2018 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 8, Issue 5: 105-111; Sep 25, 2018 ISSN 2228-7701

PRODUCTIVE RESPONSES OF GRAZING COWS TO FEED SUPPLEMENTATION IN THE COASTAL SAVANNAH ZONE OF GHANA

Frederick Yeboah OBESE[1]✉, Leonard Kofi ADJORLOLO[2] and Kwame DWUMAH[1,3]

[1]*Department of Animal Science, School of Agriculture, College of Basic and Applied Sciences, University of Ghana, Legon, Ghana*
[2]*Livestock and Poultry Research Centre, School of Agriculture, College of Basic and Applied Sciences, University of Ghana, Legon, Ghana*
[3]*CSIR-Animal Research Institute, P.O. BOX AH 20 Achimota, Ghana*

✉*Supporting Information*

ORIGINAL ARTICLE
PII: S2228770118000l4-8
Received: May 18, 2018
Revised: August 20, 2018

ABSTRACT: Daily weight gains, body condition score (BCS), milk yield, concentrations of blood metabolites and resumption of ovarian activity were evaluated in 10 Sanga and 10 Friesian-Sanga cows grazing on natural pasture and supplemented with 2.5 kg of concentrate a day for 10 weeks during the dry season. Average daily gain in weight was similar in the Sanga (293 g) and Friesian-Sanga crossbred (288 g). Body condition score was also similar in the two breeds, but Friesian-Sanga cows had higher milk yield than Sanga cows (2.23 vs 1.65 L/day; P<0.001). There were no significant differences in the concentrations of all the plasma metabolites determined apart from albumin and cholesterol concentrations. Albumin concentration was significantly higher in the Friesian-Sanga crossbred cows than Sanga cows (31.0 vs 29.3 g/L; P<0.05), but total cholesterol was significantly higher in the Sanga than the Friesian-Sanga crossbreds (2.33 vs 2.01 mmol/L; P<0.01). The two breeds had similar interval from calving to resumption of ovarian activity and proportion of non-cycling cows. The results from this study indicate the beneficial effects of feed supplementation on milk yield in Friesian-Sanga cows. Further studies need to be carried out to determine the effects of feed supplementation on milk composition and concentrations of metabolic hormones such as insulin, insulin-like growth factor-1 and leptin that mediate the effects of nutrition on ruminant reproduction.

Keywords: Blood Metabolite, Coastal Savannah, Dry Season, Nutrition, Ovarian Activity

INTRODUCTION

Livestock farming holds enormous potential for improving food security and alleviating poverty. Considerable improvement in feeding and management strategies will be needed to increase productivity to meet increasing demand for livestock products in developing countries due largely to increasing population and income levels and rapid urbanization (Delgado, 2005; Thornton, 2010). Meeting the nutritional needs of cattle for productive purposes has been a major challenge especially in the dry season for farmers grazing cattle extensively on natural pasture in the coastal savannah zone in Ghana. The dry season is usually characterized by scarcity of good quality feed resulting in poor growth rate, low milk yield, delayed resumption of ovulation and extended calving intervals in animals consequently marginalizing profits (Obese et al., 2010). The energy content of forages does not generally meet the productive needs of cows. However, supplementing the diet of grazing cattle with concentrate has been reported to improve their productivity (Pulido et al., 2009; Filho et al., 2014; Idris et al., 2014).

The Sanga and Friesian-Sanga cattle are utilized mostly for meat and milk production in the extensive cattle production system depending greatly on natural pasture in the coastal savannah zone in Ghana. Some baseline studies conducted to assess the growth and reproductive status of these two breeds indicate less than optimum performance due to nutritional deficiencies especially in the dry season (Sottie et al., 2009; Obese et al., 2013, 2015). There is however inadequate information on the productive response of these two breeds to feed supplementation in the extensive cattle production systems in Ghana. Such information is vital in the development of strategic management practices to improve productivity.

This study therefore determined the daily weight gain, body condition score (BCS), milk yield, concentration of blood metabolites and resumption of ovarian activity in Sanga, and Friesian-Sanga cows grazing natural pasture and supplemented with concentrate diet during early lactation in the coastal savannah zone in Ghana.

To cite this paper: Obese F, Adjorlolo LK and Dwumah K (2018). Productive responses of grazing cows to feed supplementation in the Coastal Savannah zone of Ghana. *Online J. Anim. Feed Res.*, 8(5): 105-111. www.ojafr.ir

MATERIALS AND METHODS

Location of Study

The study was conducted at the Council for Scientific and Industrial Research - Animal Research Institute's (CSIR-ARI) Katamanso Station located in the coastal savannah zone of Ghana on latitude 05º 44' N and longitude 00º 08' W (https://en.climatedata.org/location/777295/). The vegetation is grassland with sparsely distributed shrubs. The area has a bimodal rainfall pattern with the major wet season occurring from April to July and a minor season from September to November. The remaining months constitute the dry period. Annual rainfall and temperatures range between 600-1000 mm and 21°C to 33°C, respectively and relative humidity ranges from 69 to 94% (Obese et al., 2015). The study received approval from the In-house Committee for Research of the CSIR-ARI.

Management of Animals

Twenty multiparous cows comprising 10 Sanga and 10 Friesian-Sanga crossbred cows which calved between January and May in the year 2017 (mostly in the dry season) were used in the study. They were supplemented with a concentrate having the composition shown in Table 1. The chemical composition of the supplement provided, and the natural pasture grazed by the cows are indicated in Table 2. Each cow received 2.5 kg per day of concentrate before grazing on natural pasture comprising mainly *Panicum insularis, Sporobolus pyramidalis, Griffonia simplicifolia, Stylosanthes hamata and Stylosanthes guaineesis* for a period of 10 weeks. Water was provided twice daily and cows were milked once daily in the morning. Milk was collected from two quarters of the udder, and the other two quarters were reserved for calves (partial milking). Mating was natural with service bulls running freely with females all year round. Calves were weaned at six months of age. Cows and their calves were treated against ecto- and endoparasites once a month. They were also treated against diseases as the need arose. Weighing of cows and BCS determination (using a 9-point score of 1= very thin to 9= obese) was once a week as indicated in an earlier study (Obese et al., 2015).

Table 1 - Composition of supplement (concentrate)

Ingredient	Composition (%)
Maize	40.0
Wheat Bran	42.0
Soya bean Meal	10.0
Dicalcium Phosphate	2.0
Oyster Shell meal	5.0
Salt	0.5
Premix*	0.5
TOTAL	100

* The premix provided the following per kg of concentrate: Vit.A =30,000 IU, Vit.D = 35,000 IU, Vit.K = 33.75 mg, Vit.B=210 mg, Se = 0.375 mg, Mn =150 mg, Iodate = 5 mg, Zn = 125 mg, Cu =15 mg, Choline Chloride = 300 mg and Antioxidant 62.5 mg.

Table 2 - Chemical composition of forage (basal diet) and concentrate diet (supplement) fed to Sanga and Friesian – Sanga cows on dry matter basis

Constituent	Forage (%)	Supplement (%)
Dry matter	90.2	88.0
Crude protein	5.40	16.0
Neutral detergent fibre (NDF)	77.5	49.7
Acid detergent fibre (ADF)	49.0	13.8
Hemicellulose	28.5	35.9
Cellulose	31.9	3.97
Lignin	11.0	5.00
Silica	3.71	3.71
Digestible Energy (MJ/kg)	11.2	13.9

NDF = Neutral detergent fibre; ADF = Acid detergent fibre; MJ = Megajoules

To cite this paper: Obese F, Adjorlolo LK and Dwumah K (2018). Productive responses of grazing cows to feed supplementation in the Coastal Savannah zone of Ghana. *Online J. Anim. Feed Res.*, 8(5): 105-111. www.ojafr.ir

Blood Sampling and Metabolite analyses

Blood samples were collected from cows after calving once every week for 10 weeks after morning milking at 08.30 h by jugular venipuncture into 7-mL vacutainer tubes and the concentrations of glucose, total protein, albumin, triglyceride, cholesterol, non-esterified fatty acid (NEFA), beta- hydroxybutyrate (BHB) and urea determined in the plasma at weeks 1, 3, 5, 7 and 9 using the VITROS® 5,1 FS Chemistry System auto-analyzer (Ortho-Clinical Diagnostics, U.S.A). Globulin concentration was computed as the difference between total protein and albumin concentrations. The concentration of NEFA in the plasma was determined by enzymatic calorimetric techniques using an assay kit (Diasys Diagnostic Systems, Germany). Plasma BHB concentration was measured using a BHB assay kit (Randox Laboratories, UK).

The resumption of postpartum ovarian activity was determined by measuring the progesterone concentrations in plasma samples from cows from week 1 to week 10 postpartum using a commercial ELISA Kit (DiaMetra Immunodiagnostic Systems, Boldon-UK) according to the manufacturer's instructions. The progesterone ELISA assay had a sensitivity of 0.05 ng/mL. Cows were classified as having resumed ovarian activity when plasma progesterone concentration of ≥1 ng/mL was recorded in two consecutive samples (Tamadon et al., 2011). Cows were classified as non-cycling if progesterone concentration remained below 1 ng/mL throughout the study period.

Statistical Analyses

The average daily weight gain (ADG), BCS, milk yield, and plasma concentration of blood metabolites (total protein, albumin, globulin cholesterol, triglycerides, NEFA and BHB) in the Sanga and Friesian-Sanga cows were determined using the GenStat Release 12th Edition software (GenStat, 2009). The chi-square test was used to determine the association between resumption of ovarian cycle and breed. Values reported are least square means and standard error of mean (SEM), unless otherwise stated.

RESULTS AND DISCUSSION

Weight gain, body condition and milk yield

Daily weight gain, BCS and partial milk yield data are presented in Table 3. Average daily weight gain in the Sanga (293 g) was not different (P>0.05) from that of the Friesian-Sanga (288 g) implying the supplement fed provided enough nutrients to meet the growth needs of both breeds. This is at variance with the study of Teye et al. (2010) who observed that Friesian-Sanga crossbreds grew at a faster rate than Sanga cows when the breeds were grazed on natural pasture and offered an energy based supplement. The daily weight gains in the present study were higher than the 176 g/day and 216 g/day obtained for the Sanga and Friesian-Sanga crossbred respectively reported by Teye et al. (2010). The differences may be attributed to factors including type, amount and length of feed supplementation which can influence weight gains achieved by livestock (Detman et al., 2014; Filho et al., 2014; da Silva et al., 2017). The energy concentrate offered in the present study was based on maize and wheat bran and was fed at a rate of 2.5 kg/day, while Teye et al. (2010) used an energy concentrate based on brewers' spent malt, rice bran and wheat bran offered at a rate of 1 to 2 kg/day. The body condition score for the Sanga (7.33) was not significantly different from that obtained for the Friesian-Sanga (7.04) in the present study. These values indicate the cows were in good body condition suggesting adequate provision of nutrients from the concentrate for maintenance and productive purposes. Partial milk yield increased from week 1 to week 10 postpartum in the Friesian-Sanga crossbred, but remained stable during this period in the Sanga breed (Figure 1). The milk yield was significantly higher in Friesian -Sanga crossbred than the Sanga cows (2.23 versus 1.65 L/day; P<0.001) suggesting higher partitioning of more energy for milk production in the Friesian-Sanga crossbred cows than the Sanga.

Table 3 – Daily weight gain, body condition score and milk yield in Sanga and Friesian-Sanga cows supplemented with concentrate

Parameter	Breed		SEM	Significance
	Sanga	Friesian-Sanga		
ADG of cow (g)	293	288	8.28	NS
ADG of calf (g)	682	798	1.98	NS
BCS	7.33	7.04	0.208	NS
Milk yield (L/day)	1.65	2.23	0.081	***

*** P < 0.001; NS = not significant; SEM = standard error of mean

To cite this paper: Obese F, Adjorlolo LK and Dwumah K (2018). Productive responses of grazing cows to feed supplementation in the Coastal Savannah zone of Ghana. *Online J. Anim. Feed Res.*, 8(5): 105-111. www.ojafr.ir

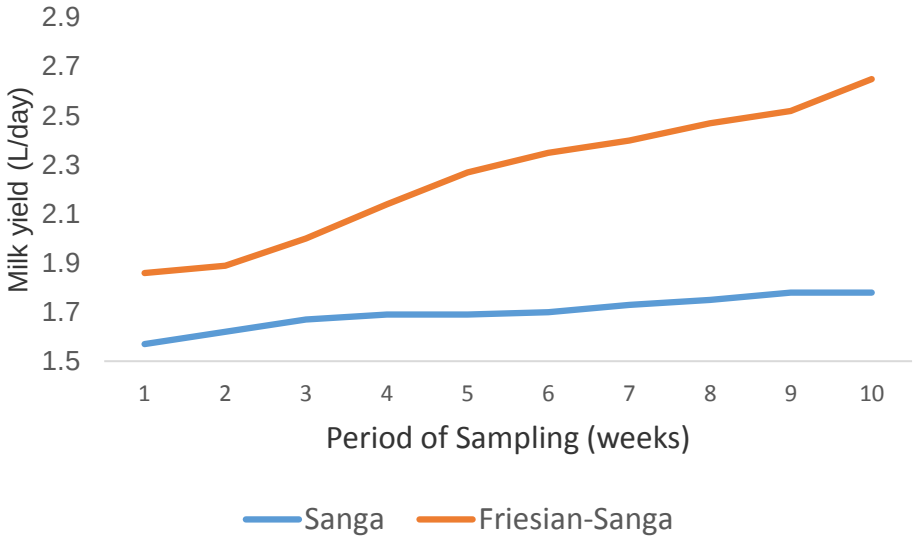

Figure 1 - Daily milk yield in Sanga and Friesian-Sanga cows during the postpartum period

Blood metabolite profiles

The concentrations of blood metabolites reflect nutritional, metabolic and health status in cattle (Ndlovu et al., 2007). The concentrations of all the plasma metabolites determined were not significantly different (P>0.05) in the two breeds apart from albumin and total cholesterol concentrations (Table 4), suggesting that the supplement provided adequate nutrients for the two breeds to maintain their health and physiological status. The concentration of glucose can serve as indicator of energy balance status in cattle. The similar concentrations recorded in the Sanga (4.41 mmol/L) and Friesian - Sanga crossbred (4.16 mmol/L) cows which fell within the normal physiological range of 2.2 - 5.6 mmol/L for cattle (The Merck Veterinary Manual, 2010) implies adequate energy supply to the cows. Although total protein concentration was similar in the two breeds, the Friesian - Sanga cows had higher albumin concentration than the Sanga (31.0 vs 29.3 g/L; P<0.05; Figure 2) indicating better protein status of the Friesian - Sanga crossbred cows than the Sanga. Albumin concentration in the blood is known to reflect protein status (Agenas et al., 2006). The concentrations of albumin obtained for the two breeds were within the normal range of 25 - 38 g/L reported for cows (The Merck Veterinary Manual, 2010) implying the cows were not malnourished. The similar plasma globulin concentrations in the two breeds suggest equal potential of fighting against diseases. Cholesterol levels in the plasma were significantly higher in the Sanga than the Friesian-Sanga crossbred (2.33 vs 2.01 mmol/L; P<0.01; Figure 3), however these values fell within the normal physiological range of 1.6 – 5.0 mmol/L reported for cows (The Merck Veterinary Manual, 2010). Plasma concentration of urea did not differ in the Sanga and Friesian Sanga cows and the levels recorded were within the normal physiological range of 3.8 -6.5 mmol/L reported for cattle (The Merck Veterinary Manual, 2010). The same trend was observed for triglyceride, NEFA and BHB concentrations.

Table 4 – Blood metabolite concentrations of Sanga and Friesian-Sanga cows supplemented with concentrate

Blood metabolite concentrations	Breed		SEM	Significance
	Sanga	Friesian-Sanga		
Glucose (mmol/L)	4.41	4.16	0.15	NS
Total protein (g/L)	76.5	72.9	1.08	NS
Albumin (g/L)	29.3	31.0	0.448	*
Globulin (g/L)	47.1	44.6	0.549	NS
Cholesterol (mmol/L)	2.33	2.01	0.070	**
Triglyceride (mmol/L)	0.23	2.01	0.007	NS
Urea (mmol/L)	4.92	5.23	0.148	NS
NEFA (mmol/L)	0.17	0.17	0.017	NS
BHB (mmol/L)	0.44	0.38	0.029	NS

*P<0.05; ** P<0.01; NS = not significant; SEM = Standard error of mean; NEFA = non-esterified fatty acid; BHB = Beta-hydroxybutyrate

To cite this paper: Obese F, Adjorlolo LK and Dwumah K (2018). Productive responses of grazing cows to feed supplementation in the Coastal Savannah zone of Ghana. *Online J. Anim. Feed Res.*, 8(5): 105-111. www.ojafr.ir

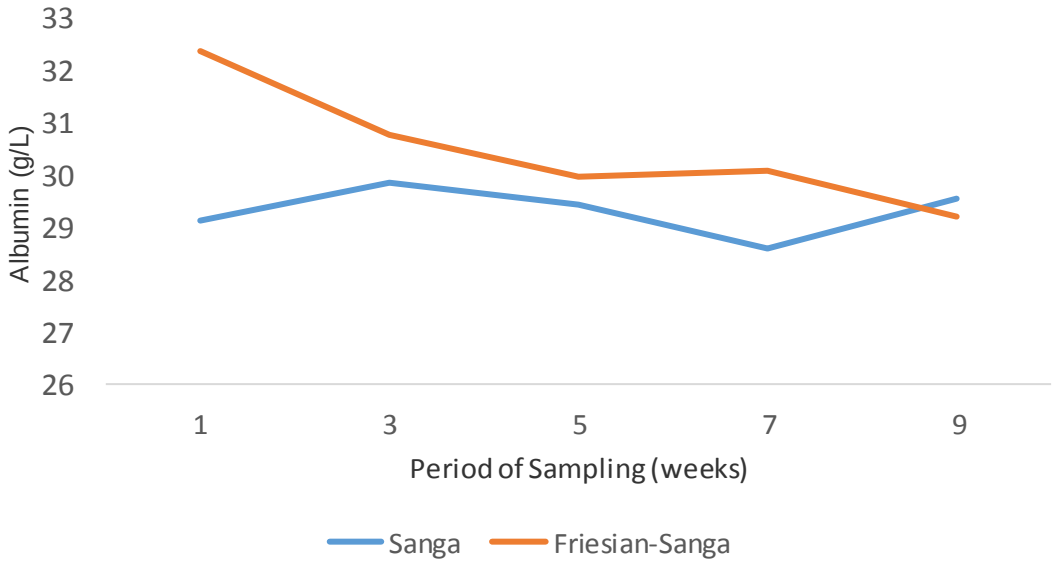

Figure 2 - Plasma Albumin concentration in Sanga and Friesian-Sanga cows during the postpartum period

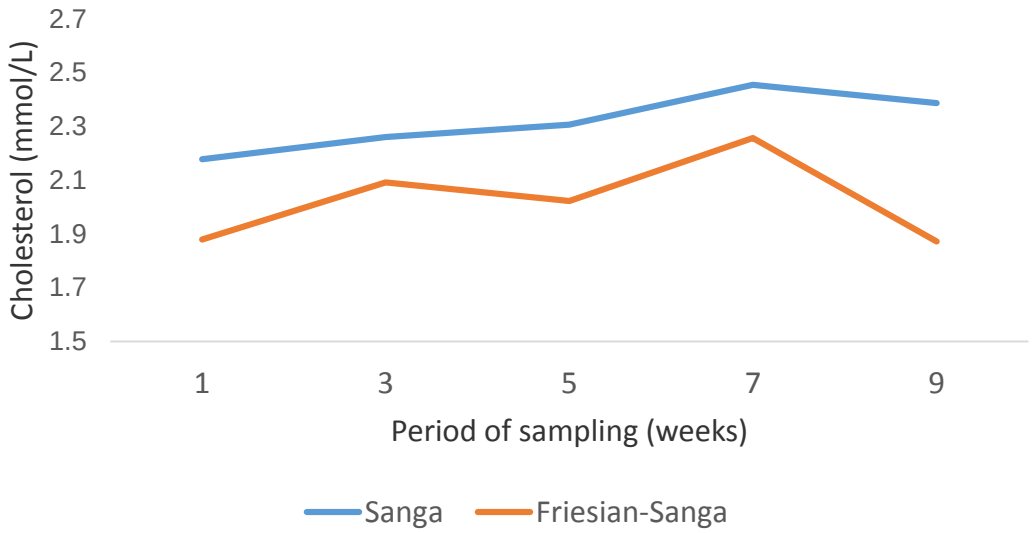

Figure 3 - Plasma Cholesterol concentration in Sanga and Friesian-Sanga cows during the postpartum period

Resumption of ovarian activity

The interval from calving to resumption of ovarian activity was not significantly (P>0.05) different in the Sanga (60 days) and Friesian- Sanga (63 days) cows indicating that the nutrients obtained by the two breeds of cows from the natural pasture and the supplement was adequate for resumption of ovarian activity. The 60 - day interval from calving -to -resumption of ovarian activity obtained for the Sanga in the present study was shorter than the 101.3 days reported in an earlier study for the same breed grazing extensively on natural pasture without feed supplementation in the coastal savannah zone (Obese et al., 1999). Inadequate nutrition delays the resumption of ovulation in cattle during the postpartum period by inhibiting the synthesis and secretion of luteinizing hormone, insulin-like growth factor-I and oestradiol which are necessary for ovarian follicular development and function (Diskin et al., 2003; Soca et al., 2014). The beneficial effects of feed supplementation in enhancing the onset of ovarian activity in Sanga cows in extensive grazing cattle production system in the coastal savannah zone has been reported (Okantah et al., 1998, 1999). For example, Okantah et al. (1999) supplemented Sanga cows grazing on natural pasture with 1.5 kg of wheat bran during early lactation in the coastal savannah zone and observed that the percentage of Sanga cows resuming ovarian activity after calving was higher than non-supplemented cows (46.4 vs 22%). Also in that study the interval from calving to the resumption of cyclic ovarian activity was shorter in supplemented than non-supplemented Sanga cows (64.6 vs 82.5%).

To cite this paper: Obese F, Adjorlolo LK and Dwumah K (2018). Productive responses of grazing cows to feed supplementation in the Coastal Savannah zone of Ghana. *Online J. Anim. Feed Res.*, 8(5): 105-111. www.ojafr.ir

CONCLUSION

Friesian-Sanga crossbred cows produced more milk than Sanga cows when grazed on natural pasture and supplemented with energy concentrate. The similar levels of most of the blood metabolites measured and their concentrations falling within the normal physiological values for cattle indicate absence of deleterious effects of the supplement provided on the health and physiology of the cows.

The similar intervals from calving to resumption of ovarian activity indicate adequate provision of nutrients from the pasture and feed supplement for resumption of ovarian function. Further studies are required on the effects of feed supplementation on milk composition and concentrations of metabolic hormones that mediate the effects of nutrition on reproduction.

DECLARATIONS

Corresponding Author

Frederick Yeboah OBESE, *Department of Animal Science, School of Agriculture, College of Basic and Applied Sciences, University of Ghana, Legon, Ghana*, E-mail: fobese@ug.edu.gh

Authors' contribution

FYO designed the trial, supervised the data collection and laboratory work and contributed to the interpretation of the results and drafting of manuscript. LKA participated in the design of the study, interpretation of data and drafting of manuscript. KD contributed to data collection, laboratory and statistical analysis.

Acknowledgement

Julius Benyuo and Doreen Owusu Ntumy of the CSIR – Animal Research Institute are acknowledged for collection and processing of blood samples for analyses.

Competing interest

The authors declare that they have no competing interests

REFERENCES

Agenas S, Heath MF, Nixion RM, Wilkinson JM and Phillips CJ (2006). Indicators of under nutrition in cattle. Animal Welfare, 15(2): 149-160.

da Silva AG, Paulino MF, Detmann E, Fernandes HJ, Amorim LD, Ortega, REM, de Carvalho VV, Lima, JAD, de Moura FH, Monteiro, MB and Bitencourt, JA (2017). Energetic-protein supplementation in the last 60 days of gestation improves performance of beef cows grazing tropical pastures. Journal of Animal Science and Biotechnology, 8:78 DOI 10.1186/s40104-017-0209-x.

Delgado C (2005). Rising demand for meat and milk in developing countries: implications for grasslands-based livestock production. In: D.A. McGilloway (Ed), Grassland: a global resource, Wageningen Academic Publishers, The Netherlands, Pp. 29-39.

Detmann E, Valente EEL, Batista, ED and Huhtanen, P (2014). An evaluation of the performance and efficiency of nitrogen utilization in cattle fed tropical grass pastures. Livestock Science, 162: 141-153.

Diskin MG, Mackey DR, Roche JF and Sreenan JM (2003). Effects of nutrition and metabolic status on circulating hormones and ovarian follicle development in cattle. Animal Reproduction Science, 78: 345-370.

Filho LCPM, Avila MD, Kazama DCD, Bento LL and Kuhnen S (2014). Productive and economic responses in grazing dairy cows to grain supplementation on family farms in south of Brazil. Animals, 4:463- 475. doi:10.3390/ani4030463

GenStat for Windows 12th Edition. VSN International, Hemel Hempstead, UK.

Https://en.climate-data.org/location/777295/Acessed on 31st May 2018

Idris A, Tibin I, Elbukhari H, Bakheetm S, Zariba S and Hamid A (2014). The effects of supplementation rations on milk yield, body condition score and calves weight of Fuja cows. Online Journal of Animal and Feed Research, 4(6): 159-163.

Ndlovu T, Chimonyo M, Okoh AI, Muchenje V, Dzama K and Raats JG (2007). Assessing the nutritional status of beef cattle: current practices and future prospects. African Journal of Biotechnology, 6 (24): 2727-2734.

Obese FY, Okantah SA, Oddoye EOK and Gyawu P (1999). Post-partum reproductive performance of Sanga cattle in smallholder peri-urban dairy herds in the Accra plains of Ghana. Tropical Animal Health and Production, 31(3): 181-190.

Obese FY, Dafour-Oduro KA, Gomda Y, Bekoe E (2010). Reproductive performance following artificial insemination in Sanga and Crossbred (Friesian x Sanga) cows in the Accra Plains of Ghana. In: Odongo, N.E., Garcia, M., Viljoen, G.J. (Eds), Sustainable Improvement of Animal Production and Health, IAEA Publication, Vienna, Austria. Pp. 201-203.

Obese FY, Acheampong DA and Darfour-Oduro KA (2013). Growth and reproductive traits of Friesian x Sanga crossbred cattle in the Accra Plains of Ghana. African Journal of Food, Agriculture, Nutrition and Development, 13: 7357-7371.

Obese FY, Martin GB, Blackberry MA, Ayim-Akonor M and Gomda Y (2015). Upgrading local cattle in tropical west Africa: Metabolic hormone concentrations during the post-partum period in Sanga and Friesian–Sanga crossbred cows. Livestock Science, 171: 84-92.

Okantah SA, Obese FY, Oddoye EOK, Gyawu P, Karikari PK and Osafo, ELK (1998). Response of Sanga cattle to brewers' spent grain and poultry litter supplementation in the Accra plains of Ghana. Country report on IAEA coordinated research programme presented at the final research coordination meeting. IAEA, Vienna.

Okantah SA, Oddoye EOK, Obese FY, Acquaye M, Gyawu P and Asante Y (1999). Final Report on the evaluation of peri-urban dairy production systems in Ghana.II. Feed supplementation and helminth control. IDRC/CARNET Peri-urban production systems project 92-8155 (West Africa).

Pulido RG, Muñoz R, Lemarie P, Wittwer F, Orellana P and Waghorn GC (2009). Impact of increasing grain feeding frequency on production of dairy cows grazing pasture. Livestock Science, 125:109-114.

Soca P, Carriquiry M, Claramunt M, Ruprechter G and Meikle A (2014). Metabolic and endocrine profiles of primiparous beef cows grazing native grassland. 2. Effects of body condition score at calving, type of suckling restriction and flushing on plasmatic and productive parameters. Animal Production Science, 54(7): 862-868.

Sottie ET, Darfour-Oduro KA and Okantah SA (2009). Comparative studies on growth traits of Sanga and Friesian-Sanga crossbred calves raised on natural pasture on the Accra Plains of Ghana. Tropical Animal Health and Production, 41: 321–328.

Tamadon A, Kafi M, Saeb M, Mirzaei A and Saeb S (2011). Relationships between insulin like growth factor-I, milk yield, body condition score, and postpartum luteal activity in high producing dairy cows. Tropical Animal Health and Production, 43(1): 29-34.

The Merck Veterinary Manual (2010). A Handbook of diagnosis, therapy, and disease prevention and control for the veterinarian, 10th edn. Kahn, CM. Line, S. (Eds), Merck and Co. Inc., New Jersey, USA, Pp. 905–908.

Thornton PK (2010). Livestock production: recent trends, future prospects. Philosophical Transactions of the Royal Society of London B, 365: 2853- 2867

Teye M, Baffour-Awuah O, Odoi FNA, Sottie ET and Okantah SA (2010). Effects of feeding different energy-based diets as supplements on the growth rate of cattle grazing natural pastures. Ghanaian Journal of Animal Science, 5 (2) 65-72.

To cite this paper: Obese F, Adjorlolo LK and Dwumah K (2018). Productive responses of grazing cows to feed supplementation in the Coastal Savannah zone of Ghana. *Online J. Anim. Feed Res*., 8(5): 105-111. www.ojafr.ir