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Acacia angustissima leaf meal use as alternative protein source in broiler (*Gallus Gallus domestics)* chicks feed

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Broiler is the cheap source of protein for human. However, high demand of broiler causing much pressure on poultry industry. This pressure is mostly due to feed requirement. This study is design to find the effect of *Acacia angustissima* leaves on growth performance, carcass weight and internal organ of broiler. Total 120 chickens are taken in this experiment. Three different treatments 5%, 10% and 15% feeds are given to broilers along with one control. Total 120 chicks were purchased and kept in 12 different groups. Every group contain 10 chickens. They were feed for 6 weeks and their live weight and feed consumption was recorded on every Friday at 8am for each bird. At the end of experiment after 6 weeks, 4 chickens from each treatment were slaughter and their carcass weight and internal organs weight were calculated. It is observed that 5% treatment give 1551g average weight on 6th week however, 10% remains 1462.2g and 15% on 1452.8g. The control group could produce 1501g. The treatments for live weight, breast weight, hot carcass and drum stick remain significant ($p<0.05$). The significant value for defeathered weight and thigh remained non-significant ($p<0.05$). Weight of intestine, gizzard and liver remained significant ($p<0.05$) and heart's weight ($p>0.05$). On average the weight of each chicken remain 1551g per chicken and feed intake 1079g/week. It is observed from this experiment, 5% inclusion of *Acacia angustissima* is best for growth performance and feed intake.

Key words: *Acacia Angustissima* leaf meal, Internal organs, Carcass, Growth Performance.

Introduction

Broiler, a meat-type of poultry; that has the ability to grow fast and reach market weight faster than ruminants (Madubuike and Ekenyem, 2001) has stirred up interest in many farmers, because it plays a significant role as animal protein source in human diets by supplying essential amino acids needed for growth, development, and repair of worn out tissues.

Changes in atmosphere and expanding human population is causing much pressure on food requirement, which lead to extraordinary challenges to overcome this high demand for nourishment, this also make the traditional protein hotspot "chicken" much expensive (Melesse et al. 2013; Mpofu et al.2016). Feed has a major part in total cost in modern broiler production, accounting about 70% of the total production cost (Sugihar- to 2019). The increase in feed price may therefore imply in the increase in total production cost and thus decrease the profit margin of broiler industry. This may also increase the market price for customers.The use of conventional protein sources such as peanut cake, sesame seedcake, soybean meal, and fish meal might sometimes be limited in poultry feeding due to their unavailability and costly (Etalem et al. 2013). There is need to improve the scientific knowledge for utilizing low cost and locally available agro-industrial by-products in poultry feed in order to reduce the feed cost. This approach involves compounding of feed in a way that all the required nutrients come from cheap alternative energy and protein sources.

Recently, there has been a trend to use leaf meal in combination with other active ingredients to further improve the functional effects of green

leaf on broiler. The search for such alternatives has been the focus of Animal Nutritionists for over a decade (Onyimonyi and Okeke, 2005). This may be beneficial in reducing the proportion of the conventional-expensive protein-rich feed ingredients in broiler rations. It has been known that some particular foliage contain a number of bioactive compounds that are beneficial for the health of chickens (Rama Rao et al 2019).Be that as it may, there are some roughage wellsprings of high nourishing evaluations especially in protein and micronutrient (nutrients promotion minerals) which could be tried as protein supplements for poultry. *Acacia angustissima*, a vegetable scavenge, has been the enthusiasm of numerous poultry researchers to use as feed for poultry. Atteh *et al*. (1995) suggested that the alternative plant protein should have comparative nutritive value to or preferably be cheaper than the conventional protein sources.

This legume could be remembered for poultry abstains from food as a protein source, which would extraordinarily diminish the extent of soybean meal. Worthiness is impacted by appearance, immovability, deliciousness, delicacy and the kind of the meat. Shading, marbling and water holding limit, thusly, impacts the presence of meat. Newness, flavor, security and delicacy are probably the most significant meat qualities buyers search for (Schönfeldt and Jooste, 2015).

Materials and Method

The leaves have been accumulated from Mianwali located on north–east side of Pakistan range from 17°35′S to 31°14′E. Fresh tree appendages cut off creating centers at period of advancement. These were accumulated by means of circumspectly drubbing twigs with a reefer. These leaves were air-dried for 5 d in a shade to safe the breakdown of supplement.

The dried leaves were then grind by passing them through 1mm sieve using a hammer mill. The powder *A.angustissima* was then embodied in diets at 0%, 5%, 10% and 15% of the overall weight of the diets (Nucbe et al.,2015).With the exception of *Acacia angustissima*, all the other ingredients used in this research were purchased from the open market in Mianwali. University of Lahore Sargodha Campus, was selected for this research that is located in Punjab area. The site gets a normal precipitation that ranges somewhere between 410 and 500 m/annum. Average summer and winter temperature remains around 28 and 17°C, separately.

Aggregate of one-day-old 120 chicks were purchased from National Chicks Farm Mianwali, then raised in cages.Grill chicks with a mean load of 41,7 ± 1,51 g were disseminated arbitrarily for 12 gatherings of 10 broilercreatures.The cages were distributed randomly for the three diets and were repeated three times in a random configuration and environmental temperature would be kept at 35 °C.The thermometer (in every cage or section of a cage) would be used to measuring the temperature. The temperature was controlled by heat lamp that was fitted above 18 inches in cage. Wood shavings were spread on the floor to serve as litter for the birds. To ensure a clean bedding material at all times, the wood shavings were changed at fortnightly interval. Each bird had an average floor space of 1.3sq ft. Lighting was done by electricity bulb and the birds had light throughout the night after the brooding period.

Chick diets were made of iso-caloric and iso-nitrogenic 3 ingredients of wheat bran, rice and maize to fulfill the nutritional needs of the chicks. This control diet is formulated using rice corn and wheat bran grind all these ingredients in the shape of granules. *A. angustissima* leaves were compounded at 0, 05, 10 and 15 per cent dietary levels after grinding. Feed blender was then used to mix the feed with each diet detailed with the crude materials. After mixing whole ingredients in balance amount add binder (vegetable oil) and water to bind ingredients.

All data collected from this experiment was analyzed through a two-way analysis of variance the (ANOVA) test.

Results

Results of average live weight of chickens taken in different weeks are presented in table 3.1. It shows that all the different treatments are significantly different from each other. Increase in inclusion percentage of *Acacia angustissima* cause reduction in weight. In 10% and 15% inclusion, it is observed that average weight reduction start from 3rd week of experiment and lasts till end. However, 5% treatment remains best throughout experiment and gives excellent results with 1551.001g average weight.

Table 3.2. shows the effect of increasing percentages of *Acacia angustissima* on growth performance parameters live weight, slaughter weight, fasted weight, defeathered weight, hot carcass, wings, back, drum stick bone, drum stick flesh, breast bone, breast flesh, thigh and chest. Out of all of these parameters, a decrease in average weights of Hot carcass, wings, back, drumstick bone, drumstick flesh and flesh was observed ($p<0.05$) with increase in *Acacia angustissima* percentage. However, the significant value for live weight, slaughter weight fasted weight and defeathered weight remain greater than 0.9 ($P>0.05$). All the growth parameter observed in this study show a decreasing response toward increase in *Acacia angustissima* percentage. The 5% *Acacia angustissima* was found to be best out of all other.

Table 3.1 – **Effect of different treatments of Acacia angustissima live weight of broilers**

Week	T0	T1	T2	T3	S. E	Sig. Value
0	41.723^{a}	43.272^{a}	42.324^{ab}	42.105^{b}	19.68	P<0.05
1st	170.578^{a}	169.638^{a}	169.580^{ab}	169.200^{b}		
2nd	367.000^{a}	371.100^{a}	364.400^{ab}	361.449^{b}		
3rd	643.100^{a}	656.988^{a}	642.800^{ab}	642.999^{b}		
4th	811.174^{a}	825.969^{a}	783.300^{ab}	773.567^{b}		
5th	1091.085^{a}	1131.014^{a}	1059.700^{ab}	1053.067^{b}		
6th	1501.900^{a}	1551.000^{a}	1462.200^{ab}	1452.800^{b}		

A and b= significantly different values (P>0.05), S.E= standard error, T0, T1, T2 and T3= various treatments.

Table 1 – **Ingredients and chemical composition of the diets**

Ingredients	T1	T2	T3	T4
Soya Bean	36	31	25	25
Leaf meal	0.00	5.00	10.00	15.00
Corn Gluten	35	35	35	10
1Premix general	0.60	0.60	0.60	0.60
Corn	14	14	14	14
Oats	14	13	13.89	14
Vegetable Oil	0.0	1	1	1
Total	100	100	100	100
Chemical composition				
% DM	90	91	90.60	89.90
% CP	23.60	23.53	23.50	23.90
%E.E	3.68	3.90	5.19	4.16
Ash	5.77	6.10	6.99	4.77

Table 3.2 – **Effect of different treatments of *Acaciaangustissima* on different carcass parts**

Body characters	T0	T1	T2	T3	Sig. Value
Live weight(g)	1447.2500^{ab}	1574.7500^{c}	1421.2500^{a}	-	P>0.05
Slaughter weight	1291.0000^{ab}	1398.7500^{c}	1236.2500^{a}	1367.0000^{bc}	
Fasted weight (g)	1359.7500^{ab}	1473.7500^{c}	1330.7500^{a}	1396.2500^{bc}	
De-feathered weight	1212.7500^{ab}	1349.7500^{c}	1185.0000^{a}	1265.0000^{bc}	
Hot Carcass	1104.7500^{ab}	1232.2500^{c}	1086.5000^{a}	1169.2500^{bc}	
Wings	73.2500^{ab}	71.7500^{c}	75.7500^{a}	73.5000^{bc}	
Back	218.7500^{ab}	216.5000^{c}	210.7500^{a}	181.2500^{bc}	
Drum stick bone	211.0000^{ab}	219.0000^{c}	207.7500^{a}	202.5000^{bc}	
Drum stick flesh	142.2500^{ab}	150.5000^{c}	127.7500^{a}	187.7500^{bc}	
Breast bone	98.5000^{ab}	146.5000^{c}	111.2500^{a}	136.0000^{bc}	
Breast flesh	117.5000^{ab}	152.2500^{c}	145.0000^{a}	127.7500^{bc}	
Chest	193.5000^{ab}	203.5000^{c}	208.5000^{a}	214.2500^{bc}	

a, b and c= significantly different values (P>0.05), S.E= standard error, T0, T1, T2 and T3= various treatments

Table 3.3. shows a relation between different percentages of *Acacia angustissima* in feed and mean weight of internal body parts intestine, gizzard, heart and liver. T2 treatment liver and proventriculus has almost same results with 10% and 15% inclusions. However, Gizzard of 5 10 and 15 % inclusion gave maximum weight for all compared to Control, studied in our experiment. It is observed that increasing percentage of *Acacia angustissima* has a positive relationship with gizzard and proventriculus (P<0.05). However, there is no significant relation observed for heart weight (P>0.05). The optimum inclusion level for *Acacia angustissima* is 5% because it has best results for all these parameters out of other inclusions.

Table 3.4. shows the average weight of each chicken in every week, total feed consumption and feed consumption of one chicken in one week. This table shows data of total 120 chickens. Feed consumption and weight obtained by feed consumption could be calculated. Feed consumption per each chicken can also be calculated and total estimated cost is lesser than feeds available in market. The 5% inclusions had best results for live body weight, consumable internal organ and carcass weight moreover, it is also economically better than market feeds because of price and availability.

Discussion

Broiler is the only cheapest source of protein for human (Biswas et al 2020). Its high demand causes much pressure on poultry industry especially on its feed (Khan et al 2018). Therefore, much of research is going on it to find any cheap and easily available feed. This experiment is design to know the effect of *Acacia angustissima* on growth performance of broiler and best percentage to be used in feet. In this research three different treatments were used to find the effect of *Acacia angustissima* on broiler's body weight, carcass weight and internal organ. Three replicates 5%, 10% and 15% of *Acacia angustissima* were used. First two week of development in broiler are called starter phase and believed that the digestive system during this starter phase remain immature. So none of feed treatment work during this developmental phase and body weight remain same in all the treatments (Mbajiorgu et al., 2011, Zijlstra and Scott 2000). Taylor and Spring stated that after two weeks of captivity, broiler's digestive system become mature and start digesting all the feed. So different treatment starts working and gives different results for different percentages of treatment (Taylor and Spring, 2008).

In our study growth performance of broiler's that were treated with different percentages of *Acacia angustissima* remain same in first two weeks. The 10% and 15% used feed case reduction in growth performance of birds. The 5% treatment gave best results for growth performance. Growth rate in any organism depends on feed intake (scott 2005). Reduction in growth performance on increasing the inclusion of *Acacia angustissima* is because of higher percentage of fibers in feed. These fibers are non-digestible, cause reduction in digestion of feed and remain no space for further feed. This cause lower in growth performance. The 5% inclusion had adequate percentage of fibers and cause better digestion in digestive system. As a little percentage is required for improving the digestive system's functionality. So 5% inclusions gave best results for growth performance (Ncube et al 2017).

Table 3.3 – **Effect of *Acaciaangustissima* treatment on internal organ**

Treatment	Liver	Heart	Gizzard	Spleen	Proventriculus	Sig. Value
T0	43.250^{a}	10.050^{a}	25.250^{a}	2.800^{a}	8.350^{a}	P<0.05
T1	43.100^{ab}	9.900^{ab}	27.275^{ab}	2.700^{ab}	9.500^{ab}	
T2	42.750^{b}	9.975^{b}	27.975^{b}	2.650^{b}	10.250^{b}	
T3	42.000^{b}	9.875^{b}	28.375^{b}	2.575^{b}	10.725^{b}	
S. E					0.47	

a, b= significantly different values (P>0.05), S.E= standard error, T0, T1, T2 and T3= various treatments

Table 3.4 – **Average feed consumption of chicken**

Treatments	1st	2nd	3rd	4th	5th	6th	Sig. Value
T0	2.9^{a}	2.4^{a}	1.8^{a}	1.8^{a}	1.8^{a}	1.6^{a}	P<0.05
T1	2.3^{b}	2.1^{b}	1.8^{b}	1.68^{b}	1.77^{b}	1.55^{b}	
T2	2.3^{b}	2.1^{b}	1.8^{b}	1.9^{b}	1.6^{b}	1.4^{b}	
T3	1.77^{c}	2.2^{c}	1.8^{c}	1.9^{c}	1.7^{c}	1.5^{c}	

a, b indicate significantly different values (P>0.05), T0, T1, T2 and T3= various treatments

Onyimonyi et al (2009) discribed that *Acacia angustissima* had high percentage of fibers that are not so easily digestible and cause imbalance of nutrients and improper digestion of fee in broiler. Lower digestion of nutrients cause reduction in energy production and disturbance in metabolism in gut. This reduction in total energy production and metabolism reduce the growth performance of birds. A similar explanation is also given by another researcher Svihus et al (2010).

Leaves of Acacia contain a large amount of condensed tannins. During feed formation these condensed tannins bind to feed protein and nutrients. These condensed tannins are non-digestible so inefficient digestion of protein and nutrients occur and cause lowering of diet intake (Makkar 2003). The reduction of carcass fat due to the tannins was observed in ruminants (Terril et al 1992). However, there is no confirmed explanation for these results and also no such study in chicken.

Gudiso et al. 2019 also observed an increase in growth performance; feed intake and carcass weight with 5% inclusion however, further increase of *Acacia angustissima* in feed cause decrease in growth performance along with feed intake and carcass weight. They further stated that *Acacia angustissima* is a good source of protein and can be used as a feed source for broilers. It is a cheaper source and easily available. One opposite statement was given by Ngambi. They stated that *Acacia* had no effect on growth performance however cause reduction in fat from pad area (Ngambi et al 2009).

El-Galil et al. 2019 observed reduction in live weight of broiler from 0 to 9% inclusion of *Acacia angustissima*. These live weight results were opposite to our results, in our study live weight and carcass weight increase up to 5% inclusion however, these may be because they added some inclusion of tartaric acid along with *Acacia angustissima* in feed. Moreover, they stated that increase in *Acacia angustissima* percentage up to 6% in broiler's feed cause increase in weight of giblet and length of digestive tract however, decrease in digestive tract weight. They didn't find any significant effect on carcass weight.

We found an increase in carcass weight up to 5% addition of *Acacia angustissima*, further increase of *Acacia angustissima* cause reduction in carcass weight. These results are consistent with Gadzirayi et al. 2012. This decrease in carcass weight with higher inclusion of *Acacia angustissima* is because of poor and inefficient digestion of nutrients. Insufficient digestion cause poor energy production (McSweeney et al. 2008). This decrease in protein digestion, consumption of nutrients and energy production cause reduction in muscle development and reduced the weight of carcass.

Ngambi et al. 2009 performed an experiment on broiler with Acacia in their feed. They find that increase in *Acacia* in feed didn't have any effect on feed intake and carcass weight. Only 9 to 12g supplementation of Acacia in feed reduced the fat weight on pad. This may be the reason of weight loss in broiler's that had Acacia in their feed in higher percentages in our study. They concluded that 6% inclusion of *Acacia angustissima* with or without addition of tartaric acid, improve the overall economic efficiency of feed.

Thigh weight reported to be increased with increasing *Acacia angustissima* in feed cause gradual reduction in thigh weight. This increase in thigh's weight is because of reduced weight of carcass. Faria et al. 2010 stated that increase in weight of body parts that are related to locomotion is related to decrease in weight of carcass. This increase in weight is also associated with breast. These organs develop earlier than any other body part to most of nutrients are taken by these organs. Reduction in weight of breast and thigh with 10 or 15% inclusion is because of inefficient nutrients (Relandeau& Le Bellogo, 2004).

The trend of weight of carcass parts was similar to live body weight in our study. Similar findings were also reported in broiler by Nwoche et al. 2006. The feed with 5% inclusions gave best result for weight of carcass part. All the groups with 5%, 10% and 15% were significantly different from each other's. The reasons for reduction in weight of carcass parts with increase in *Acacia angustissima* level in feed was for two reasons, may be due to low feed intake (Esonu et al. 2002) or poor digestion of fibers (Nwoche et al. 2006).

Mostly, measurement of internal organ's weight is used to find the effect of toxic substances in feed in animals (Ahamefule et al. 2006). In our results, weight of all organ (Intestine, Gizzard, Liver and Heart) is reported to be highest at 5% inclusion of *Acacia angustissima*. Higher level of *Acacia angustissima* cause digestion problem to animals and give lower nutrition values (Mpofu et al. 2016). Birds with strong gizzard can perform well in digesting fibers of *Acacia angustissima*. An increase in heart weight can be explained by high availability of blood and nutrition. An increase in heart weight of broiler is reported when Moringa Oleifera leaf are used in feed (Nkukwana et al. 2014).

Conclusion

This study concluded that 5% inclusion of *Acacia angutissima* in chicken feed give best results on growth performance, carcass yields and internal organs of broiler chicken. This inclusion also gave better weight increase than other treatments. Moreover, the FCR value of 5%, 10% and 15% is best in contrast of control.

REFERENCES

1. Atteh, J.O. and F.D. Ologbenla (1993). Replacement of Fishmeal with maggots in Broiler diets; Effects on performance and nutrient retention. Nig. J. Anim. Prod. 20, 40-50.

2. Biswas, S. S., Mostafa, M., &Saha, S. S. (2020). Effects of Neem, Tulsi and Ginger Extract as a Growth Promoter in Broilers Production. Int. J. Curr. Microbiol. App. Sci, 9(3), 1331-1339.

3. Etalem Tesfaye, Getachew Animut, Mengistu Urge and Tadelle Dessie (2013): Moringaolifera Leaf Meal as an Alternative Protein Feed Ingredient in Broiler Ration. International Journal of Poultry Science 12 (5): 289-297.

4. El-Galil, A., Hassan, M. M., Abu El-Soud, K. M., El-Dayem, A., &Salem, F. M. (2019). Utilization Of Acacia Saligna Leaf Meal As A Non-Traditional Feedstuff By Local Growing Hens Under Desert Conditions. Egyptian Journal OfNutritionAnd Feeds, 22(1), 211-217.

5. Faria, P. B., Bressan, M. C., de Souza, X. R., Rossato, L. V., Botega, L. M. G., & da Gama, L. T. (2010). Carcass and parts yield of broilers reared under a semi-extensive system. Brazilian Journal of Poultry Science, 12(3), 153-159.

6. Gadzirayi, C. T., Masamha, B., Mupangwa, J. F., &Washaya, S. (2012). Performance of broiler chickens fed on mature Moringaoleifera leaf meal as a protein supplement to soyabean meal. International Journal of Poultry Science, 11(1), 5-10.

7. Gudiso , X.C. , Hlatini , V.A , Chimonyo , M. , and Mafongoya , P.L. 2018. Response of broiler (Gallus gallusdomesticus) performance and carcass traits to increasing levels of Acacia angustissima leaf meal as a partial replacement of standard protein sources. J. Appl. Poult. Res. 28: 13–22.

8. Khan, A. Z., Kumbhar, S., Liu, Y., Hamid, M., Pan, C., Nido, S. A., ...& Huang, K. (2018). Dietary supplementation of selenium-enriched probiotics enhances meat quality of broiler chickens (Gallus gallusdomesticus) raised under high ambient temperature. Biological trace element research, 182(2), 328-338.

9. Madubuike, F.N. and B.U. Ekenyem, 2001. Non-ruminant Livestock Production in the Tropics. Gust Chuks Graphics, Owerri, Nigeria, pp: 185

10. Makkar, H. P. S. (2003). Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich feeds. Small ruminant research, 49(3), 241-256.

11. Mbajiorgu, C. A., Ng'Ambi, J. W., & Norris, D. D. (2011). Voluntary feed intake and nutrient composition in chickens. Asian Journal of Animal and Veterinary Advances, 6(1), 20-28.

12. McSweeney, C. S., Collins, E. M. C., Blackall, L. L., &Seawright, A. A. (2008). A review of anti-nutritive factors limiting potential use of Acacia angustissima as a ruminant feed. Animal feed science and technology, 147(1-3), 158-171.

13. Melesse, A., Getye, Y., Berihun, K., and Banerjee, S. 2013. Effect of feeding graded levels of Moringastenopetala leaf meal on growth performance, carcass traits and some serum biochemical parameters of Koekoek chickens. Livest. Sci. 157:498 505. DOI:10.1016/j.livsci.2013.08.012.

14. Mpofu, D. A., Marume, U., Mlambo, V., & Hugo, A. (2016). The effects of Lippiajavanica dietary inclusion on growth performance, carcass characteristics and fatty acid profiles of broiler chickens. Animal Nutrition, 2(3), 160-167.

15. Ncube S, Hamudikuwanda H and Banda P (2012b). The Potential of Acacia angustissima Leaf Meal as a Supplementary Feed Source in Broiler Finisher Diets. International Journal of Poultry Science, 11: 55-60

16. Ng'ambi, J. W., Nakalebe, P. M., Norris, D., Malatje, M. S., &Mbajiorgu, C. A. (2009). Effects of dietary energy level and tanniferous Acacia karroo leaf meal level of supplementation at finisher stage on performance and carcass characteristics of Ross 308 broiler chickens in South Africa. International Journal of Poultry Science, 8(1), 40-46.

17. Nkukwana, T. T., Muchenje, V., Pieterse, E., Masika, P. J., Mabusela, T. P., Hoffman, L. C., &Dzama, K. (2014). Effect of Moringaoleifera leaf meal on growth performance, apparent digestibility, digestive organ size and carcass yield in broiler chickens. Livestock Science, 161, 139-146.

18. Nwoche, G. N., Ndubuisi, E. C., &Iheukwumere, F. C. (2006). Performance of finisher broilers and cost implication of feeding palm oil as energy supplement. Nigeria Agricultural Journal, 37, 44-49.

19. Onyimonyi, A.E. and J.O. Onukwufor, 2003. Effect of toasted Bambara (VoandzeiasubterreneaThouars) waste on Performance of growing pullets. Proc. 28th Ann. Conf. Nig. Soc. For Anim. Prod. (NSAP). 16th20th March, pp: 237-239

20. Rama Rao S V, Raju M V L N, Prakash B, Rajkumar U and Reddy E P K 2019 Effect of supplementing moringa (*Moringaoleifera*) leaf meal and pomegranate (*Punicagranatum*) peel meal on performance, carcass attributes, immune and antioxidant responses in broiler chickens. Animal Production Science, 59, 288 294. Doi: 10.1071/AN17390

21. Relandeau, C., & Le Bellego, L. (2004). Amino acid nutrition of broiler chicken update on lysine, threonine and other amino acids. Ajinomoto Eurolysine Information, 27, 1-36.

22. Scott, T. A. (2005). Variation in feed intake of broiler chickens. Recent Advances in Animal Nutrition in Australia, 15, 237-244.

23. Sugiharto S 2019 A review on fungal fermented cassava pulp as a cheap alternative feedstuff in poultry ration. Journal of World's Poultry Research, 9, 01-06.

24. Svihus, B., Sacranie, A., Denstadli, V., &Choct, M. (2010). Nutrient utilization and functionality of the anterior digestive tract caused by intermittent feeding and inclusion of whole wheat in diets for broiler chickens. Poultry science, 89(12), 2617-2625.

25. Taylor-Pickard, J. A., &Spring, P. (Eds.). (2008). Gut efficiency; the key ingredient in pig and poultry production: elevating animal performance and health. Wageningen Academic Publishers.

26. Terril, T.H., Douglas, G.B., Foote, A.G., Purchas, R.W., Wilson, G.F., Barry, T.N., 1992. Effect of condensed tannins upon body growth, wool growth and rumen metabolism in sheep grazing sulla (Hedysarumcoronarium) and perennial pasture. J. Agric. Sci. 119, 265–273.

27. Vermeulen H, Schönfeldt HC & Pretorius B. 2015. A consumer perspective of the South African red meat classification system. South African Journal of Animal Science 45(3):341-352.