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# THE INFLUENCE OF FEED FORM ON BROILER PRODUCTION AND GASTROINTESTINAL TRACT DEVELOPMENT

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*Supporting Information*

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**ABSTRACT**: **A completely randomized design experiment was conducted to assess the influence of feed form on broiler production and gastrointestinal tract development. A total of (n=315) 16 days-old Ross 308 chicks were randomly assigned to three dietary treatments (mash, crumbles and pellets) with three replicates. Weekly data indicated that birds on pellet and crumble diets had a significant (P<0.05) improvement on a number of production parameters than birds fed diet in a mash form. Data for average values for the whole experimental period demonstrated that the dietary treatments had significant effect on feed intake (0.001), body weight (P=0.013), performance index (P=0.040), abdominal fat weight (P=0.010) and carcass weight. (P=0.001). However, feed conversion ratio and carcass yield did not show significant (P>0.05) response to dietary treatments. Contrary to weekly data the averages for the whole experimental period data was dominated by birds on crumble diet with the highest feed intake, body weight, abdominal fat weight and carcass weight. Gastrointestinal tract development results indicated that dietary treatment had a significant effect on intestinal length (P=0.015) whereby birds that consumed diet in a mash form had superior intestinal length. The intestinal and gizzard weight parameters were not significantly (P>0.05) influenced by the dietary treatment. The results of the current study proved that the crumble form of a diet is the most suitable for optimum broiler production during growing and finishing stages while diet in a mash form is suitable for optimum development of gastrointestinal tract.**

**Keywords:** **Carcass yield, Crumble, Feed form, GIT development, Mash, Pellets**

## INTRODUCTION

Nowadays, various commercial feed mills are producing different feed forms of broiler feed for different age group of birds. Feeding of each form has its own advantages and disadvantages (Ghazi et al., 2012). The effectiveness, digestibility and conversion efficiency of different forms of feeds are also different. However, the dilemma still exists amongst many farmers in Lesotho regarding which form of feed is suitable for production at different stages of broiler growth. The majority of feeds used in commercial production of broilers is given in the form of pellets, mash or crumbles (Waldroup, 1997; Yasar, 2003; Sarvestani, 2006). Mash is form of a complete feed that is finely ground and mixed so that birds cannot easily separate out ingredients and each mouthful provides a well-balanced diet. Mash diets gives greater unification of growth, less death loss and are more economical because pellets and crumbles costs slightly more than the same ration in mash form. However, ground feed is not so palatable and does not retain their nutritive value as well as ungrounded feeds. In general, processing complete poultry feed into pellets involve preconditioning the total mixed diet which is followed by extrusion of the mash through a pellet mill die. In the recent decade, usage of poultry feed in the form of pellet have a lot of benefits such as; decreased ingredient segregation, less time and energy expended for prehension, destruction of pathogenic organism, thermal modification of starch and protein, improved palatability and high feed intake (Jahan et al., 2006). Crumble diet also is a type of feed prepared at the mill by pelleting of the mixed ingredients and then crushing the pellet to a consistency coarser than mash. Recently this form feed is becoming popular in broiler production due to its convenience of feeding.

Crumbles are particularly suitable for young broilers (Cerata et al., 2009). The feeding of meal on the other hand at this stage can limit growth. It is therefore essential to utilize the intake and growth potential of this period to the full and crumbles are particularly suitable for this. The structure of feed for broiler chickens has a strong influence on the physiological functions and development of the digestive tract. A well-developed gastrointestinal tract will lead to



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improved feed utilization and gut motility (Ferket, 2000). Therefore the main objective of this study is to determine the effect of three dietary forms on broiler production and digestive tract development.

## MATERIALS AND METHODS

The completely randomized study was conducted at the National University of Lesotho farm in 2014. The University is located 34 km southeast of the capital city Maseru. The climate of this area alternates between the hot and cold months. The winter being the coldest season and is experienced from May to August and temperature may drop as low as -1$^0$C, summer is the hottest season is experience from September to April and temperature can be as high as 28$^0$C.

The study was made up of three dietary treatments replicated three times. The three treatments were represented by three different feed forms of broiler feeds being mash, crumbles and pellets. All the dietary treatments had similar nutritive value in terms of crude protein and metabolisable energy for all feeding phases, with the exception of feed form. The chemical composition of the feeds is illustrated in table 1. A total of 315, 16 day-old Ross 308 chicks with an average weight of 580 grams were used in the trial. Production variables including feed intake and body weight were measured on weekly basis, while feed conversion ratio and performance index were calculated from this data using the following formulas.

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Feed intake (g)}}{\text{Live weight (g)}} \quad ; \quad \text{Performance index (PI)} = \frac{\text{Live weight (kg)}}{\text{Feed conversion ratio}} \times 10$$

At the end of experimental period all birds in each replicate were killed following a 6-hour fasting in order to determine carcass yield. Carcass yield was determined as the weight of the eviscerated carcass in relation to live weight after fasting. Gastrointestinal tract parameters data was collect at six weeks of age on the following parameters; gizzard weight, intestinal weight and intestinal length. Gizzard and intestinal weights were determined by weighing them on the digital weighing scale after the removal of intestinal contents. Intestinal length was measured using a measuring type. Birds were withdrawn food for 24 hours but given water in order to empty the digestive tract and to avoid meat contamination during slaughtering.

### Statistical analysis

The response variables were analyzed as one-way ANOVA with three dietary treatments and weeks as the main effects using the GENSTAT C statistical package (IBM SPSS, 2011). Once differences were detected by ANOVA, means were separated using Tukey studentized range.

Table 1 - Chemical composition of dietary treatments

| Nutrient \ Feeding phases | Starter | Grower | Finisher |
|---|---|---|---|
| Crude protein (%) | 22 | 20 | 18 |
| Metabolisable energy (Kcal) | 3050 | 3150 | 3200 |
| Lysine (%) | 1.20 | 1.10 | 0.90 |
| Methionine (%) | 0.48 | 0.44 | 0.38 |
| Calcium (%) | 0.96 | 0.91 | 0.90 |
| Phosphorus (%) | 0.41 | 0.40 | 0.38 |

## RESULTS

### Production and carcass parameters

The effects of feed form on broiler production results are illustrated in Figures 1 to 3 for weekly data and in Table 2 for the averages of entire experimental period. According to the results presented in Figures 1 to 3, the dietary treatments had a significant ($P \leq 0.05$) influence on feed intake, feed conversion ratio, performance index across all the weeks. Birds on treatment three (crumble diet) resulted in the highest ($P \leq 0.05$) feed intake, live weight and performance index across all weeks. Live weight results (Figure 2) illustrated a tight competition between treatment two and three whereby both treatments resulted in the similar body weights during week two and three while during the fourth week treatment two (crumble) had a marginal non-significant ($P \geq 0.05$) higher body than treatment three (pellets).

The results of the average performance during the entire experimental period (Table 2) indicated that the dietary treatments had a significant ($P \leq 0.05$) influence on feed intake, live weight, performance index, abdominal fat weight and carcass weight but did not have significant ($P \geq 0.05$) effect on feed conversion ratio and carcass yield. According



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to these results birds fed crumble diet resulted in highest feed intake, live weight and carcass weight followed by birds on pelleted diet and the lowest being birds fed mash diet. Carcass parameters also followed similar trends whereby birds fed crumble diet had the highest carcass yield, carcass weight and abdominal fat while birds fed mash diet had lowest yields.

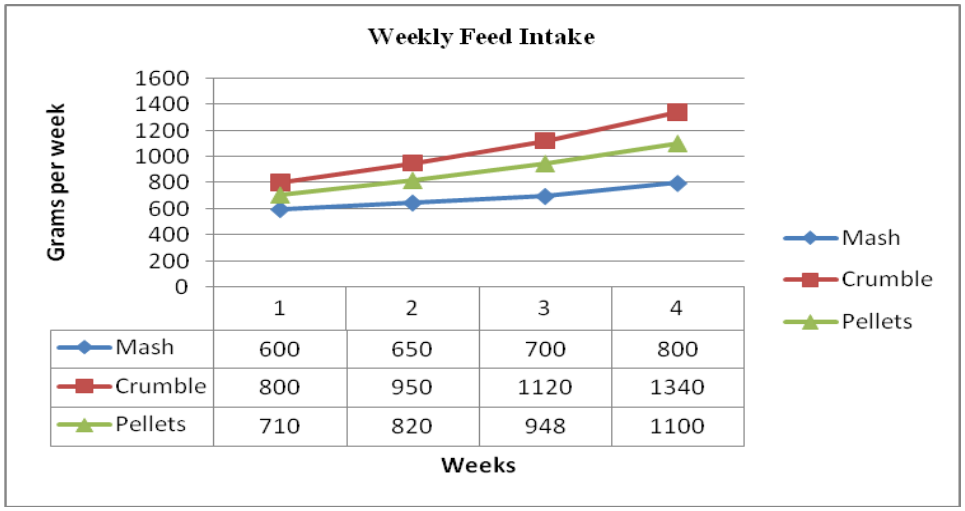


Figure 1 - Weekly feed intake

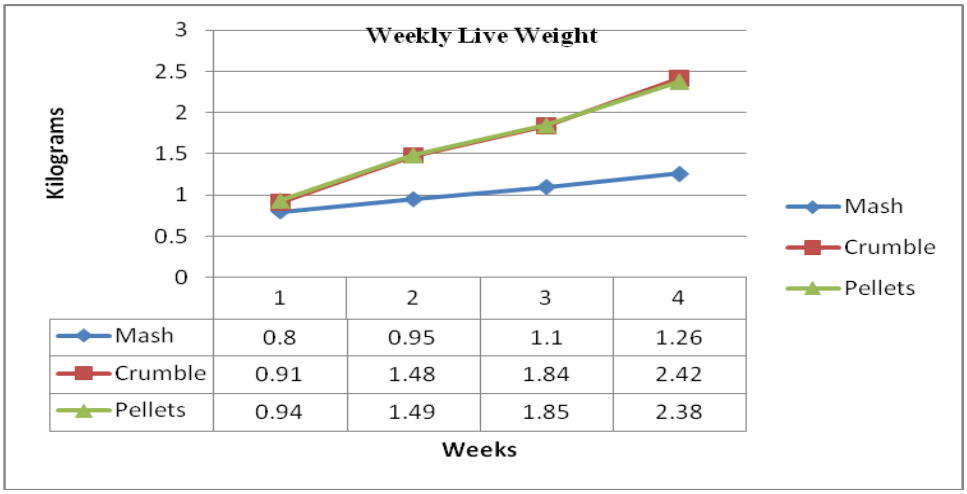


Figure 2 - Weekly live weight

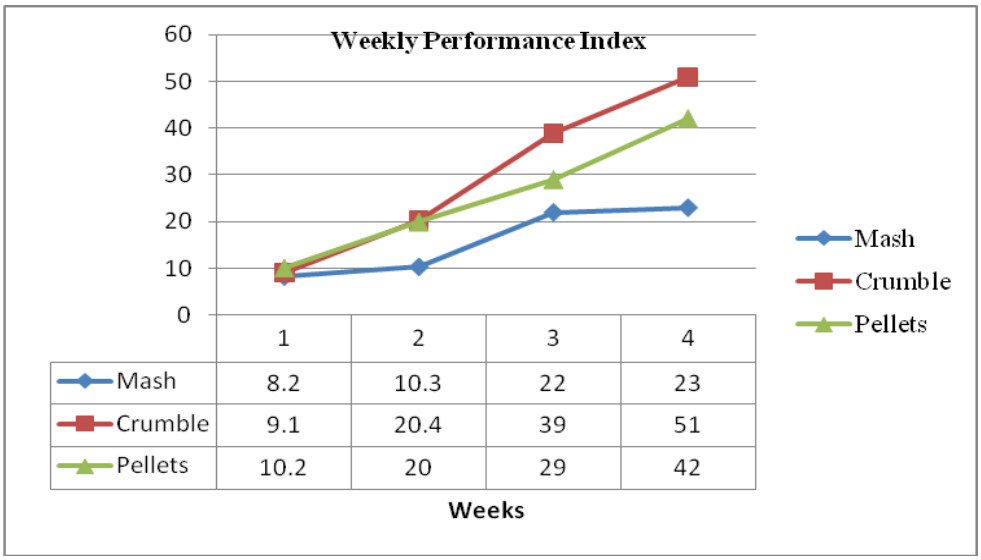


Figure 3 - Weekly performance index



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Table 2 - Production and carcass parameters

| Parameters \ Feed Forms | Mash | Crumbles | Pellets | P - value[1] | CV[2] |
|---|---|---|---|---|---|
| Feed intake (kg) | 0.769±0.82[a] | 1.107±1.17[b] | 0.952±1.01[a] | 0.001 | 20.2 |
| FCR[3] (kg/kg) | 0.723±1.06 | 0.715±1.04 | 0.615±0.90 | 0.182 | 22.8 |
| Average Live weight (kg) | 1.090±0.74[a] | 1.655±1.13[b] | 1.663±1.13[b] | 0.013 | 34.6 |
| Performance index | 16.6±0.68[a] | 25.5±1.05[b] | 30.7±1.26[c] | 0.040 | 54.0 |
| Abdominal fat Wt (g) | 18.18±0.02[a] | 25.33±1.06[b] | 24±0.1.11[b] | 0.010 | 45.2 |
| Carcass weight (kg) | 1.052±0.68[a] | 1.845±1.19[b] | 1.751±1.13[b] | 0.001 | 8.0 |
| Carcass yield (%) | 71.67±4.17 | 74.97±0.89 | 73.21±2.63 | 0.777 | 6.9 |

[a,b] Means in rows with different superscripts differ significantly (P≤0.05); [1] (P≥0.05) = non significant; [2] Coefficient of variation; [3] Feed conversion ratio

### Intestinal parameters

The effects of feed form on broiler gastrointestinal tract parameters results are shown in Table 3. According to these results dietary treatments had a significant (P≤0.05) effect on intestinal length while gizzard and intestinal weights were not statistically (P≥0.05) different between the dietary treatments. It was also observed that the increase in feed particle size from mash to pellets was negatively correlated with all intestinal parameters.

Table 3 - Intestinal parameters

| Parameters \ Feed Forms | Mash | Crumbles | Pellets | P - value[1] | CV[2] |
|---|---|---|---|---|---|
| Gizzard Wt (g) | 30.82±0.02 | 20.67±0.06 | 20.33±0.08 | 0.495 | 21.2 |
| Intestinal Wt (g) | 82.73±0.03 | 67±0.08 | 63.33±0.11 | 0.408 | 25.2 |
| Intestinal Length (cm) | 148.64±4.23[b] | 126.53±2.16[a] | 118.27±3.95[a] | 0.015 | 15.1 |

[a,b] Means in rows with different superscripts differ significantly (p≤0.05); [1] (p≥0.05) = non significant; [2] Coefficient of variation

## DISCUSSION

### Production and carcass parameters

Feed intake and live weight results of the current study are in agreement with the findings of Chewning et al. (2012), Chehraghi et al. (2013), Al-Nasrawi (2016), Gracia et al. (2016) and Omosebi et al. (2016) who reported significantly (P≤0.05) higher body weight and feed intake in birds fed crumble and pelleted diets than birds fed mash diet. Dozier et al. (2010) working with Ross 708 male broiler chickens between day 15 and 42 reported similar results to the current study where they observed that different feed forms had no significant (P≥0.05) influence on carcass yield and FCR. The findings also concurred with the results of Munt et al. (1995), Bolukbasi et al. (2005), Brickett et al. (2007), Agah and Norollahi (2008), Lv et al. (2015) and Ismail et al. (2016) who studied the effect of feed form on broilers performance and reported that feed form did not have significant (P≥0.05) influence on FCR. Contrary to these results (Quentin et al., 2004; Jahan et al., 2006; Salari et al., 2006; Amerah et al., 2007 and Agah and Norollahi, 2008) found that different feed forms had significant (P≤0.05) influence on feed conversion ratios of broilers.

Observed carcass parameters results are in-line with the findings of Nabi et al. (2017) and Hosseini and Afshar (2017) who compared the effect of different feed form on carcass parameters and observed significant (P≤0.05) difference in carcass weight and abdominal fat between birds fed mash, crumble and pelleted diets. These researchers reported that birds fed mash diet had the lowest yield compared to other treatments. On the other hand Mirghelenj and Golian (2009) and Dozier et al. (2010) indicated that abdominal fat weight was not influenced by different feed forms. The contradicting results could have been due to differences in breeds and number of feeding phases used in different studies. Dozier et al. (2010) study used Ross 708 male broiler from day–old to day-42 while the current study used Ross 308 and covered growing and finishing phases between 16 and 42th day.

Jensen et al. (1962) and McKinney and Teeter (2003) revealed that pellet-fed birds spent less time in the act of consuming meals. It could be concluded that the increased growth rate of birds fed pelleted diets is accompanied by reduction in energy expenditure during meal consumption. Reduced energy expenditure would allow for an increase in productive energy (PE) value of the diet, thus providing more calories for protein & lipids synthesis in growing birds.



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### Intestinal parameters

The intestinal length results are in agreement with the results of Amerah et al. (2007) and Frikha et al. (2009) who reported significant (P≤0.05) longer intestinal length in birds fed mash diet. Amerah et al. (2007) also observed a reduction in the relative length of all GIT components as feed particle size increased. However, a decreased intestinal weight or length may result in improved feed efficiency due to reduced maintenance costs (Xu et al., 2015). Intestinal and gizzard weight results are in agreement with Amerah et al. (2007) and Senkoylu et al. (2009) and Abdollahi et al. (2011) and partly conform with results of Gabriel et al. (2008) and Mirghelenj and Golian (2009) who confirmed that pelleted diets reduced the weights of intestinal components. Zaefarian et al. (2016) confirmed that birds do not fully develop their upper gastrointestinal tract when highly processed pelleted feeds are used.

## CONCLUSION

The findings of this current study revealed that feed forms for broiler resulted in significant impact in both production and carcass parameters during the whole experimental period, where birds fed crumble and pelleted diets performed better than birds fed diet in a mash form. With regard to gastrointestinal parameters it can be concluded that diet in the form of crumble and pellet form have a negative influence on the development of intestinal components such as gizzard and intestinal weight and length because they reduce the weight and length of these parameters.

Broiler diets in mash form despite its relatively cheaper cost resulted in significant lower production performance, low carcass yields and higher production of inedible parts (viscera). It is therefore recommended that farmers in Lesotho should opt for large particle size feed form such as crumble and pelleted diets if they want good broiler growth rates and high meat yields.

## DECLARATIONS


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### Authors' contribution

N.P.Kuleile contributed on design of experiment, data collection and the write up of the manuscript and S.M.Molapo participated in data analysis.

### Conflict of interests

The authors have not declared any conflict of interests.

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