order of fillet, head, fins and skeleton, viscera and skin for Tilapia and this in agreement with the findings of Abanuand and Ikeme (1988) who reported that the weight of whole fish and weight of fillets were highly significant difference to each other. It also agrees with Reay et al. (1943) and Vanwyk (1944), they reported that the amount of fish flesh varies with size, age, sexual status and season of captures, this disagree with the findings of Remijo (1992). The result of the fish body weight characteristics has clearly revealed that the percentage of fillet, head, fins and skeleton, viscera and skin between the studied species differ significantly this variability might to attributable to differences of food intake, diet, size, age, sex, season of capture and environmental conditions.

It could to be concluded that there was slightly differences between the wild and cultured tilapia species in term of chemical composition and physical characteristics, but the percentage of edible parts was recorded a higher in wild than cultured species.

The detailed analysis of fish chemical composition coupled with feeding intake relevance to different environmental condition and seasons should be targeted as the basis of comparing fish proximate chemical composition and grading in further studies

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FILLETING YIELD AND PHYSICAL ATTRIBUTES OF SOME FISH FROM LAKE NUBIA

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ABSTRACT: *Five commercially essential fresh water fish species were collected from Lake Nubia Northern part of the Sudan, consisting of thirty samples each of Bagrus bayad (Bayad), Bagrus docmac (Kabarous), Barbus bynni (Bynni), Labeo coubie (Kadan) and Synodonis sp. (Gargour), these fish species were investigated for physical, filleting yield and body weight characteristics. It was observed that the yield of fish was a reflection of its structural anatomy. Fish with small heads and viscera regardless of the season of spawning as in the case of Bagrus bayad produced a higher filleting yield than those with larger heads and viscera as in the case of Synodonis sp. Using a linear regression analysis, no significant difference was found (P>0.05) and the size of the fish was linearly related to the filleting yield. The physical attributes such as water holding capacity (WHC), cooking losses and sensory evaluation were employed. The results show variation in WHC ranged from 1.53–3.35, cooking losses from 18.17–25.40 %, while sensory evaluation shows that the Bargus docmac scored panel test marks (5.97), which was the most preferred than the rest of the studied species.*

ORIGINAL ARTICLE

Keywords: *Filleting yield, physical attributes, fish species*

INTRODUCTION

Study of characteristics of fish quality requirement and assessment indices are basic trade relations processes in deciding prosperity of commercial fisheries products. Therefore, study of fish products are deemed to be of paramount importance (El Tay, 1994).

Processors, nutritionists and consumers, all have direct interest in the physical and chemical composition of fish. This can be done through the studying of general condition of fishes via studying their body weight, body length and filleting yield indices. This allows some flexibility in assessing the actual amount of fish tissue consumed and inedible parts discarded.

Lake Nubia together with Lake Nasser formed the second largest human–made Dam in the world after Lake Volta in Ghana (El Shahat, 2000). It was established in 1964 after the construction of High Dam (Ents, 1974) and extends from Cataract at Dal in the Sudan to Aswan in Egypt. The Reservoir is about 480 km long consisting of 300km (Lake Nasser) in Egypt and 180km (Lake Nubia) in Sudan (El Shahat, 2000).

The most predominant fish families in commercial fish landings of Lake Nubia are Cichlidae (*Tilapia sp.*) Cyprinidae, (*Labeo sp.*), Centropomidae (*Lates niloticus*), and Bagridae (*Bagrus bayad* and *Bagrus docmac*), which is not, less than 80% of the total catches (Ali *et al*., 1992). The highest total fish production was 34206 ton in 1981 and the lowest was 751 ton in 1966 (El Shahat, 2000).

Little work has been done in the Sudan concerning fish flesh quality, filleting yield and body weight characteristics particularly in Lake Nubia. However, fragmented work was done by a few Sudanese researchers namely Ali et al. (1992), Hassan (1996), Jok (1996), Ali, (1977) and Ali, (1993) in Lake Nubia and Khalifa et al., (2000) and Pitcher & Preikshot, (2000) in Lake Nasser. The studies of these researchers were concentrated on the body weight characteristics; yield assessment, physical and proximate chemical composition of some commercial fish species of the Lake Nubia and Nasser landings for duration of two decades. The species studied included *Lates niloticus*, *Tilapa sp., S. galilaeous, Labeo niloticus* and *coubie, Synodontis sp., Barbus bynni, Bagrus bayad, Bagrus*

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docmac. The results of body weight composition and yield indices revealed clearly that the percentage decreased in the order of fillet, head, skeleton, viscera and skin for the most of studied fish species.

The objectives of this study are to evaluate and assess the yield of edible and inedible tissues and physical attributes of some important fish species from Lake Nubia represented by three different families and classes of fishes.

MATERIALS AND METHODS

Sampling Site

The sampling site was chosen at Lake Nubia on the River Nile, Northern part of the Sudan on Egyptian border. The Lake extends along latitudes 20º - 27º North, and longitudes 30º - 35º East through the Nubian Desert.

Experimental Species

A total of 150 assorted commercially fish samples, belonging to three families, were selected for this study. These families were Bagridae, Cyprinidae and Mochocidae. The studied fishes were represented by five species, namely, *Bagrus bayad* (Forscal, 1775)*, Bagrus docmac* (Forscal, 1775)*, Labeo niloticus* (Ruppell, 1832), *Barbus bynni and Synodontis sp*. (Block-Schneider, 1801). Each species was composed of 30 samples. The samples were collected fresh from fishermen at landings area, washed with tap water to remove any adhering material, and then placed in insulated boxes with crushed ice for preservation during assessment. The mean body weights of the samples were 1228.5 g, 1848.1 g, 960 g, 1221.4 g and 641.7 g, respectively. The whole fresh samples were taken to laboratory in Nubia Fisheries Plant (LNFP) where their total and standard length were recorded (in cm) using measuring board (100 cm in length) and total body weights were recorded in grams. Then, fishes were filleted, eviscerated, deheaded and skin was removed from scaled fishes (*B. bynni* and *Labeo coubie*) and left for scaleless fishes (*B. bayad, B. docmac and Synodontis sp.*) using sharp knives. The weight of viscera, fillets (with ribs), heads, skins and skeletons (with some adhesive meat and fins) were weighed separately using weighing balances (10 kg capacity for large fishes and 2 Kg capacity digital balance for small samples).

Sensory evaluation

Sensory evaluation of samples was carried out using nine panelists comprised of senior members of staff and some students of College of Animal Production, Department of Meat Science. For each session random samples were cooked and prepared carefully, and then random samples were offered to panelists in panel room. Every treatment was given a random code number, which was changed in each session. The assessors scored for color, texture, flavor and juiciness. An overall acceptability score was given to cooked fish using an eight-point hedonic scale, where eight was extremely desirable while one was extremely undesirable.

Water holding capacity

Three grams were taken from every sample of fish species, placed on filter paper and then 25 kg load was placed on the top of the sample for two minutes. The water released was absorbed by filter paper. The amount of squeezed water was determined by difference between two rings and was expressed as percentage.

Cooking losses

The samples to be used for determination of cooking losses were randomly selected. Every sample was weighed separately and placed in aluminum foil and cooked in oven (100º C). Samples were allowed to cool to room temperature then reweighed. The cooking losses were determined by weight difference between cooked and uncooked samples and expressed as a percentage (Ziprin et al., 1981).

Statistical Analysis

The data of the present study were analyzed using statistical methods according to social science software (SPSS, version 10), one way analysis of variance (ANOVA) and regression line as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results of this study shed a light on some physical, body weight characteristics and filleting yield of five commercially fresh water fishes. Table 1 shows a significant variation in the mean body weight, standard length and filleting yield indices of fish investigated. The fillet percentage was highest for the *B. bayad* at 46.86 % and lowest for *Synodontis sp*. (40.80%). The highest filleting yield of *B. bayad* was due to small viscera (4.48 %) and skeleton (20 %) while the lowest filleting yield of *Synodontis sp*. was due to its large head, which measured 33.55 %.

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The least variable component of the filleting yield indices was the viscera, which were more or less uniform except for *Labeo coubie* and *Synodontis sp*., which recorded highest percentage of viscera (11.40% and 11.39%, respectively).

Table 1 - Average filleting yield indices (± standard error) of five fresh water species from Lake Nubia

Parameter / Species	Total Wt. (g)	S.L (cm)	Fillet (%)	Viscera (%)	Head (%)	Skeleton (%)	Skin (%)	Edible Parts (%)	Inedible Parts (%)
Bagrus bayad	1228.5 ±0.12	46.10 ±1.39	46.86^{b} ±0.23	4.48^{a} ±1.38	25.00^{a} ±0.28	20.00^{a} ±0.70	-	46.86 ±0.23	49.54 ±0.95
Bagrus docmac	1848.1 ±1.68	41.46 ±0.62	45.90^{b} ±0.33	6.62^{a} ±0,29	27.83^{a} ±0.64	15.67^{a} ±0.81	-	45.90 ±0.33	50.21 ±0.77
Barbus bynni	1221.4 ±0.10	38.90 ±0.25	44.80^{b} ±0,09	7.37^{a} ±0.32	13.04^{a} ±1.21	21.96^{a} ±1.38	9.65^{a} ±1.04	44.80 ±0,09	52.02 ±0.21
Labeo coubie	957.3 ±0.28	32.20 ±0,80	43.31^{b} ±0.21	11.40^{a} ±1.15	14.17^{a} ±1.07	18.38^{a} ±0.11	9.14^{a} ±1.00	43.31 ±0.21	53.05 ±0.09
Synodontis sp.	641.7 ±1.35	28.20 ±1.39	40.80^{b} ±0.74	11.39^{a} ±1.15	33.55^{a} ±1.36	14.05^{a} ±1.42	-	40.80 ±0.74	58.99 ±1.86
SD	39.74	6.31	4.75	2.73	7.94	2.28	0.25	4.75	3.36

^{a,b} Values are mean percentage of 30 samples of each species. means in the same column bearing the same superscripts are not significantly different at (P>0.05).

The body weight characteristics and filleting yield indices revealed clearly a percentage decrease in the order: fillet, head, skeleton and viscera for *B. bayad, B. docmac and Synodontis sp*. while the percentage decrease order for *Barbus bynni and Labeo coubie* was: fillet, skeleton head, viscera and skin. These results were in agreement with Eyo (1991), Abanu and Ikeme (1988) and Ali et al., (1992).

Synodontis sp. and *B. docmac* possessed large head (33.6% and 27.8%, respectively) which had an adverse effect on the filleting yield of their bodies. Also there were some attributes, which were responsible for decreasing the filleting yield such as skeleton and skin in the case of *Barbus bynni* and *Labeo coubie*, which recorded 21.96 %, 18.34% for skeleton and 9.14 % for skin, respectively.

B. bayad had moderate head and skeleton weights which resulted in the high filleting yield (46.88 %) among the studied fishes, although the head of the B. docmac was large compared to the rest of its components. This did not affect its filleting yield which was (45.90 %) because it had lower skeleton percentage (15.70%).

Generally, the filleting yield of the studied fish species was a reflection of their anatomy i.e. species with large heads and skeleton relative to musculature give lower filleting yield than those with smaller heads and skeletons (Eyo, 1991; Ali et al., 1992).

On the other hand, Synodontis sp. had high inedible parts (head, skeleton and viscera) that recorded 58.99% whereas B. bayad recorded relatively less inedible parts (49. 54 %). These inedible parts are often discarded except for a few considerations where head, skeleton and gonads are used as by-products and sometimes used as diet for low-income people.

The edible parts (fillets) weight of studied fishes was very low when compared with fishes such as Carp (53 %) and Trout (70%) (FAO, 1985). Generally, the percentage of body components of inedible parts (skin, skeleton, viscera and head) of the fresh water fishes was in most cases, higher than the edible parts (fillet) (Table 1). Since these inedible body components (head, skeleton, skin and viscera) are usually discarded except for a few considerations where heads and skeletons are eaten, the purchaser may thus suffer economic loss. Therefore, the use of such inedible parts for manufacture of fish silage or fish meal in different fisheries sectors is suggested.

Little work has been done in Sudan concerning sensory evaluation of fish products. The organoleptic test was carried out for the treated samples to evaluate the mean value of color, texture, flavor and juiciness depending on the personal preference score (Table 2).

Table 2 - Mean organoleptic scores for five fresh water fishes

Treatment / Species	Color	Texture	Flavor	Juiciness	Overall Acceptability
Bagrus bayad	5.8^{a}	5.6^{a}	5.9^{a}	5.8^{b}	5.85
Bagrus docmac	6.2^{a}	6.1^{a}	5.7^{a}	5.9^{b}	5.97
Barbus bynni	5.3^{a}	5.2^{a}	5.6^{a}	5.2^{b}	5.31
Labeo coube	5.9^{a}	5.5^{a}	5.5^{a}	5.4^{b}	5.57
Synodontis sp.	5.7^{a}	5.7^{a}	5.2^{a}	5.4^{b}	5.62
SE	0.47	0.48	0.42	0.49	0.43

^{a,b} Values are mean percentage of 30 samples of each species. Means in the same column bearing the same superscripts are not significantly different at (P>0.05).

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The study showed no significant difference (P<0.05) in the parameters of color, texture and flavor for all samples. However, for the parameter of juiciness there was a significant difference observed (P<0.05). This might be due to the effect of water holding capacity and the cooking method. The juiciness was considered to be related to water holding capacity as it was preferred by the panelists. This finding was in agreement with Tibin (1982), Bennion (1980) and Cross et al. (1979).

The overall acceptability scores obtained during this study would closely be related to the overall preference of the consumer for the samples. Remarks made by individual panelists of the organoleptic test showed that *B. docmac* (5.97) was the most preferred one among the studied fishes. This might be attributed to its good color (6.2) and texture (6.1), while *Barbus bynni* scored the lowest marks due to fewer score of color (5.3) and texture (5.2).

Concerning cooking losses, the mean values of samples as given in Table 3, which ranged from 18.9–25%, were in agreement with Culcas (1981) and Tibin (1982) who reported that heat causes the protein in muscle fibres to coagulate and the flesh becomes firmer which resulted in some shrinkage and a lot of weight lost. The cooking losses materials are composed of drip losses, evaporation and material that accumulated in aluminum foil. Factors behind the losses of cooking were the internal temperature of meat, cooking time, method of cooking and pH of flesh. Similar findings were reported by Osman (1995) on flesh of *Labeo niloticus* where the losses were found to be 20 %.

Table 3 - Water holding capacity and cooking losses of five fresh water fishes

Treatment Species	Water holding Capacity (%)	Cooking losses (%)	Significant level
Bagrus bayad	2.62	18.17	*
Bagrus docmac	3.35	22.13	*
Barbus bynni	1.75	25.48	*
Labeo coube	1.77	21.34	*
Synodontis sp.	1.59	19.59	*
SE	0.78	2.46	–

Values are means of 9 samples for each species

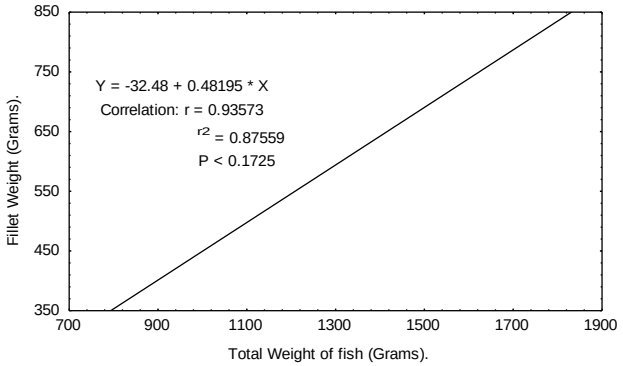

Figure 1 - The regression line of the relationship between fillets and total weight of studied fish from Lake Nubia

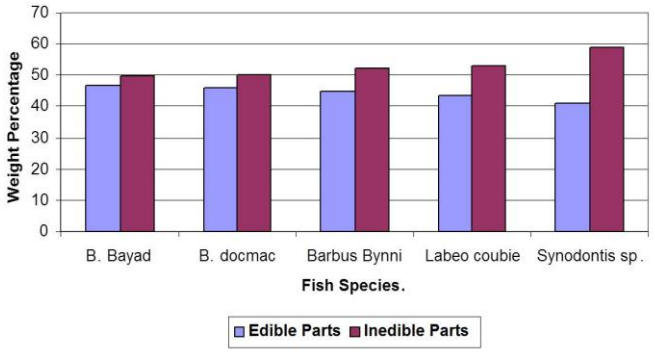

Figure 2 - Shows the relationship between edible and inedible parts studied fish species

The value of water holding capacity (WHC) of the flesh of fish studied, as given in Table 3, were variable from fish to another. *B. docmac* had highest WHC (3.35%), while the *Synodontis* sp. had lower value (1.59%). These results were in agreement with Hamm (1972), who attributed the variation to many factors such as species of fish, physiological condition, seasonal variation, age and stage of sexual maturity. Finally, the results revealed clearly that muscles (flesh) with high WHC were juicy and obtained high organoleptic scores than muscles with low WHC a result that confirmed the findings of Hamm, (1972), Tibin, (1982), Osman, (1995) and Huss, (1988).

It can be concluded that *B. bayad* had highest filleting yield (47%) followed by *B. domac* (46%), *Barbus bynni* (45%), *Labeo coubie* (43%) and the lowest one was *Synodontis sp*. (40%). The percentage composition of inedible parts of studied fish was higher than the edible parts. Also, flesh with high WHC was juicy and obtained high organoleptic scores.

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GROWTH AND DEVELOPMENT OF MUSCLES, BONES AND FAT OF RED-NECKED OSTRICH (STRUTHIO CAMELUS CAMELUS)

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ABSTRACT: *This study was conducted to evaluate the growth pattern of muscles, bones and fat of red-necked ostrich. Six ostrich chicks were captured and reared for 40 weeks and serial slaughters were done every eight weeks for evaluation. Results showed that the feed conversion ratio was 1: 5, Feed intake reached a peak at the 23rd week of age (161 days). The weight gain was high during the 16th week of age (112 days). Carcass yield was 57%. The great mass of muscle was found in the hind limb, highest bone percentage was found in the pelvis and the flank had high percentage of fat. Hind limb had high growth rate when compared with thorax, pelvis, wing, neck and flank*

Keywords: *carcass yield, body regions, serial slaughter*

ORIGINAL ARTICLE

INTRODUCTION

Growth is often measured as live weight gain per unit time; live weight could be a useful measure of growth as it is highly predictive of the amount of desirable edible products such as muscles. Carcass weight is more useful than live weight and the components of the carcass when measured, give a true picture of the benefit from the animal. Carcass composition is measured by the proportion of components, muscles, bones, fat and connective tissues.

Factors that affect carcass composition are slaughter, breed or genetic differences, sex and plane of nutrition, Nheta et al. (1997) said that sex has no effect on the growth rate of birds. The carcass is the most important unit in meat studies, since it finally settles the value of the meat animal, both for the farmer and the butcher, (Callow, 1948). The muscle is the most important tissue in the animal because it is most desired by the consumers. The superior carcass has a maximum yield of muscle, minimum of bone and an optimum amount of fat (Berg and Butterfield, 1976). Hammond (1932) stated that during their lives animals have two sets of muscles; early developing and late developing ones. So there must be causes for the changes in the proportion of individual muscles as animals grow. The growth of muscles can be measured by comparison of weights of the individual muscles on serial animal slaughters, and dissected throughout the lifespan of homogenous animals (weight, breed and sex) raised on a similar plane of nutrition. This method compares the percentage values of weight of individual muscles or muscle groups relative to total muscle weight at various stages of development (Berg and Butterfield, 1976). The growth patterns of the tissues show that the bones growing at a steady, but slow rate, the muscle grow relatively fast, so that the ratio of muscle to bone increases. In poultry the first ossification takes place 12 – 24 hours later in the form of laminae of bone which eventually fuse to form a thin, compact cylinder which is the periosteal bone collar (Hall, 1987). Long bone growth is a complex process which takes place in the growth plates located at the end, it consists of cartilage cells which form a template over which bone is laid. Fat is the most variable tissue in the carcass and it varies even in its partitioning among various depots and alters markedly throughout growth; therefore it has the greatest influence on both the amount of each of the other tissues in the carcass at any particular weight and the proportionate size of cuts. Fat comprises a relatively small amount of the carcass at birth and then increases so that it approaches and occasionally in very fat animals surpasses muscle tissues in absolute amount, (Berg and Butterfield, 1976).

Ostriches are large herbivorous, flightless birds, native of Africa, (Gegner, 2001). They were adapted to live in open arid countries. Their longevity is up to 75 years with an average of 50 years. Adult males can reach eight feet

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of height and weighing about four hundred bounds. The male has a black color with white wing tips and tail plumes. The female is smaller than the male with a grey color. Ostriches live in flocks of five to fifty in the wild and can do well under captivity (Donegan, 2002).

The early rate of growth of ostrich chicks is important in establishing the bird for subsequent growth up to slaughter mass. Hatching weight is dependent on the initial egg mass from which the bird emerges. After hatching, ostrich chicks lose up to 20% of their mass within five to seven days (Deeming, 1999). Goonewardene et al. (2003) studied the growth characteristics of emus compared with broilers and said that the mature weight of emus were estimated to be 49.5 kg and broilers were estimated to be 4.6 kg. The lifetime absolute growth rate of emus was 68.4 gram/day, and they matured 12.5 times slower than broilers, they concluded that growth efficiency of emus is poor and the feed cost per kilogram of gain is high, because emus are slaughtered late. Champion and Weatherly (2000) found that the peak rate of growth in ostrich is between 120 to 180 days of age when they are fed under grazing system, and the ostrich growth has a rapid decline after 10 to 11 months of age. Deeming and Ayres (1994) found that the growth rates of ostrich chicks in captivity were correlated with their weight on day ten of age and concluded that the growth of the ostriches appeared to be influenced by environmental factors. The genotype has a great influence on the carcass yields of ostrich. Hoffman et al. (2007) studied this effect in three different subspecies of ostrich which were South African Black, Zimbabwean Blue-necked and Zimbabwean Blue-necked X South African Black. They found that the live weight (100.9±4.2) and carcass weight (51.6±1.1 kg) were high in Zimbabwean Blue-necked and the dressing percentage was not differing significantly among the three subspecies. Harris et al. (1993) studied the carcass yield of ostrich and found that on the live weight basis the dressing percentage was 58.59%, and then they found that in further dissection the percentages of lean, fat and bone were 62.5%, 9.2% and 26.9% respectively. Also they found that the largest portion (34.6%) of the ostrich carcass was the semi-boneless leg and thigh; they comprise the majority of the muscle mass. Morris et al. (1995) said that the average percentage of ostrich carcass weight could reach 57-58% of the live body weight of 100-130 kg carcass composition consists of more than 62% lean meat and 9% fat, the majority of the lean portion of the ostrich carcass is found in the leg and thigh muscles (41.4%) and sex appears to has no effect on carcass composition or muscle color, total pelvic muscle mass (considering both limbs and assuming symmetry) of the ostrich was found to account for 33.7±2.1% of the body mass, corresponding to a unilateral mean pelvic limb muscle mass of 16.97±1.08 kg for a 105 kg ostrich live weight (Smith et al., 2006).

MATERIALS AND METHODS

Six red-necked ostrich chicks at approximate age of four to six weeks were captured from Dindir National Park, Sinnar State, 560 km south east Khartoum, Sudan. The birds were transported to the faculty of Animal Production–Elmanagil, University of Gezira, where this study was done. The six experimental captive chicks were lodged in a house of dimensions 7x9x3 m. The house was well protected using a mesh-wire of fine openings set over a half – meter brick wall up to the roof height which is made of corrugated metal. The ground was gritless concrete. The pen was equipped with two one-gallon flat plastic containers as feeders and waterers. When the birds reached the age of 16 weeks, they were transferred to an open pen of dimensions 10x15 m. surrounded with a brick wall 1.5 m. high and equipped with bigger feeders and waterers. Experimental birds were phase-fed with starter, grower and finisher rations (Tables 1 and 2).

The starter ration was a commercial broiler starter ration (20% crude protein and 11.65 MJ/kg metabolizable energy) fed for two weeks as adaptation feeding. The formula feed were the grower ration (17.15% crude protein and 8.55 MJ/kg metabolizable energy) which was fed for 24 weeks before the finisher ration (16.10% crude protein and 5.99 MJ/kg metabolizable energy) was fed for 12 weeks when experimental feeding was concluded. Ingredients for these rations were dura, groundnut cake, wheet bran, groundnut hulls, lucern and ostrich concentrate that is formulated by adding a premix of bone meal, fish meal and salt 6:3:1 respectively to a commercial broiler concentrate in a 1:1 ratio (Faki, 2001).

Table 1 - Percent composition (fresh weight basis) of ostrich experimental rations

Ingredients%	Starter	Grower	Finisher
Dura	70	40	20
Groundnut cake	18	08	06
Wheat bran	05	15	14
Groundnut hulls	-	24	44
Lucerne	-	05	10
Ostrich concentrate*	-	08	06
Broiler concentrate	05	-	-
Vitaminerals mix	02	-	-
Total	100	100	100

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Table 2- Percent chemical composition (dry-matter basis) of ostrich experimental rations

Components %	Starter	Grower	Finisher
Dry matter	95.00	91.58	91.37
Crude protein	20.00	16.25	14.32
Ether extract	3.26	3.20	3.13
Crude fiber	12.05	21.00	33.30
Nitrogen-free extract	40.2	45.10	34.04
Ash	07.31	6.03	6.56
Energy (MJ ME/kg)	11.65	08.55	05.99
Energy/protein ratio	01.82	01.91	02.39

Feed intake was recorded on the first day of experimental feeding and thereafter on daily basis by difference between offered and refusal. Weekly body weights were recorded to the nearest 0.5 kg at 7:00 am before feeding, using a small ruminants' balance for the starter/grower chicks and a ground level pressure balance for the grower/finisher birds. One bird was randomly selected for slaughter every eight weeks for carcass analysis and muscle groups study. The bird was allowed water but not feed for the last 12 hours before slaughter. The bird was first controlled using an S-shaped neck-catch before hooding the head with a black cloth. The legs were tied immediately to restrict the bird movement. Slaughter weight was recorded. The bird was hung by the legs to the slaughter arch allowing the head closer to the ground (Figure 1). The slaughter followed the Muslim practice. The right and left jugular veins and carotid arteries were severed by a sharp knife just behind the head. After complete bleeding; the blood was collected and weighed.

Feathers were manually plucked, collected and weighed. The head was removed at its occipito-atlantal articulation and weighed. The bird was dressed by making a longitudinal ventral incision extending from the neck up to the cloaca with lateral right and left incisions to the wings and legs at right angles. The skin was then removed and weighed. The bird was reversed and hooked by the wings. The feet were removed at the tibiotarsal (hock) joint and weighed. A longitudinal ventromedial incision from the breast down to the abdomen was made to eviscerate the abdominal organs and empty the thoracic cavities. The tissues and organs; heart, lungs, trachea, esophagus, gastrointestinal tract, liver, spleen, left and right kidneys, cavity fat and genitals were each individually removed and weighed. The hot carcass was weighed first and the neck was removed at the last cervical vertebra. The hot carcass was then divided into right and left halves by sawing along the vertebral column. The left side was divided into six regions; hind limb, pelvis, flank, thorax, neck and wing. Each region was separated from the other by separating entire muscles from either origin or insertion. Each region was dissected to separate muscles, bones, connective tissues and fat, and each of the above regional tissues weight was recorded. The carcass, divided parts and dissected tissues, were all kept under wet towels to prevent evaporation and dryness.

RESULTS AND DISCUSSION

Average performance values of the red – necked ostrich of the final slaughter are shown in Table 3. Final weight was 66.0 kg and the feed conversion ratio was approximately 1:5. Aganga and Omphile (2003) said that ostriches have very efficient feed conversion ratio during the first thirty weeks until 45 weeks of age before a drop in feed conversion ratio occurred. In this study the same result was obtained and the feed conversion ratio was found to be 1:5 during 38 weeks of age.

Table 3 - Performance values (Kg) of the red–necked ostrich raised to 40 weeks of age

Item	Value
Initial weight	6.8
Final weight	66.0
Daily weight gain	0.350
Daily feed intake	1.669
Feed conversion ratio	1:5

Figure 1 illustrate the feed intake and weight gain of the ostrich raised to the final slaughter weight at 40 weeks of age. Feed intake reached a peak at the 23rd week of age (161 days). This result is similar to that found by Waugh et al. (2006) who reported the feed intake in ostrich gradually increased until 170 days of age (24 weeks of age) when it reached a peak. The weight gain of ostrich was found to be highest during the 16th week of age (112 days). This result nearly agrees with that found by Champion and Wetherly (2000) who found that the peak rate of growth in ostrich is between 120 to 180 days of age under the grazing system. The slight difference between the two results may be due to the better pattern of growth achieved in this study adopting captive intensive feeding.

The slaughter weights of the six serial slaughters (every 8 weeks) were 7.00, 10.00, 23.6, 37.00, 61.00, and 66.00 kg (Figure 2).

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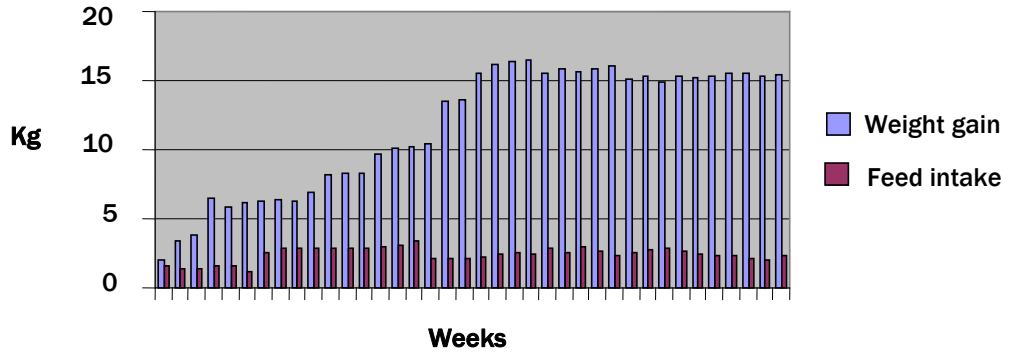

Figure 1 - Average values of feed intake and weight gain (Kg) of red–necked ostriches raised to 40 weeks of age

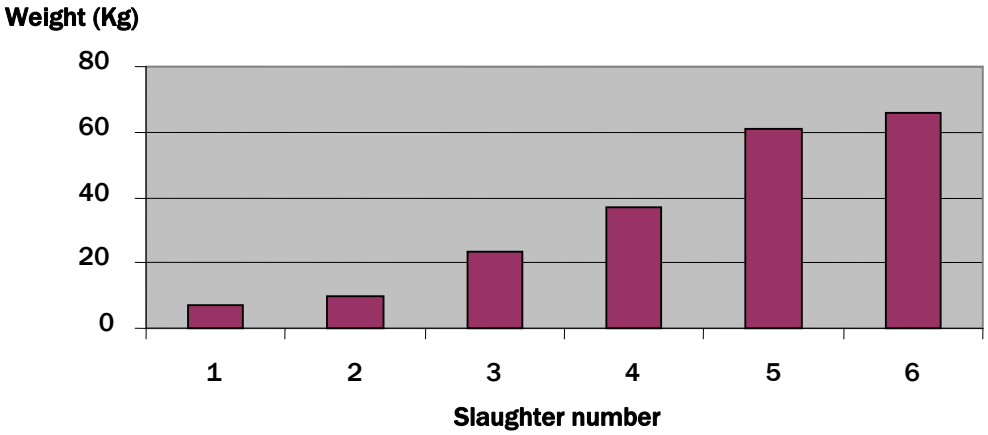

Figure 2 - The slaughter weights of the six serial slaughters of the red-necked ostriches

The hot carcass weights of the six slaughters are shown in Figure 3. Hot carcass weights were 2.59, 3.93, 11.70, 20.55, 35.00 and 37.50 kg. At the final slaughter (38 weeks of age) the carcass weight was 37.5 kg when the live weight was 66 kg, i.e. the dressing percentage was 57%. The dressing percentage obtained by Harris et al. (1993) was 58.6% which is close to the result recorded in the present study.

Figure 3 - The hot carcass weights of the six serial slaughters of the red-necked ostriches

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Table 4 shows body regions absolute weights (kg) and their percentages from the left side weight and their tissues percent of the left side region weight at last serial slaughter. The hind limb comprised the highest percentage from the left side of the carcass (70%) and the flank had the lowest percentage which is 3%. The hind limb had the greatest mass of muscle (76%), and lowest fat contents (3%). The highest bone content was found in the pelvis (54%), but the hind limb had a lowest bone percentage (15%) and the flank is boneless. Most connective tissues were found in the flank followed by the wing and the flank had the highest (9%) fat content. The total muscle, fat and bone percentages of the six regions were 54, 5.8 and 26.6 respectively, this result was similar to that found by Harris et al. (1993) who found the total percentage of lean, fat and bone to be 62.5, 9.2 and 26.9 respectively.

Figure 4 shows average development values (kg) of different body region weights on serial slaughters of the red–necked ostriches. The growth rate of the hind limb was the highest of all other regions. This result was similar to that found by Harris et al. (1993) and Morris et al. (1995) who said that the majority of the lean portion of the ostrich carcass is found in the leg and thigh muscles (41.4%).

Table 4 - Body regions absolute weights (kg) and their percentages from the left side weight and their tissues percent of the left side region weight at last serial slaughter.

Region	Weight	Percentage	Muscle %	Bone %	Connective tissue %	Fat %
Pelvis	1.300	7	38	54	4	4
Thorax	1.500	8	43	47	3	7
Flank	0.600	3	58	-	33	9
Hind limb	13.500	70	76	15	6	3
Wing	0.700	4	43	36	21	0
Neck	1.600	8	66	34	6	0

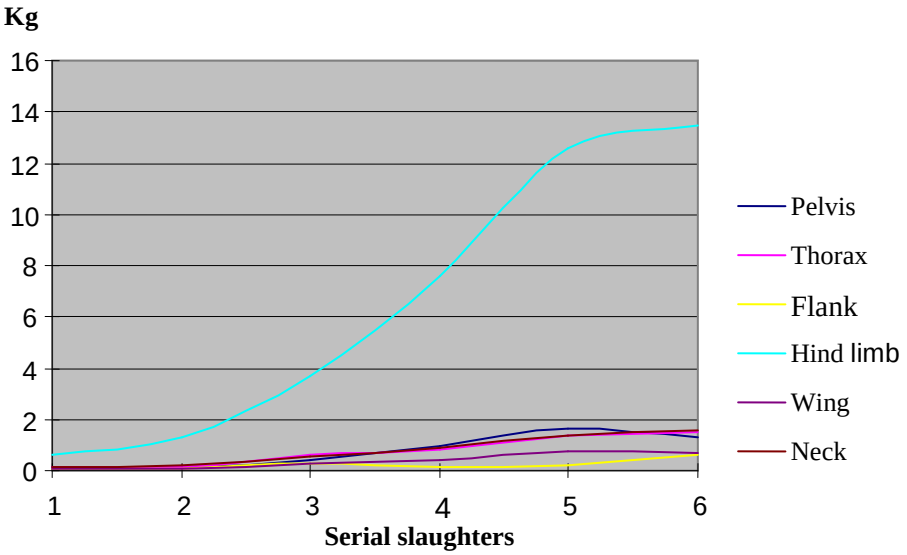

Figure 4 - Average development values (kg) of different body region weights on serial slaughters of the red–necked ostriches

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LIVESTOCK INTEGRATION IN THE IRRIGATED AGRICULTURAL SYSTEM IN SUDAN

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ABSTRACT: *Towards the end of the 1990's a significant decline in the areas sown to various crops and a sharp drop in productivity have been witnessed in Sudan's irrigated agriculture. At the same time feed shortages formed a main constraint on livestock production in the country. Under such a situation integration of fodder production activities within the existing crop rotations in irrigated agriculture seems plausible. Based on an optimization economic model, namely linear programming, this paper aims at investigating such prospects. The objective function in the basic model was to maximize farm returns. The analysis was based on primary data collected in the irrigated Gezira Scheme, generated through a comprehensive field survey in addition to supportive secondary data. The results showed the feasibility of introducing the fodder legume Dolichos lablab in the rotation for various reasons, such as no fertilizer needs and low demands for water and labour. A number of scenarios analyses of fodder-introducing were conducted around the results of the basic model run. All scenarios demonstrated tangible increases in farm returns, indicating that fodder cultivation would be profitable. Farmers' income would be enhanced, either directly through fodder returns or indirectly by raising livestock products. Furthermore, fodder introduction would be conducive to reducing irrigation water requirements. Under the present and suggested changes in resource availability tomato, sorghum and cotton production would yield superior profitability to that of wheat, groundnut and onions. With the optimal production plan returns were higher than in the present situation by about 24%, while water requirement was 32% less.*

Keywords: *Livestock integration, linear programming, Sudan Gezira irrigated scheme*

ORIGINAL ARTICLE

INTRODUCTION

Guinea fowl is a wild bird found in most parts of Botswana. Many of them were captured and reared in captivity by farmers for the purpose of protein consumption of the people.

Livestock plays an important role in human society and particularly in mixed farming. The animal gives multiple products in return such as meat; milk, eggs, income and fibers, while dung and urine are valuable to fertilize gardens, fields and fish ponds (Schiere and Kater, 2001). Many benefits can be gained from animal integration with other farming system components. For example, manure, which is an important component of livestock production (Harris, 1998), may contribute to as much as 35 % of the soil organic matter (Steinfeld et al., 1996). Farmers throughout semi-arid Africa employ manure for crop production, save crop residues for feed, and use animals for cultivation and transport (McIntire et al., 1992). Livestock can also guarantee a daily source of income to the tenant, in addition to his annual income from field crops. Increased livestock production can improve the income position of low-income farmers and women, and in this way reduces malnutrition within this group (Singh, 2001).

In Sudan, livestock contributed almost 50% of the total agricultural sector GDP during the last decade (Sudan Bank, 2006). According to records of the Ministry of Animal Resources (2002), the livestock population has been steadily increasing during period 1997-2000 (Figure 1). From 2002 to 2005, the livestock population remained approximately constant. In 2005, the total animal population reached 131.6 million heads, composed of 38.30

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(29.0%) million heads of cattle, 48.0 (36.50%) million heads of sheep, 42.0 (32.0 %) million heads of goats and 3.30 (2.5%) million heads of camels (Figure 1). About 90% of the livestock production in the Sudan is produced under rained traditional farming system (Zaroug, 2006).

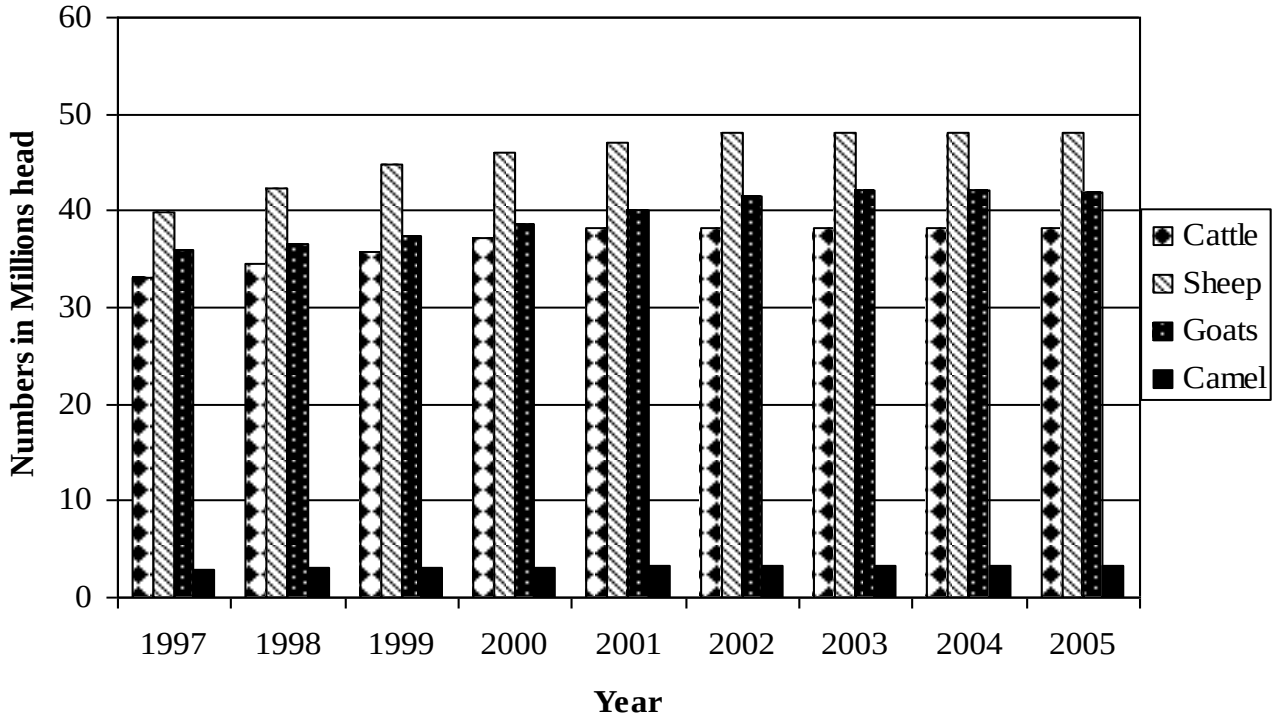

Figure 1 - Trends in the livestock population in Sudan 1997/2005
Source: Various sources, Ministry of Animal Resources (2000), Sudan Bank (2001) and FAO (2005)

The most important constraints faced by livestock production in Sudan include technical constraints (e.g. lack of reliable statistics, poor health and genotypes, etc.), marketing constraints (e.g. lack of marketing facilities, improper infrastructure, etc.), financial and investment constraints (e.g. risk of financing the traditional pastoralists, because of endemic diseases, prevailing natural and environmental hazards, etc.), public sector involvement (e.g. impact of the liberalization policy on prices) and institutional constraints (e.g. deficiency in input supply and services, etc.).

In general, two main methods of livestock integration have been identified. The first is the situation in which crop and livestock production is combined under the same management (McIntire et al., 1992). The second is a situation in which the herders and crop produces are separate, but involved in an exchange contract based on the exchange of manure for crop residues and grazing with transhumance herders (Williams et al., 1995; Powell et al., 1996). While the first is referred to as closely integrated farms, the second has been termed segregated integrated farms (Mc Crown et al., 1979).

Irrigated agriculture in Sudan is represented by many governmental Schemes. The Gezira Scheme is the most important one in terms of area, production and scale of management (World Bank, 2003). The call for animal integration within the rotation in the Gezira Scheme is not a new concept. It had been advocated since 1975 when full integration of both crop and animal production in the rotation constituted a major demand in the call for nationalization of the Scheme (Yousif, 1997).

Study motivation

Faced with the liberalization policies and the subsequent liberalized economic atmosphere, which were implemented within the agricultural sector since the early 1990's (World Bank, 2000), farmers in the Gezira Scheme found themselves in a difficult situation, having to abide to a predetermined rotation and crop mix. Countenanced by this situation, many study teams and governmental committees investigated the problems of the Gezira Scheme. All of them urged the need for planning the cropping pattern of the Scheme taking into account the liberalized economic environment and emphasized the introduction of livestock production into the production system. However, although the latter may be favorable to rectify the odd cropping pattern (exclusively plant crop production), it poses additional problems, such as planning the livestock production activities along with the plant crop production activities.

Moreover, livestock had always been highly ignored and treated as a foreign body. It was not incorporated in the management concerns of the Scheme, and all the modifications that took place, were solely concerned with

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securing cotton production and increasing its productivity (Yousif, 1997); i.e. in spite of the importance of crop-livestock integration in increasing household welfare, there are no opportunities for introducing livestock activities with crop activities

Objectives and hypothesis

This paper uses an economical model to investigate the prospect of livestock integration in irrigated agriculture in Sudan in terms of fodder and (2) to assess whether and how livestock may best be integrated into the Gezira Scheme's production system.

The specific objectives set to this study are:

- To determine the optimal crop combination including fodder within the current rotation.
- To introduce leguminous fodder crops in the current rotation.
- To satisfy the food and fodder requirements for human and animal consumption respectively and to satisfy the water requirements for food-feed production.

This study hypothesized that:

- Livestock – crop integration has a significant effect on farm profit and farmer's incomes and increases the total efficiency of the agricultural sector.
- Livestock – crop integration reduces the water requirements via the introduction of labia legume in the rotation
- Livestock –crop integration satisfies the animal feed requirements, directly increases animal production and indirectly enhances the farmers' income and hence circles out the poor tenants from the poverty sphere

MATERIALS AND METHODS

The study depends heavily on the primary data drawn from a farm survey conducted during the agricultural season 2001/2002, during the period February-October. Structural questionnaires were distributed among the target groups, which are mainly the Scheme's tenants and a personal interview was conducted.

With regard to sampling, multi-stage stratified random sampling technique was adopted as it gives more precise results because the variation within each stratum is less than the variation in the whole population. Gezira Scheme is comprised from Gezira main and Managil Extension regions.

These two main regions were considered as the basic strata as a first step in the employed procedure. The second step was to randomly select four Blocks from Gezira Main (sub-strata) and four Blocks from Managil Extension. The third step was to select four villages, one randomly selected village from each selected Block.

The sample size for this study is 120 farmers. Of those, 60 farmers were selected from Gezira Main and 60 from Managil Extension, which constituted about 3.2% and 1.3% of the total farmers in the surveyed villages in Gezira Main and Managil Extension, respectively. From each Block 15 farmers were selected randomly.

Data pertaining to crop activities, livestock activities and feeding types and regimes are collected.

Analytical Technique of Data Analysis

Linear Programming (LP) has been used to derive optimal farm plans and least cost feed mixes (Doll and Orazem, 1984). To achieve the stated objectives of this study the LP technique was used to determine the optimal plan or course of action for the production of livestock products and plant crops in the Gezira Scheme in a way that maximizes farmer's income and domestic consumption.

Dent et al. (1986) stated that, in general, constraints on the free selection of activity levels can be grouped into six categories: land; labour; capital; husbandry; legal; institutional and marketing constraints; and personal factors. The constraints in the LP model in this study were land, irrigation water, labour, fertilizers, seed, feed and cash requirements. The activities used were the crops and vegetables activities (cotton, wheat, groundnut, sorghum, onions and tomatoes) in addition to the livestock activities (cattle, goats, and sheep). The basic data used for the construction of the matrix are the production capacities, the production activities and the input-output coefficients per cropped area and raised animal unit, in addition to the costs of variable inputs.

The justification of using the LP technique is that there are no clear rational plans for the Scheme with respect to crop rotations and feed supplementation. Additionally, the nutritional situation of livestock producers is characterized by the usage of different kinds of feed stuff, different quantities and levels of costs, for which the derivation of economically optimal levels is important.

Mathematical Statement of the LP Livestock-Crop Model

The LP livestock-crop model is written mathematically. The conventional statement of the LP model takes the following form (Boehlje and Eidman, 1984 and Hazell and Norton, 1986):

$$Max\, Z = \sum_{j=1}^{n} CjXi \quad \text{----------} \quad (1)$$

Such that:

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$$\sum_{j=1}^{n} aij\ Xj \le bi,\ all\ i = 1\ to\ m \quad \text{----------} \quad (2)$$

$$and\ Xj \ge 0\ all\ j = 1\ to\ n \quad \text{----------} \quad (3)$$

Where:

Z=Total gross margin.

X_j=Level of the j^{th} farm activity such as the area grown with field crops, vegetables or fodder or the type of animal held by tenants.

N=The number of possible activities.

C*j*=The objective value, in this case the forecasted gross margin of a unit of the j^{th} activity ($ per feddan or head i.e. One Feddan= 0.42 ha. = 1.038 acres).

a_{ij}=Quantity of the i^{th} resource (land, water, feed etc…) required to produce one unit of the j^{th} activity.

m=The number of resources

b_i=The available amount of the i^{th} resource (feddan of land or days of labour or kg of nutritional value or kg of feed etc….).

The objective is to find the cropping system in the scheme (defined by a set of activities levels X_j, j = 1 to n) that has the highest possible total gross margin, Z, but does not violate any of the fixed resource constraints or involve any negative activity levels.

GAMS for Livestock-Crop Integration

The Linear Programming model was analyzed by using the GAMS (General Algebraic Modeling System) Software. GAMS is a software package to solve systems of equations and is constructed by GAMS Development Corporation (Dellink, et al., 2002). GAMS has its origin in economics modeling. The general structure of a simple GAMS input file for this study contains the following elements:

A. Sets: Sets are fundamental building blocks in any GAMS model (Brooke et al., 1998). A set is a collection of elements or labels (Gotsch, 1993). The sets used in the study model include the following:

- *Activities (j) and Inputs (i)*

Activities include the field crop production activities, vegetable production activities, crop and vegetables selling, consumption and buying activities, livestock production, selling and purchasing activities. Inputs correspond to constraints and include land, water, labour, seeds, fertilizer quantities, cash and feed requirements, crops and animal balance*.

- *Nutritional values (n) and Feed (f)*

The basic information used in the LP model concerned with animal feed is the nutritional requirement for animals. The quality of various crop residues is determined by the protein content and energy or digestible dry matter (DDM) content (Shanhan et al., 2003). Nutritional requirements were defined in the model in terms of dry matter (DM), crude protein (CP), crude fiber (CF), ash, oil, calcium (Ca), phosphorus (P), and metabolism energy (ME). Metabolism energy values are expressed as MJ/kg. Daily dry matter consumed by various animals based on their body weight and animal unit are used. The feed sets include crops residues, cakes and concentrates feed.

- *Period (t)*

Period illustrates the seasonality of some constraints (water, labour and land) from January to December. The letter (t) denotes the period of time, expressed in months.

B. Parameters: The parameters are denoted with C_jX_i (in equation 1) and b_i in equation (2). There is no formal procedure for estimating the parameters and coefficients within the LP approach, which can result in consistency problems (Bauer and Kasnakoglu, 1988). The parameters used in the study model are: Number of animals held by tenants, number of animals sold, average price per animal sold in SD, price of feed per kg, gross margin of crop, vegetable and livestock activities (C_jX_i in equation 1), amount/level of constraints e.g. land, water, labour and feed (bi in equation 2), the right-hand side for animal balance, feed balance†, milk balance‡, crop balance and vegetable balance§ and the amount of nutritional contents per kg of feed, e.g. DM,CP, CF, ash, oil, calcium CA, P and ME.

C. Tables: The tables contain data arrays, which correspond to aij (equation 2), describing the amount of resources (i) required to produce activities (j). Different types of tables were introduced in the model. The first one shows the numbers of animals held by tenants and types of feed used. The second table is related to the technical coefficients used (land, water, seed, fertilizer and cash requirements). The third table pertains to crops and livestock balance. Three specialized tables for livestock production are constructed to show (1) the monthly nutritional requirements for different animals, (2) the nutritional value of the different feed types and (3) feed

* Crop balance means amount of consumption and production of crops. Animal balance means number of animal purchased and sold during surveyed year.

† Feed balance means difference between amounts of feed produced from filed, amount purchased from market and amount consumed by animal.

‡ Milk balance means difference between amount of milk produced and consumed by tenants.

§ Vegetables balance means differences between amount of vegetables selling, consumption and production.

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characteristics. The other tables describe the seasonality of labour, water and land limits during the surveyed season.

D. Variables: The variables to be estimated in the model include the revenue from animal sales, level of crop and livestock activities (j), nutritional requirements for feeding animals and total gross margin (Z, the objective function of the model in equation 1). The model maximizes gross margin, while adopting positive values for activities (j), including x animal (j), x crop (j), x animal sold (j), x feed (j) x animal held (j), x nutritional value (N), where the letter x denotes the name of the activity.

E. Equations: Equations are a key to specify the types of equations included in the model. For example, resources (i) denote constraints or resources available to produce the corresponding crops yields or animal products. Equations are written through two steps: firstly, the equation must be declared and secondly, the equation itself must be written in the equation definition section. The main written equations to be estimated in the model are the following:

- *Objective function of crop and livestock production* (equation 1)
- *Resources constraint equation* (equation 2)

Two types of constraints equations were introduced in the model: The first equation estimates the technical coefficients of inputs (available amounts of land, labour, water, seed, fertilizer...etc). The second equation estimates the available amount of feed provided for different species of animal.

- *Labour balance equation*

The 218 limit is the available amount of labour (mandays) used during the season for the different crops per feddans in the scheme. This limit of labour is introduced in the model to estimate the labour balance** equation in the scheme.

- *Land limit equation*

This equation illustrates the land occupied by different crops in feddan per month during the surveyed season, implying that the crops occupy the land for certain periods during the season and not all a year-round. The total size of tenancy in the scheme is 20 feddans.

- *Water limit equation*

The annual crop water requirement for the different crops activities in the scheme was introduced in the model. The total water available in the scheme is 27613 m^3.

- *Nutritional balance equation*

This equation illustrates the nutritional value of feed provided to animals in the scheme throughout the surveyed season.

- *Returns from animal sold equation*

This equation illustrates the returns gained from cattle (calves, cows and bulls), goats and sheep sold during the surveyed season in the scheme.

Scenarios Analysis Technique

A counter-factual analysis is done. Dellink *et a*l. (2002) divided the counter-factual analyses in two types, the scenario analysis and sensitivity analysis. The former tries to answer questions of the type "What happens if one or more elements in the model change", while the sensitivity analysis tries to answer "What is the consequence of miss-specification of some parameter values". In this study some parameter values in the model or equation specifications are changed, the changed model is run and the new results are compared to the reference results.

In a scenarios analysis, several alternative model specifications are compared to each other. These scenarios may differ due to differences in parameter values, but also due to differences in the model equations. In principle, each of the scenarios specified may be equally viable. The input matrix contains activities and consists mainly of the present, five-course rotation (Cotton-Wheat- Sorghum - Groundnut/Vegetable - Fallow).

Three main scenarios were adopted in the study as follows:

In the first scenario: vegetables were completely removed from the rotation, as they are risky for tenants.

In the second scenario: *lubia* (*Dolichos lablab*) was introduced in the rotation. The *lubia* legume is introduced in the rotation for various reasons. It needs no fertilizer and low amount of water and labour. It is cultivated in the winter season when only wheat and some other vegetables are grown. Moreover, it increases soil fertility and hence adds an additional improvement to the soil for the next crop in the rotation (e.g. cotton) leading to higher cotton productivity.

In the third scenario: the *lubia* legume was introduced in vegetable land. Based on the extra vegetables are cultivated in the private farms and neighboring gardens.

** Labour balance means differences between hired and family labour.

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A change of technical coefficients (land, water, labour, seeds, fertilizers and cash requirements) are compared between the basic solution and the scenarios. Furthermore, other types of scenario analysis were implemented. A multiple changing of data or bounds in second scenario was implemented to observe the change of optimal solution with the fodder integration.

RESULTS AND DISCUSSION

The information obtained from the LP analysis includes the objective function value (returns), optimal crop and animal combination, nutritional value of feed, resources used and their respective marginal productivities.

Cropping pattern and optimal returns

From Table 1 it is clear that for cotton, sorghum and tomatoes there are big differences between the actual land cultivated and the optimal allocation. Wheat, groundnut and onion did not appear in the optimal plan. The optimal land areas for cotton, sorghum and tomatoes are 5.08, 7.57 and 5.29 feddans, respectively. The actual returns from crop production were $ 511.2, while the optimal returns are $826.2, which is 23.6% more than the actual returns.

Resources use and seasonal constraints

The total land used in the optimal plan solution is 17.24 feddans, which is 89.7 % of the total land used in the actual scenario (Table 1).

Seasonality is a major determinant of comparative advantage in most agricultural systems (Gotsch, 1993). Hazell and Notron (1986) stated that, introducing seasonality in the model would further restrict the model solution and will likely lead to lower values of the objective function. It is clear that in the optimal plan all labour available (218 mandays) was used. There are two peaks of labour. The first peak is during July and August, when land preparation, sowing and weeding needs to be done. The second peak is from December to February, which coincides with the harvesting period for sorghum, groundnut and first and second periods of cotton picking.

The water use dropped from 36766.3 m^3 (in the actual solution) to 24183.4 m^3 (in the optimal solution). This means that because of introducing the fodder crop in the rotation the water requirement decreased by 32%. The peaks of water used are during July, September and October, coinciding with the sowing of most of cotton, sorghum, groundnut and summer tomatoes.

Table 1 - Optimal crop production plan per tenancy of 20 feddans area

Item	Actual	Optimal	Units
Cropping pattern:			
- Cotton	4	5.08	Feddan
- Wheat	4	-	Feddan
- Sorghum	4	7.57	Feddan
- Groundnut	4	-	Feddan
- Tomatoes	2	5.29	Feddan
- Onions	2	-	Feddan
Resource use:			
- Total land	20	17.24	Feddan
- Total labour	218	218	Mandays
- Total water	36766.3	24173.7	M^3
- Seed	62.55	34.67	Kg
- Fertilizer	650	650	Kg
- Cash 1	60	38.91	$
- Cash 2	55	33.82	$
- Cash 3	55	44.00	$
- Cash 4	75	54.81	$
Returns: Objective function value	511.2	826.2	$

Source: Model results, 2001/2002.

Optimal livestock production

The optimal composition of the cattle herd is 2.4 heifers, 1.2 bulls, 1.2 mature cows and 3.3 calves (Table 2). The optimal structure of the sheep herd is 0.06 ewes, 0.01 rams and 0.031 lambs, while that of the goat herd is 0.06 does, 0.04 bucks and 0.96 kids. The optimal number of milking animals was 7.3 milking cows and 0.2 milking sheep. Many lambs sold during the surveyed season, due to the occasion of the various ceremonies. Most of the tenants who owned sheep during the surveyed season had purchased them for resale after fattening. But the optimal solution indicates that the optimal numbers of sheep sold was 1.0 sheep per tenant. While the optimal numbers of cows, calves and goats are 1.0 cow, 1.0 calve, and 1.0 goat per tenant; respectively. The optimal total animal unit (AU) held per tenant was 26.07 AU (Table 2). The LP result shows that, the optimal value from animal sales was $1162.7.

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Optimal feed mix and nutritional value

The model results show that the optimal level of feed mix used were 207 kg of sorghum stalks and 850 kg of cakes feed and 1299 kg of fresh fodder per month per herd (Table 3). Comparing the model results with the actual feed quantity and quality, the maximum number of animals that can be raised on the optimal level of feed can be determined.

All nutritional ingredients appeared in the basic solution, expect for phosphorus. The optimal dry matter and crude fiber were more than the other ingredients, which is due to the high quantities of groundnut hay in the ration (Table 3). Even though the groundnut crop disappearance from the optimal solution the tenants fill gap of groundnut hay feed from the market. In the scheme majority of the tenants are failure to harvest the groundnut seeds and they harvest only the groundnut residue (hay). Beside the cheaper cost of the groundnut hay the Scheme tenants prefer to feed their animal with extra groundnut hay and believe that it's more beneficial for animal in contrast with other types of feed.

Table 2 - Optimal solution of livestock level held by tenant

Animal composition	Actual level in head	Optimal level in head
A) Cattle		
Heifers	3.5	2.4
Bulls	2	1.2
Mature cows	1.7	1.2
Calves	2.8	3.3
Milking cows	7	7.3
Cows sold	2.0	1.0
Calves sold	2.8	1.0
Subtotal in AUA*	21.8×1.0 AU=21.8AU	17.4×1.0AU=17.4AU
B) Sheep		
Milking sheep	16	0.2
Ewes	14	0. 6
Rams	2.7	0. 1
Lambs	11.6	0. 31
Sheep sold	6.8	1.0
Subtotal in AU	51.1×0.15AU=7.7AU	1.2×0.15AU=0.18AU
C) Goats		
Milking goats	23	0.3
Does	13.5	0. 6
Bucks	5.4	0. 4
Kids	9.2	0.9
Goats sold	6.2	1.0
Subtotal in AU	57.3×0.10AU=3.73AU	2.2×0.10AU=0.22AU
D) Transportation animal		
Female donkey	1.5	2.8
Male donkey	1.4	2.5
Horses	1.0	1.5
Subtotal in AU	2.9×1.05AU+1.0×1.80AU=4.05AU	5.3×1.05AU+1.5×1.80AU=8.27AU
D) Total in AU	37.28AU	26.07AU

Source: Model results, 2001/2002. *AU = Animal unit.

Table 3 - Optimal solution of the nutritional balance and feed used by tenants in optimal plan

Feed type	Optimal level in kg per month per herd	Nutrient value	Optimal	Unit
Sorghum stalks	207	DM	970	MJ/kg
Sorghum grain	-	CP	56.700	G/kg
Groundnut hay	-	CF	642.200	G/kg
Wheat straw	-	Ash	63.200	G/kg
Wheat bran	-	CA	5.400	G/kg
Concentrates	-	P	-	G/kg
Cakes feed	850	Oil	26.600	G/kg
Fresh fodder	1299	ME	7.23	G/kg

Source: Model results, 2001/2002

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Marginal productivities of the activities and constraints

The Marginal Value Product (MVP) of a resource is its shadow price. For farm situation, MVPs indicate the increase in the objective function value that would be obtained if a particular resource is expanded by one unit. A negative value of marginal productivity indicates a reduction in the objective function if an additional unit of resource is introduced.

From Table 4, it is clear that labour has the highest marginal value productivity; reaching $ 1.432 per season, explaining why tenants are always giving it more care. The marginal value product of feed varied from $ 0.06 to $ 0.36 (Table 4). The optimal returns reduced by $ -32.45 when an additional feddan of land was cultivated by groundnut (Table 4).

Table 4 - Shadow prices for limiting resources

Resources	Shadow price in $
Wheat land	-0.00583
Groundnut land	-32.4562
Onions land	-0.01395
Labour	1.432
Fertilizer	0.580216
Cash 3	0.00474
Sorghum consumption	0.004
Cakes feed	0.1018
Sorghum stalks	0.36
Concentrates	0.36
Sorghum grain	0.16
Wheat straw	0.16
Wheat bran	0.16
Fresh fodder	0.06

Source: Model results, 2001/2002.

Scenarios result

- ***In the first scenario***: the result shows that the optimal returns was $ 675.688, which is 10 % less than the basic solution, while the optimal land was increased by 8%. Water and labour used were remained as the same as in the basic solution. Wheat and groundnut disappeared from the optimal solution (Table 5). The optimal crop combination in this scenario was 10 feddans of cotton and 10 feddans of sorghum (Table 6).

Table 5 - Comparative Analysis between Basic Solution and Various Scenarios

Optimal resource used	Basic solution	Scenario I	Scenario II	Scenario III
Total land (feddan)	17.24	20	12.69	13.23
Total water (M^3)	24183.73	24130.0	12421.21	12241.30
Total labour (Mandays)	218	218.50	97.12	99.86
Fertilizer (Kg)	650	441.28	45.93	18.66
Returns:				
Objective function value ($)	826.19	675.68	1179.67	1161.64

Source: Computed††.

Table 6 - Optimal crop combination for the various scenarios

Item	First scenario	Second scenario	Third scenario
Cotton	10 feddans	-	0.93 feddans
Wheat	-	-	-
Sorghum	10 feddans	-	-
Groundnut	-	-	-
Onions	-	-	-
Tomatoes	-	0.306 feddans	-
Lubia	-	12.3 feddans	12.3 feddans

Source: Computed‡‡.

- ***In the second scenario***: the optimal return was found to be $1179.67 (Table 5), which is 17.6% more than the basic solution. Land, water and labour used were reduced by 15%, 32% and 38%; respectively. The optimal crop combination in this scenario was 0.306 feddans of tomatoes and 12.38 feddans of lubia legume (Table 6). Husson et al. (2003) stated that when introduced the livestock- crop in the rotation the whole farming system benefits from this integration, food (Omolehin et al., 2003) and feed systems performances are increased, while use of the farm resources are optimized.

Furthermore, Fakoya (2007) verified that utilization of crop-livestock was enhanced income through sales, sustain food production and enhancing soil fertility (Hoffmann, 2002) and help to exploiting the byproducts and residues from crop.

†† Water requirements in all scenarios are reduced. Slightly changes in labour level in first scenario while it reduced in second and third scenarios.

‡‡ The optimal crop combination in first scenario was 10 feddans of cotton and 10 feddans of sorghum (no fodder introduced in this scenario). Introduction of *lubia* in second and third scenarios shows the profitability of this fodder.

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- ***In the third scenario***: the optimal return was found to be $ 1161.64 which is 16.8% more than the basic solution (Table 5). The optimal crop combination for this scenario was 0.93 feddans of cotton and 12.3 feddans of *lubia* (Table 6). Land, water and labour used were reduced by 13%, 33% and 37%, respectively.

From this scenario analysis it is clear that the introduction of fodder in the rotation increases farm returns and reduces water requirements. This result agreed with study performed by Abdelmagid (1986) in the mechanized irrigated Scheme in Sudan. The second scenario was used as the basic solution for the other types of scenarios analysis because in second scenario the fodder were introduced in the rotation and the objective value was more than two other scenarios.

First Scenario with Fodder Integration (SF_1): The gross margins of cotton, wheat, sorghum, groundnut and onions were increased by 25% subject to the potential of higher yields with improved technology use as well as the possibility of subsidy provision to inputs, which matches WTO concessions to Least Developed Countries (WTO, 1995). The optimal solution was found to be 10.95 feddans of sorghum, 2.87 feddans of tomatoes and 4.51 feddans of *lubia*. Land utilization was increased by 10%. The optimal return was $ 1197.17 (Table 7).

Second Scenario with Fodder Integration (SF_2): Based on the fact that tenants face marketing problems with *lubia* and tomatoes in the scheme, gross margins of these two crops were reduced by 25%, while those of cotton, wheat, sorghum, groundnut and onions were increased by 25%. The optimal solution was found to be 1.95, 11.98, 2.47 and 3.59 feddans of cotton, sorghum, tomatoes and *lubia*; respectively. The optimal resources used were 19.99 feddans of land, 26939 m^3 of water and 221 mandays of labour. The optimal return was $ 1012.86 (Table 7).

Third Scenario with Fodder Integration (SF_3): Wheat is currently grown by farmers and in areas where productivity potential is high and its profitability is reasonable. Accordingly, the gross margin of wheat was increased by 75% and that of *lubia* was decreased by 25% where wheat straw and wheat bran form partial substitutes to *lubia*. The optimal solution was found to be 2.0 feddans of cotton, 2.0 feddans of wheat, 4.20 feddans of sorghum, 3.21 feddans of tomatoes and 5.52 feddans of *lubia*. The optimal resources used were 16.89 feddans of land, 25846 m^3 of water and 213 mandays of labour. The optimal return was $ 1132.30 (Table 7).

Fourth Scenario with Fodder Integration (SF_4): The wheat crop was totally removed from the rotation because of risks of high temperatures and its low returns. The optimal solution was found to be 0.30 and 12.4 feddans of tomatoes and *lubia*, respectively. The optimal resources used were 12.6 feddans of land, 12421m^3 of water and 97.13 mandays of labour. The optimal return was $ 179.67 (Table 7).

Fifth Scenario with Fodder Integration (SF_5): The total labour available was increased by 25%. This is based on the labour deficits faced by the scheme due to successive migration from rural to urban areas. Therefore the optimal solution was found to be 3.9 feddans of sorghum, 3.8 feddans of tomatoes and 6.4 feddans of *lubia*. The optimal resources used were 14.10 feddans of land, 25221 m^3 of water and 201 mandays of labour. The optimal return was $ 1121.84 (Table 7).

Sixth Scenario with Fodder Integration (SF_6): Under the possibility that financial facilities could improve through credit provision for agricultural practices, the available cash was increased by 25%. The optimal solution was found to be 1.0 feddan of cotton, 4.2 feddans of tomatoes and 8.6 feddans of *lubia*. The optimal resources used were 13.8 feddans of land, 26434.51 m^3 of water and 218 mandays of labour. The optimal return was $ 1261.65 (Table 7).

Table 7 - Optimal crop combination of the various scenarios analysis under the situation of the fodder integration

Item	Basic solution (Second scenario)	SF_1	SF_2	SF_3	SF_4	SF_5	SF_6
Cotton (in feddan)	-	-	1.95	2.0	-	-	10
Wheat (in feddan)	-	-	-	2.0	-	-	-
Sorghum (in feddan)	-	10.95	11.98	4.20	-	3.9	-
Groundnut (in feddan)	-	-	-	-	-	-	-
Onions l (in feddan)	-	-	-	-	-	-	-
Tomatoes (in feddan)	0.306	2.87	2.47	3.21	0.30	3.8	4.2
Lubia (in feddan)	12.38	4.51	3.59	5.52	12.4	6.4	8.6
Resources use:							
Land (in fedda)	12.69	18.33	19.99	16.89	12.6	14.10	13.8
Water (in M^3)	12421.21	26091	26939	25846	12421	25221	26434
Labour (in man days)	97.12	205.95	221	213	97.13	201	218
Objective Function ($)	1179.67	1197.17	1012.86	1132.30	1179.67	1121.84	1261.65

Source: Computed§§.

§§ The farm return was increased in SF_1 and remains unchanged in SF_4. *Lubia* legume was appeared in all *lubia* scenarios while it reached it highest level in SF_4. Reduction in water use in all *lubia* scenarios were notes in comparison with the basic solution, while land allocation was increased comparing with the basic solution.

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CONCLUSIONS AND POLICY IMPLICATIONS

- Although wheat and groundnut represented 50% of the total cultivated land in the present rotation, they have almost disappeared from the rotation in the optimal production plan. This indicates that they were unprofitable. Tomatoes and cotton areas were increased by 11% in the basic solution, while sorghum increased by 31%. This was due to large areas cultivated with hybrid sorghum crop in the sampled area. The total land size decreased from 20 feddans to 17.4 feddans. Cotton, tomatoes and sorghum under the present system in the Gezira Scheme were comparatively most profitable. For cotton crop the scheme management usually finances this crop during various stages of production (as cash crop) furthermore, the sorghum is cultivated in this area are hybrid type (high productivity crop) and also tenants prefer to cultivated sorghum crop because its the main food staff of the tenants in the Scheme. The total farm returns in the optimal solution is high than the actual situation by 23.6%.

- No significant increase were recorded in the number of milking cows in the optimal solution (7.3 cows), while the number of milking sheep was reduced from 16 to 0.2 heads and the milking goats were reduced from 23 to 0.3 heads. The ruminant animals in the Scheme are highly ignorable, lacking of the veterinary services and feed is the main factor affecting the milk yield of those animal.

- Sorghum grain, wheat straw, wheat bran and concentrates disappeared from the optimal plan. The percentage of crude fiber was higher than the other components of the different ingredients. Phosphorus also disappeared from the optimal solution. From this result the study concluded that there are feed insufficiency for animals in the Scheme, particularly the milking animals and no economic feed were cultivated in the scheme.

- When introducing the irrigated fodder crop in the Scheme rotation the farm return is increased and resources use was reduced.

- The Gezira Scheme management still appears to accord much higher priority to crop production than livestock production.

- Cotton and tomatoes crops are linked to fodder crop. When fodder integrated in the rotation these two crops are appeared in the optimal solution and lead to enhance the farm returns and reduction in the inputs resources (e.g. water, labour and land). Furthermore when no fodder integrated in the rotation reasoned for low farm returns.

Suggestions and recommendations based on the results and analysis of this study can be summarized as follows:

- Effort should be made by appropriate government institutions to sensitize livestock integration to be applied in all irrigation schemes in the Sudan on account of its multi-dimensional benefits.

- Fodder crops must be quickly incorporated into the farm structure of those tenants who have dairy animals to avoid farmer-pastoral conflicts. Such conflicts can only be avoided if the linkage between the two systems is well understood and accepted.

- A cropping pattern that incorporates a combination of two feddans of cotton, 12 feddans of sorghum, 2.5 feddans of groundnut or vegetables and 3.5 feddans of fodder should be promoted.

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THE USE OF ORGANIC ACIDS IN RABBIT FARMING

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ABSTRACT: *During the last decades, organic acids (acidifiers) have been used as potential alternative to antibiotics in non monogastric animals' diets in order to improve growth performance and prevent diseases. Their beneficial effects include enhancement of growth rate by improving gut health through the reduction of pH, promoting of beneficial bacterial growth and increasing the digestibility of nutrients through the improvement of pancreatic secretions. Furthermore, acidifiers appear antimicrobial activity, by controlling the bacterial populations in the gut, increasing activity of proteolytic enzymes, and inhibiting the proliferation of pathogenic bacteria. Dietary organic acids can actually become an alternative solution to antibiotics, in order to improve health status and performance in rabbit farming. The purpose of this study is to summarize the beneficial effects of using organic acids in rabbit diet.*

ORIGINAL ARTICLE

Keywords: *Acidifiers, organic acids, effect, growth performance, health status, rabbit*

INTRODUCTION

Organic acids and salts have a long-history in the food and the feed industries, which commonly use them as preservatives. Organic acids are routinely included in diets for monogastric animals in Europe in order to replace antibiotics as growth promoters.

As a group of chemicals, organic acids are considered to be any organic carboxylic acid of the general structure R-COOH (including fatty acids and amino acids). Not all of these acids have effects on gut microflora. Organic acids (C1-C7) with specific antimicrobial activity are short-chain acids (C1–C7) and they are widely distributed in nature as normal constituents of plants or animal tissues. They are also formed through microbial fermentation of carbohydrates mainly in the large intestine. They are sometimes found in their sodium, potassium or calcium form. Most organic acids with antimicrobial activity have a pKa—the pH at which the acid is half dissociated-between 3 and 5. Table 1 shows the common name, chemical name, formula, molecular weight, and first pKa of organic acids that are commonly used as dietary acidifiers for pigs or poultry (Dibner and Buttin, 2002).

Table 1 - List of acids and their properties

Acid	Chemical name	Formula	pKa
Formic	Formic Acid	HCOOH	3.75
Acetic	Acetic Acid	CH3COOH	4.76
Propionic	2-Propanoic Acid	CH3CH2COOH	4.88
Butyric	Butanoic Acid	CH3CH2CH2COOH	4.82
Lactic	2-Hydroxypropanoic Acid	CH3CH(OH)COOH	3.83
Sorbic	2,4-Hexandienoic Acid	CH3CH:CHCH:CHCOOH	4.76
Fumaric	2-Butenedioic Acid	COOHCH:CHCOOH	3.02
Malic	Hydroxybutanedioic Acid	COOHCH2CH(OH)COOH	3.40
Tartaric	2,3-Dihydroxy- Butanedioic Acid	COOHCH(OH)CH(OH)COOH	2.93
Citric	2-Hydroxy-1,2,3- Propanetricarboxylic Acid	COOHCH2C(OH)(COOH)CH2COOH	3.13
Benzoic	Benzenecarboxylic acid	C_6H_5COOH	4.19

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Organic acids in monogastic animals' diet

Several organic acids have been reported to improve growth performance (eg. increased palatability, feed efficiency, mineral absorption, phytate-P utilization) when they are supplemented in non-ruminant diets (Partanen and Mroz, 1999; Dibner and Buttin, 2002; Boling et al., 2000). In addition, organic acids are believed to have antimicrobial activity and they have suggested for the control intestinal microbial growth (Partanen and Mroz 1999; Davidson, 2001). The antimicrobial activity of organic acids is basically the same, irrespective of acting in food, feed, or gut lumen (Diebold and Eidelsburger, 2006). Most available information about the use of acidifiers in animal feeding is focused on swine and poultry (Partanen and Mroz 1999; Michi et al., 2001; Dibner and Buttin, 2002; Papatsiros et al., 2011).

Several mechanisms through which dietary organic acids may produce beneficial effects on health status and growth performance have been proposed (Partanen and Mroz, 1999; Partanen 2001; Knarreborg et al., 2002, Diebold and Eidelsburger, 2006, Tung et al., 2006) the following appear to be the most prominent:

-Reduction of gastric pH
-Reduction of buffering capacity of diets
-Increase of proteolytic enzymes activity / Improvement of pancreatic secretions
-Stimulating the activity of digestive enzymes
-Increase of nutrient digestibility
-Promotion of beneficial bacterial growth
-Reduced survival of pathogens through the stomach / balancing the microbial population
-Direct killing of bacteria
-Alterations in the nutrient transport and synthesis within the bacterium
-Depolarization of the bacterial membrane

Considerable variations in the results of their response due to possible dietary and other factors such as (Partanen and Mroz, 1999; Strauss and Hayler, 2001; Decuypere and Dierick, 2003; Morz 2005):

-type and pKa of acid
-inclusion rate and dose of supplemented acids
-type / composition of diets and their acid-base or buffering capacity
-level of intraluminal production of acids in GI tract by inhabiting microflora
-feed palatability
-intrinsic acid activity
-receptors for bacterial colonization on the epithelial villi
-maternal immunity by vaccinations against pathogens
-hygiene and welfare standards
-age of animals

Beneficial effects of organic acids on rabbits

The mucosa of the small intestine has a major role in the digestion and absorption of nutrients and represents an important area of defence against antigenic aggressions in young rabbits (Gallois et al., 2005). The use of organic acids appears interesting, even if scientific data concerning their effect on microflora population, mucosal immunity and growth performance are few and often contradictory in rabbits (Falcao et al., 2007). Also the mode of action of these products on caecal microflora is not completely understood, although it is demonstrated that organic acids play a direct action on the bacterial cell integrity (Maertens et al., 2006).

The effects in digestibility and productive performances of the inclusion of organic acids in rabbit nutrition are not clear. Improvements in daily gain have been reported in many studies (Table 2), but no effects were recorded by others (Hollister et al., 1990, Scapinello et al., 2001). In addition, antimicrobial activity of organic acids in rabbits has also been reported (Skřivanová and Marounek, 2002), reducing the damage caused by both Gram– and Gram+ pathogen bacteria (Gardinali et al 2008). In contrast, in other studies testing sodium butyrate (Carraro et al., 2005) and fumaric acid (Scapinello et al., 2001) or formic acid (Skřivanová and Marounek, 2007) no antimicrobial activity was indicated. Combining organic acids with prebiotics (Scapinello et al., 2001) or with probiotics (Michelan et al., 2002) did not significantly improve performances, though mortality was significantly reduced in trial by Hollister et al. (1990).

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Table 2 - Review of trials' results with organic acids in rabbits

Trial	Organic acids	Results
Castrovilli, 1991	fumaric acid (1.5 g/kg)	Improvements in daily gain
ZiLin et al., 1996	fumaric acid (1.25 g/kg)	Improvements in daily gain
Hullar et al., 1996	fumaric acid (3 g/kg)	Improvements in daily gain
El-Kerdawy, 1996	fumaric acid (0.5%)	Increase of digestibility of crude protein and crude fibre
Hullar et al., 1996	sodium butyrate	Increase of diet digestibility
Skřivanová and Marounek, 2002	caprylic acid (5 g/kg)	Decreased mortality due mainly to *Pasteurella multocida*, *Clostridium perfringens, Bordetella bronchiseptica* No significant effect on the growth rate
Abecia et al., 2005	fumaric acid (5 g/kg and 10 g/kg)	No significant effect affect the caecal environment, except for a higher concentration of amylolytic bacteria
Scapinello et al., 2001 Michelan et al., 2002	fumaric acid (1,5%)	tended to improve both the daily gain and the feed efficiency, but the differences were not statistically significant
Skøivanová and Marounek, 2006	Oil containing caprylic, capric and lauric acid at 60.8, 38.7 and 0.3 g per 100 g of fatty acid methylesters, respectively at 10 g/kg	Decreased mortality post-weaning mortality no effect on No significant effect on zootechnical parameters (growth rate, feed intake, daily gain, or carcass yield)
Cesari et al., 2008	-a blend of formic acid, lactic acid and essential oil originating from rosemary, thyme and cinnamon (4 g/kg) -formic and lactic acid (5 g/kg)	stimulated weight gain, increasing also feed conversion rate in the second phase of fattening,
Gardinali et al., 2008	0.4% mixture of microencapsulated formic and citric acids and essential oil	Reduction of the damage of both Gram– and Gram+ pathogen bacteria permitting to obtain a better serum innate response in experimentally infected rabbits

CONCLUSIONS

During last decades there is growing increase in public awareness about the relationship between the feed medication with antimicrobials in farm animals' diets and the risk of developing cross-resistance of pathogens to antibiotics used in human medicine (Corpet, 1996, Mathew et al., 2007, Hunter et al., 2010). Digestive disorders constitute the main health problem in weaned rabbits and antibiotics are widely used for prevention of infections and as a growth promoter, altering the gut flora, suppressing bacterial catabolism and reducing bacterial fermentation (Pinheiro et al., 2004). Due to consumers' concern about the possibility of drug resistance of pathogenic bacteria, dietary acidifiers can actually become the most common and efficacious alternative solution to antibiotics, in order to improve health status and growth performance of rabbits.

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THE ROLE OF LIVESTOCK PRODUCTION ON FOOD SECURITY IN SUDAN: RURAL WHITE NILE STATE

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ABSTRACT: *Food security status is determined by the combination of aggregate food availability, household food access and utilization. In Sudan, given climate extremes and insecurity, food availability is a crucial component of household food security status. Communities that rely on raising livestock are most vulnerable to hunger when drought or other disaster strikes. The general objective of this study was to assess the role of livestock production on food security in the White Nile State. Specifically it aims to identify the main factors that may be responsible for food insecurity among livestock producers. It also attempts to identify the livestock conditions in the region. The study was depends on primary data collected during 2009/2010. Statistical tools of data analysis are implemented focusing on correlation analysis and food security indicators. The SPSS (1983) and Excel software programs are used for data analysis. The study results show that majority of the surveyed animal producers are illiterate, and landless. It also indicates that there was instability in food security using the coefficient of variation of producers' income (CV) as a proxy for food consumption. There was positive correlation between education level, food availability and accessibility. Furthermore, the food utilization was significantly affected by family size and number of males in the households and it is significantly affected by milk production and animal selling in the region*.

Keywords: *Food Security, Livestock, Socioeconomic factors, Sudan*

ORIGINAL ARTICLE

INTRODUCTION

The livestock sector is extremely important to the livelihoods of many developing countries households, and in many areas it also plays an important cultural role. For instance, it has been estimated by the World Bank (2008) that around 10% of the population of Sub-Saharan Africa is primarily dependent on their livestock whereas another 58% depend to varying degrees on their livestock (Ziervogel, et al., 2006). In Sudan an approximately 30% of Sudan's total population rear livestock and it's contributed as 46% from the share of agriculture growth domestic product (Sudan Bank, 2009). Beside there is traditional conflict between pastoralists and agriculturalists (Elzaki, 2005) and this is normally threatened by changes in agricultural practices (WFP, 2006). The expansion of farming into livestock migration routes is also a source of conflict between farmers and herders.

Food security is a major or central objective of food and agriculture development policies in Sudan. During the 1970s Sudan has probably done more to develop its agriculture, many projects were carried to boost agriculture development and achieving food security and poverty reduction (GNU, 2010). In the 1990s, a policy of self sufficiency is reflected in increasing area under sorghum and wheat production in the irrigated scheme (Mubarak et al., 2011). This is also supported with promotion of the recommended technological packages and supply of inputs and credit by banks.

One of three Sudanese suffered from food deprivation in 2009, based on the 2009 Sudan NBHS data. The prevalence of undernourishment was 31 and 34 % for the urban and rural populations, respectively (NBHS, 2009). The depth of hunger, which refers to the amount of daily dietary energy consumption per person required by the undernourished population to reach the minimum dietary energy requirement, was 344 Kcal at the national level and 343 and 344 Kcal in urban and rural areas, respectively. Inequality, as measured by the (CV) of daily dietary energy consumption due to income were similar for urban and rural populations, 31.2 and 32.2 % respectively;

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however, it was higher in male than in female headed households, 35.1 and 29.6 percent, respectively (Ministry of Agriculture, 2010).

Research justifications and goals

Food insecurity problems in Rural Sudan regions are largely due to drought, poor soil fertility, weak market infrastructure and poor access to farm inputs (e.g., fertilizers). In most rural areas there are shortage of poultry products and dramatically increasing cost of food items. Communities that rely on raising livestock are most vulnerable to hunger when drought or other disaster strikes e.g. White Nile. Drought has been critical in increasing the number of animal death in the region. The animal producers in the White Nile are exposed to unexpected disasters of natural changes of climate, spread of diseases and lack of the resources and capability. In addition, lowering productivity e.g., internal parasites, trypanosomes, brucellosis, tuberculosis, hemorrhagic septicemia, anthrax, black quarter, and malnutrition. Livestock rising was overwhelmingly in the traditional sector, and, although initial steps had been taken to improve productivity and develop market orientation for the modern monetized economy, the sector represented largely a potential asset.

In spite of the great potential of livestock and Sudan's self-sufficiency in meat and other livestock products, the following summarized constraints on production are important:

- Overgrazing in some areas, particularly around settlements, while vast areas are under-grazed because of lack of water for the animals.

- The great distances those animals often have to walk from water points to graze; lack of infrastructure and market access.

- Prevalence of disease, poor veterinary services and poor husbandry.

- Inefficient utilization of crop residues, including poor integration of livestock in the rotation of acacia (A. Senegal) and arable crops and lack of processing of feeds and export of by-products

The general goal of this research is to study the influence of selected demographic and socio-economic characteristics of the animal producers on food security and to assess the role of livestock production on food security in Sudan. The precise goals of this study are as follows:

1. To address the main factors that may be responsible for food insecurity creation or intensification related to livestock production.
2. To illustrate the livestock conditions in the rural areas.
3. To examine the role that livestock play in food security in rural areas

MATERIALS AND METHODS

Data Sources and Sampling

This study was conducted in the White Nile State in central Sudan. The State was divided into southern and northern regions where the livestock was concentrated, since these regions are most vulnerable and wealthy in livestock. One province within each of these regions, are selected according to vulnerability and importance of livestock production on the livelihood of the farm households. The study is focusing on the rural areas of the State. Data employed in study is collected by using structural questionnaire from the Household Budget Survey carried out by the researchers during the period 2009- 2010. This survey is based on the sampling method which allows for the generalization of the results to the whole population of households within a margin of an error. The data from household budget survey covered information on households representing:

- Information about the household demographic and socio-economic attributes of the households (e.g. age, employment patterns, and educational attainments)
- Inputs and output items from the livestock and agricultural activities and Livestock information (e.g. compositions, prices, production and consumption pattern, diseases as well as marketing and livestock income aspects).
- Food security indicators.

Additionally supported secondary data related to the study is collected.

ANALYTICAL METHODS OF DATA ANALYSIS

Simple Analysis

The study used different methods to achieve it stated objectives. These include descriptive analysis and rank matrix correlation analysis. The collected data was subjected to statistical analysis programs in the SPSS (1983) and Microsoft offices Excel 2003.

Instability of food security

The instability of food security for livestock producers in the White Nile in this study is measured by variation in their income. The income of livestock producers is used as it is a good indicator of the relative purchasing power of people to buy food and have access to other resources. Accordingly, the coefficient of variation of producers' income (CV) is used as a proxy for food consumption variability as follows:

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CV = (Qta – Qtt / Qtt)) / 100,
Where:
Qta = actual income,
Qtt = trend level income.
A higher value indicates higher instability in food consumption and thus higher instability in food security.

RESULTS AND DISCUSSION

The influence of the dietary protein level on feed intake, weight gain and feed efficiency is shown in table Table 2. Feed intake increased with increasing protein levels of 16% and 18 % crude protein respectively.

Association of Socioeconomic, Biophysical Characterization and Food Security in the White Nile State

The predominant socioeconomic grouping in the State is consists of a mix of agro-pastoralists and transhumant who are extremely vulnerable to drought. In the case study sites, the two major forms of agricultural production are arable farming and pastoralism. The surveyed results show that households in the Nile State community consist of large compound houses headed by male (95%) and 5% of the household headed by female. The mean of the household headed age is 52 years with the mean of the family size of the animal producers is 8 members and this is normal in rural Sudan as quoted by many researchers. The results also indicate that more than half of the animal producers do not received education (55.7%). About 63% of the animal producers have no other secondary occupation beside the farming occupation.

Naturally the food availability is significantly affected by food access and utilization. Availability of livestock products contributes 7-16 percent in daily diet of rural people (Khan and Gill, 2009). In this study the availability of the livestock products estimates 5-10% in the common daily diet of rural households. Additionally the rural households who have livestock in dairy farming may have good food availability (Kassa, et. al., 2002).

As observed in Table 1, there is positive correlation between education level and food availability and the food access have a negative impact on secondary occupation. Furthermore the food utilization is significantly affected by the family size and number of males in the households. The result also was shown instability in food security indicated by the coefficient of variation (3.4%).

Livestock Conditions and Food Security in the White Nile State

In general the livestock provides an important source of farm income to the people of this State. Cattle, sheep, goats and camels constitute the animal wealth in the area. Milk and cheese- making are providing food and source of income generation. Natural pastures and sugar cane supplemented by concentrates provide the animal feed in the State.

The field crops can provide food when rains are good, but it is not uncommon for whole crops to fail when the rain is insufficient and irregular. Animal producers who produce surplus are able to sell some of their vegetables, but marketing is a key constraint, and there are not big consistent markets. Animal producers reported strong increases in small ruminant and cattle populations and declines in traveling and draft animals.

Table 2 shows that the majority of animal producers in the State owned goats (62.3%) which named in various literatures are poor household animal. A few proportions of the animal producers are kept horses (3%) and camels (5.7%). Most of the farmers owned donkey (63%). The total livestock population of the surveyed regions is 31244 heads. 5.7 % of the animal producers owned the cross breed of animal and those cross breed are cows while 64.3 % of the animal producers owned the indigenous breed for all types of the animals. 44.3 % of the animal producers kept their animals in fences in home side. The fences are mainly constructed from the crops residues and wild shrubs. One percentage of the animal producers kept their animal inside home. Throughout droughts months and during the rainy season they send their animal to natural pasture with shepherd management. The remainder (54.7%) of the animal producers kept their animal in natural pasture near their villages under the household head and/or under one of the family members and shepherd management.

The average of the milk production per week is 11.6 Kg form sheep, 21.5 Kg from cattle, 7.9 Kg from goats and 9.15 Kg from camels. Normally no milk gets from donkeys and horses. The most of milk production are consumed in houses or contribution with their relatives those who have no milk product. The camels milk are used for medicinal issues, the households headed believe that is treated some infection (e.g. childhood diseases), contaminated (e.g. diarrhea) and chronic diseases (e.g. diabetes mellitus and hypertension).

All the surveyed producers indicate that various diseases are affecting their animal during the surveyed period. A few proportions of the animal producers (4.3%) calling the veterinarian doctor to village for treatment of their sickness animal, and they pay for him high fees than usual when they contact to veterinary offices. 8.3% of the animal producers get the medicines from the villages, that some producers who have experts in animal diseases they trade the medicines for others with prices some extra higher than the veterinary pharmacy in the town. While majority of the animal producers (86%) get the medicines from neighboring town.

Some animal producers (17.7%) sold their animals inside villages for urgent issues. While majority of them (76%) sold their animals outside village mainly in big and famous markets of animal in the towns and at this cases some

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time they obligated to travel along distances to catch these markets for high prices and some animal unable to reach healthy. The famous marketing towns in the region are *Getina, Kosti and Gaballen*.

Table 1 - Rank matrix correlation of the socioeconomic factors and food security factors in the while Nile state

item	Sex	Age	EL	MS	SO	FS	NM	NF	FV	FA	FU
1. Sex											
Pearson Correlation	1	-0.005	-0.006	0.220**	0.223**	-0.103	-0.148*	-0.163	0.087	-0.095	0.111
Sig. (2-tailed)	-	-0.005	0.924	0.000	0.000	0.075	0.010	0.284	0.135	0.102	0.084
2. Age											
Pearson Correlation	-0.005	1	-0.323**	-.308**	-0.085	0.264**	0.286**	0.105	-0.024	0.082	0.098
Sig. (2-tailed)	0.933	-	0.000	0.000	0.144	0.000	0.000	0.076	0.676	0.157	0.127
3.EL											
Pearson Correlation	-0.006	-0.323**	1	0.077	0.056	-0.086	-0.116*	-0.074	0.166**	-0.077	-0.014
Sig. (2-tailed)	0.924	0.000	-	0.184	0.334	0.136	0.046	0.210	0.004	0.185	0.823
4. MS											
Pearson Correlation	0.220*	-0.308**	0.077	1	0.124*	-0.336**	-0.261**	-0.159**	-.143*	0.004	-0.144*
Sig. (2-tailed	0.000	0.000	0.184	-	0.031	0.000	0.000	0.007	.014	0.945	0.025
5. SO											
Pearson Correlation	0.233**	-0.085	0.056	0.124*	1	-0.143*	-0.081	-0.147*	0.059	-.303**	0.073
Sig. (2-tailed)	0.000	0.144	0.334	0.031	-	0.013	0.166	0.013	0.313	.000	0.256
6.FS											
Pearson Correlation	-0.103	0.264**	-0.086	-0.336**	-0.143*	1	0.749**	.876**	0.100	0.099	0.134*
Sig. (2-tailed)	0.075	0.000	0.138	0.000	0.013	-	0.000	0.000	0.086	0.088	0.037
7. NM											
Pearson Correlation	-0.148*	0.286**	-0.116*	-0.261**	-0.081	0.749**	1	0.363**	.021	0.062	0.151*
Sig. (2-tailed)	0.010	0.000	0.046	0.000	0.166	0.000	-	0.000	.721	0.286	0.019
8. NF											
Pearson Correlation	0.-063	0.105	-0.074	-0.159**	-0.147*	0.076**	0.363**	1	0.086	0.111	0.083
Sig. (2-tailed)	0.284	0.076	0.210	0.007	0.013	0.000	0.000	-	0.151	0.062	0.234
9. FV											
Pearson Correlation	0.087	-0.024	0.166**	-0.143*	0.059	0.100	0.021	0.086	1	-0.347**	0.335**
Sig. (2-tailed)	0.135	0.676	0.004	0.014	0.313	0.086	0.721	0.151	-	0.000	0.000
10. FA											
Pearson Correlation	-0.095	0.082	-0.077	0.004	-0.303**	0.099	0.062	0.111	-0.347**	1	-0.327**
Sig. (2-tailed)	0.297	0.157	0.185	0.945	0.000	0.088	0.286	0.062	0.000	-	0.000
11. FU						.					
Pearson Correlation	0.111	0.098	-0.014	-0.144*	0.073	0.134*	0.151*	0.083	0.335**	-0.327**	1
Sig. (2-tailed)	0.084	0.243	0.823	0.025	0.526	0.037	0.019	0.207	0.000	0.000	-

Source: Authors calculation, 2009/2010. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Note: EL= education level, MS = marital status, SO= secondary occupation, FS = family size, NM= number of male, NF= number of female, FV= food availability, FA= food access, FU= food utilization.

All the surveyed producers indicate that various diseases are affecting their animal during the surveyed period. A few proportions of the animal producers (4.3%) calling the veterinarian doctor to village for treatment of their sickness animal, and they pay for him high fees than usual when they contact to veterinary offices.

8.3% of the animal producers get the medicines from the villages, that some producers who have experts in animal diseases they trade the medicines for others with prices some extra higher than the veterinary pharmacy in the town. While majority of the animal producers (86%) get the medicines from neighboring town.

Some animal producers (17.7%) sold their animals inside villages for urgent issues. While majority of them (76%) sold their animals outside village mainly in big and famous markets of animal in the towns and at this cases some time they obligated to travel along distances to catch these markets for high prices and some animal unable to reach healthy. The famous marketing towns in the region are *Getina, Kosti and Gaballen*.

Table 2: Livestock in the White Nile State

Livestock Types	Owned (%)	Mean owned	Population (Head)	Mean no. of male sold	Average price of male in SDP	Mean no. of female sold	Average price of female in SDP
Camel	5.7	11.8	200	5.6	1871.4	13	1789
Cattle	55.7	32.6	5454	7	632	29	909.5
Sheep	43.7	82.1	10667	27.2	193.7	69.2	169.7
Goats	62.3	41.7	7806	17.5	135.4	31.5	141.7
Donkey	63	1.8	343	7.5	451	1.6	365.2
Horses	3	1.4	13	1	578.7	1	1800
Poultry	28.3	79.5	6761	7	52	13	51

Source: Field survey, 2009/2010.

It clears that from Table 3 the food security factors (food utilization) are significantly affected by milk production and animal selling in the region. Additionally the milk produced from goat and animal selling are negatively affected by food access and positively affected by food availability. Molden (2008) indicated that for enhancing income and food security, livestock play a big role in livelihood strategies for 70% of the world's rural

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poor. In the White Nile State the livestock contributed about 30% of the total income of the household. Also this result in confirmed by Elzaki (2005), she reported that the livestock contributed about the 36% of the total income in the irrigated areas in Sudan.

Table 3- Rank matrix correlation of the food security factors, milk production and live animal selling in the while nile state

Item	CMP	SMP	GMP	LAS	FV	FA	FU
1. CMP							
Pearson Correlation	1	0. 322*	0.060	0.180	0.002	-0.036	0.198*
Sig. (2-tailed)	-	0.026	0.665	0.130	0.983	0.707	0.049
2. SMP							
Pearson Correlation	0.322*	1	0.585**	0.381**	-0.034	-0.195	0.298**
Sig. (2-tailed)	0.026	-	0.000	0.002	0.755	0.067	0.007
3.GMP							
Pearson Correlation	0.060	0.585**	1	0.393**	0.353**	-0.327**	0.501**
Sig. (2-tailed)	0.665	0.000	-	0.001	0.000	0.000	0.000
4. LAS							
Pearson Correlation	0.180	0.381**	0.393**	1	0.266**	-0.377**	0.643**
Sig. (2-tailed	0.130	0.002	0.001	-	0.001	0.000	0.000
5. FV							
Pearson Correlation	0.002	-0.034	0.353**	0.266**	1	-0.347**	0.335**
Sig. (2-tailed)	0.983	0.755	0.000	0.001	-	0.000	0.000
6.FA							
Pearson Correlation	-0.036	-0.195	-0.327**	-0.377**	-0.347**	1	-0.327**
Sig. (2-tailed)	0.707	0.067	0.000	0.000	0.000	-	0.000
7. FU							
Pearson Correlation	0.198*	0.298**	0.501**	0.643**	0.335**	-0.327**	1
Sig. (2-tailed)	0.049	0.007	0.000	0.000	0.000	0.000	-

Source: Authors calculation, 2009/2010. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Note: CMP = Cattle milk production, SMP= Sheep milk production, GMP = Goat milk production, LAS = Live animal selling, FV= food availability, FA= food access, FU= food utilization.

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PERFORMANCE OF NILE TILAPIA (OREOCHROMIS NILOTICUS) FED FISH MEAL AND POULTRY BY-PRODUCT

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ABSTRACT: *This study was conducted at the Department of Fisheries and Wild life Science, College of Science and Technology of Animal Production, Sudan University of Science and Technology, to determine the feed efficiency of two locally formulated diets (A and B) on performance of Nile Tilapia (Oreochromis niloticus). Two iso-caloric iso-nitrogenus diets were formulated by adding 60% wheat bran, 30% cotton seed cake and 10% poultry by-product (offal+intestine), while the diet (B) contained 60% wheat bran, 30% cotton seed cake and 10% fish meal. The fish were fed twice a day at affixed feeding rate of 5% body weight of fish per day for 90 days. The total body weight, total length and standard length were measured every 10 days throughout the experimental period. The growth response and performance data of the studied fish (Oreochromis niloticus) fed with diet (B) containing fishmeal recorded a better growth response than that fish fed poultry by- product meal (diet A). The final weight increment, specific growth rate (SGR), feed conversion ratio (FCR) and protein efficiency ratio (PER) over the experimental period showed lowest value for the group fed the diet with poultry by-product (Diet A) compared to those fed with the fishmeal (Diet B). Except the apparent protein utilization (APU) was recorded higher for those fed with Diet A (23.31) than Diet B (11.99). The groups fed diet (A) attained SGR 0.24, FCR 1.9, PER 0.75, APU 23.31, while it recorded in group (B), SGR 0.34, FCR 1.2, PER 1.06, APU 11.99. Therefore, fish meal is better as compared to poultry by-products for Nile Tilapia (Oreochromis niloticus) nutrition.*

ORIGINAL ARTICLE

Keywords: *Nile Tilapia, performance, fish meal, poultry byproduct*

INTRODUCTION

The Nile tilapia (*Oreochromis niloticus*) was one of the important fish species cultured in the Sudan. All illustrations from Egyptian tombs, suggest that Nile tilapia were cultured more than 3000 years ago. It is still the most widely cultured fish species in Africa, and it is an important cultured fish group in the world, after carps and salmonids.

Tilapia rearing is also one of the fastest growing farming activities, with an average annual growth rate of 13.4% during 1970-2002 (FAO, 2004), as well as widely cultured in more than 100 countries in tropical and subtropical regions in the world. As in reports, the production of farmed tilapia increased from 383.654 in 1990 to 1.505.804 Mt in 2002 representing about 6% of total farmed finish in 2002 (FAO, 2004).

Tilapia is a hardy prolific, fast growing tropical fish, and it can survive on a diversity of food. Algae is probably their most common food in the wild. On fish farms they are fed a high-protein pelleted feed. They can be fed by hand or with sprinkler mechanism, and generally fed twice per day.

Nutrition is the most expensive component in the intensive aquaculture industry, where it represents over 50% of operating costs. Moreover protein itself represents about 50%of feed cost in intensive culture, therefore, the selection of proper quantity and quality of dietary protein is a necessary tool for successful tilapia culture practices. Several factors including fish size or age, dietary protein source, energy content, water quality and culture conditions have been reported to affect protein requirements of tilapia (Elsayed, et al., 2003). Fishmeal (FM) has been traditionally used as the main protein source in the aqua feed industry. However the increased demand for FM coupled with a significant shortage in global and the supply of fishmeal is not growing worldwide (Rumsey, 1994). FM production has created sharp competition for its use by the animal feed industry. As a result, FM has become the

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most expensive protein commodity in aquaculture feeds in recent years (Tacon, 1993). Moreover the price of fish meal is often high, these necessitate replacing FM with cheaper protein sources (Shepherd, 1998) therefore, and many attempts have been made to partially or totally replace FM with less expensive, locally available protein source.

Terrestrial animal byproducts including poultry by-product meal, blood meal, meat and bone meal have been widely used as protein sources for many fish species, due to their high protein content and good essential amino acid (EAA) profiles (Tacon, 1993). Cost beneficial analyses indicated that these sources can be used as single dietary protein sources for *Nile tilapia* profiles (Elsayed, 1998). On the contrary poultry by-product is not efficiently utilized by profiles due to low digestibility and poor essential amino acid profiles (Viola and Zohar, 1984; Davies et al., 1989). Cottonseed, groundnut and sun flower cakes are one of the best plant protein sources for tilapia in developing countries due to its high availability, relatively low price, good protein content not less than 26.54% depending on processing methods and amino acid profile (FAO, 2004). Replacement of fishmeal by cheaper ingredients of either animal or vegetable origin in aquatic animal feed is necessary because of the rising cost and uncertain availability of fishmeal (Kaushik, 1995; Higgs et al., 1979). The main objective of this study to determine and comparing growth performance of *Oreochromis niloticus* fed with formulated different supplementary feed (fish meal, poultry by product).

MATERIALS AND METHODS

Experimental area and Fish Samples

The experiment was carried out at Sudan University of Science and Technology, College of Science and Technology of Animal production, Department of Fisheries and Wildlife Science. The fish fingerlings used in this experiment were two hundred forty eight (248) of Nile tilapia (*Oreochromis niloticus*) collected from the fish farm of the Fisheries Department using gill nets.

Experimental diets

Ingredients used in the study were purchased from the local market to formulated a two iso-caloric and iso-nitrogenous deits. Diet (A) containing 60% wheat bran, 30% cottonseed cake, 10% poultry byproduct (Offal +Intestine). Diet B, 60% wheat bran, 30% cottonseed cake, 10% fishmeal to attained a desirable calorie for studied fish 4755Kcal/kg.

The experimental diets (A&B) were prepared by mixing the above dry ingredients followed by the addition of hot water (90^{o}C) until a stiff tough paste was obtained. The tough paste was extruded through grinding machine to give pellets, and then dried on the shelves at room temperature. The diets were stored in plastic bags under ambient conditions over the experimental periods. Chemical composition of the experimental diets was shown in Table (1).

Table 1 - Chemical composition of the experimental diets

Diet	DM	CP	CF	EE	Ash
A	93.09	17.93	30.51	7.8	8.85
B	92.52	18.84	27.55	5.65	5.74
ME (Kcal/kg)			4755		

ME=Metabolizable energy, calculated according to MAFF(1977); DM=Dry matter; CP=Crude protein; CF=Crude fiber; EE=Ether extract

Experimental trials

The initial mean weight of Nile Tilapia fingerlings was 41.9 gm with total length 12.7 cm and standard length 10.57 cm. The fish was randomly allocated at a stocking rate of 28 fishes per hapa (Mosquito net) (190 × 100 × 90 cm) with three replicates for each experimental diet, fitted in the fish farm pond (20 × 15 m)^{2}. All fishes were fed two times daily at a fixed feeding rate of 5% body weight per day for 90 days. Total biomass of the fish from each hapa was weighed at 10 days as intervals and feeding rates adjusted accordingly. At the end of the trial nine fishes per hapa were sacrificed and sent to the laboratory to determine the proximate analysis of the whole body of studied fish. Over the experimental period the water temperature and pH levels were measured and recorded every week using normal thermometer and digital pH meter.

Proximate analysis was done according to the AOAC (1980) to determine protein, fat, ash fiber and moisture content. The protein content of the diets and the whole body weight composition was determined by Kjeldalh, method. Fat using solvent extract method. Ash content was obtained by placing the samples in a muffle furnace (550^{o}C for 12 h), fiber by placing the sample remaining in muffle furnace 550^{o}C for 6 h after acid and alkali hydrolysis, moisture by drying the sample in (105^{o}C) until consistent weight has been attained.

Statistical analysis

The data of this study was analyzed using computer statistical package of social science software (SPSS, version 10, one way ANOVA to test for significance according to Gomez and Gomez, 1980).

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RESULTS AND DISCUSSION

The growth response and performance data of Nile Tilapia *(Oreochromis niloticus)* fed with experimental diets containing poultry by-product and fish meal (diets A and diet B) are presented in Table (1, 2 and 3). Results showed a variability in growth rate responses to studied fish (*Oreochromis niloticus)*.The final increment weight and specific growth rate (SGR), feed conversion ratio FCR) and protein efficiency ratio (PER) over the experimental period showed a lower rate level in group fed diet with poultry by-product (Diet A) compared to those fed fish meal (Diet B). While the better apparent protein utilization (NPU) was recorded for those fed with Diet (A).

The results revealed that the better growth rate and feed conversion ratio (FCR) in the fishes fed diet (B) than the other group fed with diet (A). The feed conversion efficiency (FCE), and protein efficiency ratio (PER) also better in the group fed the fish meal diet (B) compared to the other group fed poultry by-product diet (A), while the apparent protein utilization was better in the fishes fed poultry by-product diet (A) than those fed fish meal diet(B). This is in agreement with study of Lim and Domany (1989), they reported that, the main source of the fish diet for protein is the fish meal which still constitute subsistent part of the feed formulation for Nile Tilapia (*Oreocromis niloticus) in* many fish farms. Olvera (2002) evaluated the effect of substituting animal protein (fishmeal) with mixture of plant feed stuffs Soybean meal and Alfalfa leaf in diets of Nile tilapia (*Oreochromis niloticus*) fingerlings showed the best growth performance on this species.

Table 2 - Chemical composition (%) of the studied fish at the end of experiment

Fish groups	DM	EE	CP	CF	Ash
Control	23.59	1.61	19.10	3.98	1.31
Diet A	25.95	1.70	23.28	2.55	2.32
Diet B	27.97	2.24	21.36	3.16	5.00

Table 3 - The effect of diets on the fish growth performance during the trial periods

Parameter	Diet A	Diet B
Specific growth rate (SGR)	0.24	0.34
Feed conversion ratio (FCR)	1.9	1.2
Feed conversion efficiency (FCE)	5.40	8.49
Protein efficiency ratio (PER)	0.75	1.06
Apparent protein utilization (NPU)	23.31	11.99
Weight gain	113.43	120.11

Table 4 - Summary of the main effect of the two formulated diets (A & B) on total bodyweight of studied fish (*Oreochromis niloticus*)

Period \ Diet	A	B
P_1	43.71	40.01
P_2	47.88	45.35
P_3	50.80	50.94
P_4	54.31	55.12
P_5	55.59	57.39
P_6	57.14	60.89
Main effect:		
Diet (A):	51.57^{a}	
Diet (B):	51.61^{b}	
Sig. level	**	
Period:		
P_1:	41.86^{b}	
P_2:	46.61^{c}	
P_3:	50.87^{bc}	
P_4:	54.71^{bc}	
P_5:	56.49^{b}	
P_6:	59.01^{a}	

Where, a, b, c means within the same column followed by different superscript are significantly (P<0.05) different

Hassan and Amin (1997) found that processing technique greatly affected the nutritional quality of poultry by-product and it could replace 50% of fishmeal in the diet, these findings were in the line of Fowler (1991) and Sevgili (2002) and the results of this study.

In Pacific white shrimp and Sun shine bass diet could be replaced by about 80% and 100% of fishmeal by poultry by-product and has no negative effect on the weight gain and feed conversion ratio of the fish species. The results obtained in this study are agreement with many authors such as Elsayed (1998); Catla sp. Hasan et al.

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(1993); Rohu sp. Hasan and Das (1993); Steffens (1998), who indicated that the total replacement of fish meal with poultry by-product could be possible and significantly increased the final weight of fish.

This study might be explained the poorest growth rate of the fish in group (A) could be attributed to a lack of some essential amino acid or the quality of the ingredient itself.

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