

The Effects of Feed Forms on Broiler Metabolic and Skeletal Disorders

^aNchele Kuleile* ^bKhotso NCHECHE, ^bSehlabo KAMOHO, ^bThato MACHELI,
^bTeboho JOBO.

^a *nchelekuleile@gmail.com*

^a*Lesotho Agricultural College, Private Bag A4, Maseru 100, Lesotho*

^b*The National University of Lesotho, P.O. Roma 180, Lesotho*

Abstract

The study was undertaken at the National University of Lesotho Animal Science Farm (altitude 1650 metres) to investigate the causal agents of metabolic and skeletal disorders in broiler chickens. The incidence of ascites also increases significantly at altitudes greater than 1300 meters above sea level, presumably because of the low oxygen partial pressure. The ascites incidences are very high in Lesotho during the cold winter months, accounting for more than fifty percent of the total mortality. The main objective of the current study was to assess the effect of different feed forms on the occurrence and control of metabolic disorders in broilers. A total of (n=200) day-old Ross 308 chicks were randomly distributed into two dietary treatments made up of two broiler feed forms namely mash and pelleted diet replicated four times with twenty-five birds per replicate. The two dietary treatments had similar nutritive value across all feeding phases with exception of feed form. Chicks were housed in a well-ventilated house where treatment diets and water were offered on ad libitum basis. Data collection was done on weekly basis for production parameters such as feed intake, feed conversion ratio, live weight and growth rate while mortality, signs of ascites, lameness and Sudden Death Syndrome (SDS) data were collected daily. All dead birds were examined for the signs of ascites by presence or accumulation of fluids in the abdominal cavity. The findings of the current study indicated that dietary treatment had a significant (P<0.05) effect on SDS. However, there were more incidences of SDS in birds offered pelleted diets than mash diet. Birds fed mash diet had fewer incidences because they were experiencing moderate growth rates compared to birds fed pelleted diet with fast growth rates. Birds offered mash spend more time consuming their feed compared to birds fed pellets and therefore, expend more energy in this process resulting in lower feed conversion efficiency. It was evident from the results that diet in mash form can be used to control the incidences of metabolic disorder by reducing growth rates of broilers.

Published by IJRP.ORG. Selection and/or peer-review under responsibility of International Journal of Research Publications (IJRP.ORG)

Keywords: Form; Ascites; Mash; Pellets; Growth; Mortality

1.0 Introduction

The negative effects of metabolic and skeletal disorders on broiler production are significant when considering the fact that ascites, sudden death syndrome (SDS) and skeletal disorders accounted for 32%, 21% and 10% of total mortality respectively (Van Biljon, 2006). Ascites is characterized by the accumulation of fluid in the abdominal cavity which later affects bird movement (Saffar and Khajali, 2010). SDS or flip over disease as it is commonly known can be recognized by sudden death and birds lying on their back with feet raised up (Saki and Hemati, 2011). Skeletal disorders affect the total yield of carcass as a result of condemnations of broilers with bone deformities. The country is also suffering economic losses because the majority of smallholder farmers are producing their broiler on seasonal basis. The majority of them avoid production during cold winter season because of the high mortality rate due to metabolic disorders. The most common metabolic disorders in Lesotho are ascites and sudden death syndrome. The two are influenced by a number of factors of which broiler feed form and fast growth rate (SCAHAW, 2000) as well as the height above sea level are the major culprits.

Lesotho altitude ranges between 1000 and 3250 metres above sea level. Optimum broiler production on the other hand requires maximum of 1400 metres above sea level. Altitude above this threshold means that oxygen supply to birds will be compromised and hence increased susceptibility to ascites. The incidences of ascites are very high during winter and dry season because of low oxygen carrying capacity of air and poor ventilation which is exacerbated by cold temperatures. Singh et al. (2013; 2018) highlighted the importance of temperature and ventilation optimization in cold weather as beneficial management practices to decrease incidences of ascites, SDS and lameness.

In an attempt to curb the severity of metabolic and skeletal disorders, animal nutritionist had resorted to the use of feed restriction. There are two types of feed restriction that can be employed and they are referred to as qualitative and quantitative depending on their mode of operation (Davoodi-Oman et al., 2019). The quantitative feed restriction focussed on reducing the amount of feed consumed by the birds while qualitative feed restriction concentrate on the reduction of nutrients or chemical composition of feeds (Leeson and Zubair, 1997). The current study is aiming at using different broiler feed forms to alleviate the negative impacts of fast growing broilers and their influence on metabolic disorders. The use of different feed forms for broiler in Lesotho is not well understood because the majority of farmers use different forms interchangeably depending on the price and availability of feeds. The majority of farm feeds retailers seldomly stock all three forms of feeds for farmers to explore and these impact farmers negatively.

Broiler feed form had a direct influence on the occurrence of ascites and SDS because it affects growth rates of broilers (Camacho et al., 2004). Kuleile and Molapo (2019) studied the effects of feed form on broiler production and profitability in Lesotho and revealed that feeds in particulate form gave better performance and fast growth rate while feeds in mash form reduced growth rate significantly. Hasani et al. (2018) observed high incidence of ascites, SDS and leg problems on birds fed crumble and pelleted diet than those offered mash. Sanotra (1999) assessed the prevalence of lameness in commercial flocks and found that 30.1% of the birds were suffering from chronic pain and they could not move around to access feeds. Sahraei (2014) reviewed factors affecting metabolic and skeletal disorders in broiler and highlighted that any means that reduce broiler growth rate had a potential to minimize incidence of disorders.

The objective of the current study, therefore, was to use nutritional strategy in the form of different broiler feed forms to control the incidences of ascites, SDS and lameness.

2.0 Materials and Methods

2.1 Ethical Approval

The study scientific and ethical protocols were approved by the Faculty of Agriculture of National University of Lesotho scientific committee entrusted by the University for quality research attainment.

2.2 Study Site

The study was conducted at the National University of Lesotho poultry farm located at 29°28'S latitude; 27°44'E Longitude (AfriGIS, 2020); at the altitude of 1650 m a.s.l. and it is situated at 35 km southeastern away from Maseru the capital city of Lesotho. It is characterized by very cold winters and warm summers. Winter temperatures can read as low as -5°C and during summer it can reach the maximum of 38°C. Overall this place has an average summer temperature of 22°C.

2.3 Experimental Design

The experimental design was Completely Randomized Design with two dietary treatments replicated four times. Dietary treatments were made up of two broiler feed forms for growing and finishing birds namely mash and pellets. The diets were formulated based on National Research Council (1994) and met nutrient requirements for broiler chickens. The two diets had similar nutritive value but differ in structural composition.

2.4 Birds Housing and Management

A total of (n=200), one day old mixed-sex Ross 308 chicks were obtained from Letsatsi (local agro dealer) on the hatching day. Birds were housed in a well-ventilated house which was properly cleaned and fumigated and then left to dry for 7 days. Birds were offered vitamin and micro mineral mixture stress pack on arrival at the farm. The brooder area was pre-heated before the arrival of the chicks to avoid chilling. The birds were reared in deep litter floor pens. The chicks were allocated into 8 pens and they were 25 birds per replicate. The room was lit 24 hours for the first 42 days. All chicks had similar starter diet in the form of meal from day one and they were separated into different dietary treatments at fourteen days. The experimental feeds and water were provided on ad libitum basis during the whole experimental period of 28 days and all necessary prophylaxis and vaccination requirements for broilers were administered equally.

2.5 Data Collection

2.5.1 Production Parameters

Data on production parameters, such as live weight, growth rate, feed intake and feed conversion ratio were collected on weekly basis, while mortality rate, signs of ascites and lameness were recorded on daily basis. Live weight was measured using a platform weighing scale, Feed conversion ratio (FCR) was calculated as feed intake (g) over live weight (g). Feed intake was determined by the difference between feed supplied and leftovers. Growth rate was measured as the final weight minus initial weight divided by number of days. Mortality rate was recorded from 0 weeks until the 6 weeks by the following formula: $\text{Mortality \%} = \text{No. of death birds in a replication} / \text{No. of initial birds in a replication} \times 100$.

2.5.2 Disorders Parameters

Data collection started at the beginning of the growing phase up to the end of finishing phase (15 to 42 days) because pellets were too big for consumption by the day-old chicks. Birds were observed on daily basis for the signs of lameness, abnormal gait and those sitting down all the time not able to reach waterers and feeders. United State gait-scoring system was used to measure the prevalence of leg weakness by assessing the walking ability of broilers. Walking ability was scored according to three category as follows; 0 (No obvious signs of problems), 1 (Obvious signs) and 2 (Severe signs). Sudden death syndrome was recorded as birds that die without any symptoms of illness and they usually lie on their back with the feet raised. Dead birds were collected daily, weighed, and necropsied for the presence of water accumulation in the abdomen, which was considered as ascites. Any skeletal abnormalities were noted as they were discovered.

2.6 Statistical Analyses

Data collected was analyzed using IBM SPSS (Version 20.0) and then subjected to the analysis of variance (ANOVA) to identify any interaction and influence between two feed forms on production and metabolic disorders.

3.0 Results and Discussion

3.1 Production Parameters

The broiler feed forms had significant ($P < 0.05$) effect on all production parameters (Table 1). Birds that had access to diet in pellet form had significantly ($P < 0.05$) higher feed intake, growth rate, feed conversion ratio, live weight and mortality rate than birds offered diet in a mash form. Feed intake and feed conversion ratio and growth rates results are in agreement with the findings of [Kuleile and Molapo (2019), Hasani et al. (2018), Hosseini et al. (2017), Naderinejad et al. (2017), Chehraghi et al. (2013), Dozier et al. (2010), Amerah et al. (2007)] who reported that feeding pelleted diets during growing and finishing phases increased broiler feed efficiency. On the contrary, Fasuyi and Odunayo (2015) reported that mash diet resulted in higher feed intake and feed conversion ratio than birds fed pelleted diet. The discrepancy may be due to the size of the pellets which was not suitable for chicks during this growth stage. Broiler mortality rate results are in accordance with the findings of [Bricket et al. (2007) and Van Biljon (2006)] who reported higher ($P < 0.05$) mortality in chickens fed the crumble-pellet regimen (6.57% at 42 days), compared to chickens on the ground crumbles and pellets (4.03% at 42 days) and all-mash regimen (2.85% at 42 days). They also noted that feeding mash reduced the overall mortality as well as the mortality in every time period, starting at 14 d of age, in comparison with feeding pellet diets. On the other hand Al-Nasrawi (2016), Moayyedian et al. (2011), Dozier et al. (2010), Norollahi (2008), Scott (2002), Engberg et al. (2002), Nir et al. (1995) stated that different broiler feed forms did not have a significant influence on mortality rate. Ommati et al. (2013) also reported no differences in mortality rate. However, they observed that mortality was highest in pellets fed broilers with 12.7% while mash fed birds group had 9%. The inconsistency of reports on the effect of feed forms on mortality may be due to the difference in the duration of feeding.

The observed results on production parameters clearly revealed the superiority of pelleted diets to optimize broiler production during growing and finishing phase items of feed intake, growth and high feed efficiency. Pelleted diet offers a complete nutrient package for broilers because it reduces nutrient segregation and feed wastage as compared to mash diet (Ghazi et al., 2012). Broilers fed pelleted diet had

high feed intake than birds fed mash diet because pelleted diet has a bigger particle size than mash and therefore it is consumed relatively faster than diet in mash form. Birds consuming diet in mash form spent a lot of time and energy in the act of eating and hence why low feed conversion efficiency. Moran, (1987), Flemming et al. (2002). Skinner-Noble et al. (2005) indicated that pellet rations increased available dietary energy for live weight gain, which improved feed efficiency by reducing the time spent eating and increasing the time spent resting. The benefits of pellet feeding on broiler performance have been extensively reported and the current work confirms the benefits in terms of higher feed intake, weight gain and feed efficiency but prone to high incidences of metabolic disorders.

Table 1. The effects of feed form on broiler production

Parameters	Treatments		Significance	
	Mash	Pellets	P ¹	CV ²
Feed intake (grams/week)	769	951	0.033	11.26
Growth rate (grams/day)	59	84	0.019	9.34
Feed conversion ratio (g/g)	2.2	2.6	0.024	28.28
Live weight	1698	2470	0.001	8.91
Mortality rate	0.7	7.5	0.002	0.21

P<0.05) = Means differed significantly

P¹= Probability at 5%

CV²= Coefficient of variation

3.2 Metabolic Disorders Parameters

The broiler feed forms had significant ($P<0.05$) difference on ascites and skeletal disorders however, there were no differences ($P>0.05$) between feed forms on sudden death incidences. The incidence of ascites and skeletal disorders were significantly higher in broilers fed pelleted diet than birds fed mash diet. Similar trend in results were observed for sudden death syndrome where more incidence were observed in birds offered diet in form of pellets. Van Biljon (2006) results concurred with the findings of the current study on incidences of ascites and skeletal disorders who reported significantly higher mortality mainly caused by ascites (2.11%) and SDS (1.39%) in crumble-pellet treatment than in all mash diets. Skeletal disorders incidences were higher in ground crumble-pellet treatment than in group fed all mash diet. A number of researchers also confirmed the findings of the present study that feeding pellets to broilers lead to fast growth rates that in turn resulted in high incidences of ascites and SDS [Hasani et al., 2018; Meshram and Bijoy 2017; Ghazi et al., 2012; Arce-Menocal et al., 2009; Sarvestani et al., (2006); Bolukbasi et al., 2005; Arce et al., 1985]. Arce et al., (1985) observed 15% incidence of ascites in pellets compared to 4% in mash diets. In the current study broilers fed pellets diet grew significantly faster than birds fed mash and hence the high incidence of ascites and skeletal disorders in these group of birds. Variation in observed results amongst researchers could be as a result of combination of feed form treatment with cold induced treatment, different altitudes, lighting programme, stocking density in rearing house as well as the use of bioenzymes. Researchers also reiterated that skeletal disorders, ascites and SDS are the common cause of economic losses due to mortality and downgrades in fast-growing broiler strains.

Table 2. The effects of feed form on incidences of ascites, sudden death and skeletal disorders

Parameters	Treatments		Significance	
	Mash	Pellet	P ¹	CV ²
Ascites (%)	0.75	6.25	0.033	11.26
Sudden death syndrome (%)	0.00	1.30	0.356	28.28
Skeletal disorders (%)	0.75	5.75	0.001	8.91

P<0.05) = Means differed significantly

P¹= Probability at 5%CV²= Coefficient of variation

4.0 Conclusion

The findings of the current study revealed that broiler feed forms had a profound influence on the occurrences of ascites, sudden death syndrome and skeletal disorders whereby feed in the form of mash significantly reduced metabolic disorders in broilers compared to feed in the form of pellets which resulted in significantly high incidences. However, broiler mash diet gave significantly poor growth rates, feed conversion ratio and final live weight. It was concluded that pelleted feeds improved growth rate and feed conversion ratio, albeit by inducing metabolic disorders in broilers. It is recommended that farmers in Lesotho especially those in the highlands should consider feeding their broilers diet in the form of mash during the period of high susceptibility such as winter time. Farmers in the highlands should feed their broilers diet in the form of mash coupled with improved management practices that are known to influence metabolic disorders such as temperature control, oxygen, dust percentage in air, microorganism toxins, nitric oxide metabolism, vitamin E and selenium supplementation. Future research should evaluate the economic advantage of feeding mash versus pelleted feed through partial budget analysis.

Acknowledgements

The authors wish to thank the National University of Lesotho for providing financial support to undertake this study. We also thank Mr Mahlaha for assisting with animal housing and structures needed to house the experimental animals.

Competing Interests

The authors declared that they did not have a conflict of interest with respect to the research.

Author's Contribution

Nchele Kuleile designed the experiment, supervised data collection, analyzed data and compiled the manuscript. Ncheche, Kamoho, Macheli, and Jobo collected data, conducted post mortem for dead chickens and inserted data in statistical analysis tool. All authors have proof read the final manuscript.

References

- AriGIS 2020. Map of Lesotho. <https://www.afrigis.co.za>
- Agah, MJ., Norollahi, H., 2008. Effect of feed form and duration time in growing period on broilers performance. *International Journal of Poultry Science* 7(11), p. 1074-1077.
<http://dx.doi.org/10.3923/ijps.2008.1074.1077>
- Al-Nasrawi, MAM., 2016. The impact of different dietary forms (mash, crumble and pellets) on some growth traits and carcass characteristics of broilers. *Journal of Animal Health and Production* 4(2), p. 31-36. <https://doi.org/10.14737/journal.jahp/2016/4.2.31.36>
- Arce-Menocal, J., Avila-Gonzalez, E., Lopez-Coello, C., Garibay-Torres, LA., 2009. Body weight, feed particle size, and ascites incidence revisited. *The Journal of Applied Poultry Research* 18(3), p. 465–471, <https://doi.org/10.3382/japr.2008-00095>
- Bolukbasi, SC., Aktas, MS., Guzel, M., 2005. The effect of feed regimen on ascites induced by cold temperatures and growth performance in male broilers. *International Journal of Poultry Science* 4(5), p. 326-329.
- Brickett, KE., Dahiya, JP., Classen, HL., Gomis, S., 2007. Influence of dietary nutrient density, feed form, and lighting on growth and meat yield of broiler chickens. *Poultry Science* 86, p. 2172–2181.
<http://dx.doi.org/10.1093/ps/86.10.2172>
- Camacho, MA., Suarez, ME., Herrera, JG., Cuca, JM., Garcia- Bojalil, CM., 2004. Effect of age of feed restriction and microelement supplementation to control ascites on production and carcass characteristics of broilers. *Poultry Science* 83, p. 526-532.
- Chehraghi, M., Zakeri, A., Taghinejad-Roudbaneh, M., 2013. Effect of different feed forms on performance in broiler chickens. *European Journal of Experimental Biology* 3, p. 66-70. ISSN: 2248 –9215
- Davoodi-Omam, M., Dadashbeiki, M., Corazzin, M., Seidavi, A., 2019. Effect of feed restrictions on performance, blood variables and immunity of broiler chickens. *Veterinarski Arhiv* 89, p. 71-86.
<https://dx.doi.org/10.24099/vet.arhiv.0130>
- Dozier, WA., Behnke, KC., Gehring, CK., Branton, SL., 2010. Effects of feed form on growth performance and processing yields of broiler chickens during a 42-day production period. *The Journal of Applied Poultry Research* 19 (3), p. 219-226. <https://dx.doi.org/10.3382/japr.2010-00156>
- Engberg, RM., Hedemann, MS., Jensen, BB., 2002. The influence of grinding and pelleting of feed on the microbial composition and activity in the digestive tract of broiler chickens. *British Poultry Science Journal* 43, p. 569–579.
- Fasuyi, AO., Odunayo, OT., 2015. Particulating broiler feeds into forms and sizes for nutritional and Economic benefits (part 1). *African Journal of Food Science* 9(4), p. 223-229.

- Ghazi, AMZ., Al-Maktari, GA., Amer, MM., 2012. A comparative effect of mash and pellet feed on broiler performance and Ascites at high altitude (field study). *Global Veterinaria Journal* 9 (2), p. 154-159.
<http://dx.doi.org/10.5829/idosi.gv.2012.9.2.63156>
- Hasani, A., Bouyeh, M., Rahati, M., Seidavi, A., Makovicky, P., Laudadio, V., Tufarelli, V., 2018. Which is the best alternative for ascites syndrome prevention in broiler chickens? Effect of feed form and rearing temperature conditions. *Journal of Applied Animal Research* 46(1), p. 392–396
<http://dx.doi.org/10.1080/09712119.2017.1309320>
- Hosseini, SM., Chamani, M., Mousavi, SN., Hosseini, SA., Sadeghi, AA., 2017. Effects of dietary physical form and dietary inclusion of probiotic and enzyme on growth performance, cellular and humoral immunity, and relative weights of lymphoid organs at early period of broiler chickens fed triticales-based diets. *African Journal of Animal Science* 47(6), p. 776-784.
<http://dx.doi.org/10.4314/sajas.v47i6.5>
- Kuleile, N., Molapo, S., 2019. The influence of feed form on broiler production and gastrointestinal tract development. *Online Journal of Animal and Feed Research* 9(1), p. 38-43. ISSN 2228-7701
- Leeson, S., Zubair, AK., 1997. Nutrition of the broiler chicken around the period of compensatory growth. *Poultry Science Journal* 76, p.992-999.
- Meshram, PV., Bijoy, F., 2017. Managemental and nutritional disease - sudden death syndrome in broilers. *International Journal of Science, Environment and Technology* 6(1), p. 260-266. ISSN 2278-3687 (O)
- Moayyedean, H., Asasi, K., Nazifi, S., Hassanzadeh, M., Ansari-Lari, M., 2011. Relationship between venous blood gas parameters, thyroid hormone levels and ascites syndrome in broiler chickens exposed to cold temperature. *Iranian Journal of Veterinary Research* 12(1), p. 31-38
- Naderinejad, S., Hassanabadi, A., Kermanshah, H., Zaefarian, F., Abdollahi, MR., Ravindran, V., 2017. Influence of feed form and particle size on the performance and nutrient utilisation of broiler starters fed maize-based diets. *Animal Feed Science and Technology* 215, p. 92-104
<https://dx.doi.org/10.1016/j.anifeeds.2016.02.012>
- National Research Council, 1994. *Nutrient Requirements of Poultry*. (9th rev. Ed). National Academy Press. Washing, D.C., USA.
- Ommati, MM., Rezvani, MR., Atashi, H., Akhlaghi, A., 2013. Effect of physical form of diet and ambient temperature on performance and carcass attributes in broilers. *Arch.Geflügelk* 77 (4), p. 247- 253, ISSN 0003-9098
- Owen, RL, Wideman, RF, Hattel, AL, Cowen, BS., 1990. Use of a hypobaric chamber as a model system for investigating ascites in broilers. *Avian Discovery* 34, p. 754-758.
- Saffar, A., Khajali, F., 2010. Application of meal feeding and skip-a-day feeding with or without probiotics for broiler chickens grown at high-altitude to prevent Ascites mortality. *American Journal of Animal and Veterinary Sciences* 5 (1), p. 13-19, ISSN 1557-4555
- Sahraei, M., 2014. Effects of feed restriction on metabolic disorders in broiler chickens: a review.

Biotechnology in Animal Husbandry 30 (1), p 1-13. DOI: [10.2298/BAH1401001S](https://doi.org/10.2298/BAH1401001S)

- Saki, AA., Hemati, M., 2011. Does nutrition help to alleviate sudden death syndrome in broiler chicken? Global Veterinaria 6 (3), p. 262- 268. ISSN 1992-6197.
- Sarvestani, TS., Darbiri, N., Agah, MJ., Norollahi, H., 2006. Effect of pellet and mash diets with biozyme enzyme on broiler performance. International Journal of Poultry Science 5, p. 485-490, <http://dx.doi.org/10.3923/ijps.2006.485.490>
- SCAHAW., 2000. The welfare of chickens kept for meat production (broilers). Report of the Scientific Committee on Animal Health and Animal Welfare. Adopted 21 March 2000.
- Scott, TA., 2002. Evaluation of lighting programs, diet density, and short-term use of mash as compared to crumbled starter to reduce incidence of sudden death syndrome in broiler chicks to 35 days of age. Canadian Journal of Animal Science 82, p. 375–383. <http://dx.doi.org/10.4141/A01-067>
- Singh, PK., Shekhar, P., Kumar, K., 2013. Nutritional and managemental control of ascites syndrome in poultry. Journal of Poultry Farming and Vaccination 1(1), p. 076-082
- Singh, S., Verma, H., Chakraborty, D., 2018. Ascites Syndrome: a challenge for blooming poultry industry. International Journal of Advances in Agricultural Science and Technology 5(6), p. 9-15
ISSN: 2348-1358
- Van Biljon, NJ., 2006. The effect of feed processing and feed texture on bodyweight, feed conversion and mortality in male broilers. Abstract. University of Pretoria MSc Thesis. <http://hdl.handle.net/2263/23371>