



Productive Performance and Economics of Broiler Chicken Fed Heat Treated Sheep Manure based Diets Supplemented with Enzyme

I.U. Sheikh, M.T. Banday, A.A. Khan, S. Adil, I.A. Baba, H. Hamadani, R.A. Patoo, B. Zaffer, S.S. Nissa

10.18805/ajdfr.DR-1707

ABSTRACT

Background: Feed is the single largest input which accounts for 60-70% of the total cost of poultry production. Sheep manure is an unconventional feed relatively high in protein and energy levels and can be used in poultry diet to reduce the cost of production. Inclusion of exogenous enzymes will improve its nutritional value as it contains relatively high fibre and utilization by birds. The performance of broiler chicken fed with heat treated sheep manure (HSM) based diets supplement with or without enzyme was studied.

Methods: 210 broiler chicks were randomly distributed to five groups viz. T1 (Control), T2: 5% HSM without enzyme, T3: 5% HSM with enzyme, T4: 10% HSM without enzyme and T5: 10% HSM with enzyme containing 42 chicks in each group having three replicates of 14 chicks each.

Result: The chemical composition of HSM like Dry matter, Organic matter, Crude protein, Ether extract, Crude fibre, Total ash, NFE, Calcium and Phosphorus were estimated as 90.15 ± 1.85 , 71.88 ± 1.62 , 15.24 ± 1.23 , 4.22 ± 0.86 , 17.09 ± 0.92 , 28.12 ± 1.32 , 35.33 ± 1.28 , 1.15 ± 0.08 and $0.48 \pm 0.03\%$. The ME (Kcal/kg) was 1565.33. The final body weight at 6 weeks of age was highest in T3 (1998.25 ± 13.29 g) and lowest in T4 (1949.22 ± 15.14 g). The cumulative feed conversion ratio ranged between 1.79 ± 0.083 in T1 to 1.83 ± 0.078 in T4. The cost of production per kg live weight was highest (Rs. 89.78) in T1 and lowest (Rs. 83.76) in T5 group. The benefit cost ratio was 1.14, 1.17, 1.19, 1.20 and 1.22 for T1, T2, T3, T4 and T5 groups respectively.

Key words: Broiler, Composition, Enzyme, Performance, Sheep manure.

INTRODUCTION

Feed cost accounts for 60-70% of the total cost of either egg or poultry meat production and protein accounts 15% of feed cost in poultry rearing, (Singh, 1990). Poultry also competes with human being for cereal grains which is costly. Nutritionists are often forced to formulate cheaper diet with incorporation of unconventional feed ingredients. So, Sheep manure may be one such unconventional feed ingredient which can be used in poultry diets. Sheep manure is an unconventional feed ingredient that is relatively high in protein and energy levels and can form a satisfactory feed ingredient in poultry diet (Onu, 2007; Abeke *et al.*, 2008; Onu and Otuma, 2008) to reduce the cost of production. However, the usefulness of sheep manure as feed ingredient in monogastric diets is constrained by its relative high fibre content which causes increased viscosity of the gut content resulting lower nutrient digestibility (Galassi *et al.*, 2004; Len, 2008). According to Kanengoni *et al.* (2002) and Partanen *et al.* (2007), as the level of fibre in monogastric diets increases, digestibility of nitrogen and energy decreases. Trait and Wright (1990) reported that fibre dwindle availability of nutrients by dropping the period of exposure of the food to digestive enzymes and absorptive surfaces due to the increase rate of passage of the feed induce by its fibre content. Endogenous enzymes of broilers cannot effectively digest non-starch polysaccharides and thereby the ingestion of high levels of soluble NSP leads to increased digesta

Division of Livestock Production and Management, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agriculture Sciences and Technology of Kashmir, Srinagar-190 006, Jammu and Kashmir, India.

Corresponding Author: I.U. Sheikh, Division of Livestock Production and Management, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agriculture Sciences and Technology of Kashmir, Srinagar-190 006, Jammu and Kashmir, India. Email: sheikhiu@gmail.com

How to cite this article: Sheikh, I.U., Banday, M.T., Khan, A.A., Adil, S., Baba, I.A., Hamadani, H., Patoo, R.A., Zaffer, B. and Nissa, S.S. (2022). Productive Performance and Economics of Broiler Chicken Fed Heat Treated Sheep Manure based Diets Supplemented with Enzyme. Asian Journal of Dairy and Food Research. 41(3): 323-328. DOI: 10.18805/ajdfr.DR-1707.

Submitted: 05-05-2021 **Accepted:** 16-06-2021 **Online:** 28-07-2021

stickiness and reduced nutrient digestibility and absorption (Hajati, 2010). The adverse effects of NSPs can be overcome by supplementation of diets with suitable exogenous enzyme preparations as suggested by many researchers (Zanella *et al.*, 1999; Gracia *et al.*, 2003).

However, its incorporation in the diet of monogastric animal is encumbered by its relatively high fibre content that reduces its nutritional value (Onu, 2007). Inclusion of

exogenous enzymes will improve its nutritional value and utilization by birds. In recent years the use of animal manure for feeding of livestock has generated considerable interest because the conventional feed stuffs can no longer adequately meet the need of fast growing poultry industry (Abeke *et al.*, 2003). In Kashmir valley there is shortage of quality feed ingredients which are to be imported from other states of the country adding more production cost. Inclusion of locally available non-conventional feed like sheep manure may help in formulation of cheaper diet. Therefore, the present study was conducted to evaluate the performance of broiler chicken fed with sheep manure (SM) based diets supplemented with or without enzyme

MATERIALS AND METHODS

Collection of sheep manure

The sheep manure was collected from Mountain Research Centre for Sheep and Goat, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, India and the residues of roughages and other inanimate objects present were removed. The manure was dried at 80°C for 3 hours in the hot air oven and then grounded and made ready for use in the diet of broiler chicken. The heat treated sheep manure (HSM) was then incorporated at different levels in broilers diet.

Preparation of experimental diets

All together five types of diets were prepared viz. T1 (Control) group: Basal diet only prepared as per BIS (1992), T2 group: Basal diet replaced at 5% level with HSM, T3 group: Basal diet replaced at 5% level with HSM with Exzyme- a multi enzyme supplementation, T4 group: Basal diet replaced at 10% level with HSM and T5 group: Basal diet replaced at 10% level with HSM with multi enzyme supplementation. For incorporation of sheep manure to the basal diets, the basal diets were spread on clean concrete floor and then measured quantity of HSM was spread over the basal diet and mixed properly to obtain the experimental diets.

Procurement of birds

A total of 210 broiler chicks were procured from reputed source and brooded in battery cages under uniform feeding and managemental condition for one week with optimum brooding temperature of 95°F.

Distribution and rearing of birds

On 8th day 210 chicks were distributed into five treatment groups viz. T1, T2, T3, T4 and T5 containing 42 chicks in each which were subdivided into three replicates of 14 chicks each. The birds were distributed randomly to different treatment groups having similar body weights and reared in battery cages for a period of six weeks. The birds were vaccinated as per standard schedule.

Feeding of birds

The birds were offered *ad lib.* measured quantity of experimental diets twice daily with clean potable drinking water.

Chemical analysis

The dried HSM was analysed for the proximate components of dry matter (DM), organic matter (OM) crude protein (CP), ether extract (EE), crude fibre (CF), total ash and nitrogen free extract (NFE) as per the method of AOAC (1990). The calcium and phosphorus were estimated as per the method of Talapatra *et al.* (1940). The True metabolizable energy (TME) of the HSM was calculated by using the formula of Wiseman (1987) as $TME (Kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 ash$. Metabolizable energy (ME) was then determined on the basis of TME by assuming that TME was 8 per cent higher than the ME, since TME is noted to be 5-10 per cent higher than the ME (Wiseman, 1987).

Collection and analysis of data

The present study was conducted at Experimental Poultry Farm, Division of Livestock Production and Management, Faculty of Veterinary and Animal Sciences, SKUAST Kashmir, Jammu and Kashmir, India. The weekly body weight, weekly feed consumption, cumulative feed consumption and mortality were recorded for all the treatment groups. The body weight of the experimental birds was recorded on individual basis at weekly intervals. The feed consumption was recorded on group basis at weekly intervals. From recorded data, body weight gain, feed conversion ratio, daily protein intake, protein efficiency ratio *etc.* was calculated. The daily weight gain was divided by daily protein intake to determine the protein efficiency ratio (PER).

The economics of feeding was calculated by taking into account all the inputs as per the prevailing market rates and the sale proceed of the birds obtained at the end of experiment. The data obtained were statistically analysed as per the method of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Chemical composition of sheep manure

The chemical composition of sheep manure has been presented in Table 1. The per cent dry matter, organic matter, crude protein, ether extract, crude fibre, total ash, NFE, calcium and phosphorus were estimated as 90.15 ± 1.85 , 71.88 ± 1.62 , 15.24 ± 1.23 , 4.22 ± 0.86 , 17.09 ± 0.92 , 28.12 ± 1.32 , 35.33 ± 1.28 , 1.15 ± 0.08 and 0.48 ± 0.03 . The ME (Kcal/kg) was calculated to be 1565.33.

The chemical composition of experimental diets incorporated with HSM is presented in Table 2. The crude protein ranged between 20.94-21.42%. The Ether extract ranged between 4.35-4.42% in the experimental diets. The NFE ranged between 59.53-62.30%. The crude fibres (4.77-5.83%) and total ash (7.13-9.28%) of the diets was increased as the level of HSM increased in the diet. The overall chemical composition of the diet did not alter markedly by addition of HSM except the metabolizable energy level. The energy levels of the diets ranged between 2745.49 Kcal/kg in 10% HSM to 2883.98 Kcal/kg in 0% HSM

(Control) diet. The energy levels depreciated with increasing level of HSM in the diets.

Since broilers are monogastric animal, so, high crude fibre content of HSM does not advocate high inclusion level of HSM in broilers diet. The dry matter, crude protein, ether extract and ash are similar with the results of Onu (2007). Similar results also reported by Abeke *et al.* (2003). The dry matter, crude protein, ether extract, ash and ME (Kcal/kg) values are slightly lower than the values reported by (Onu and Madubuike, 2010). The higher crude protein, crude fibre and metabolizable energy and lower ether extract and ash than the present study were also reported (Onu, 2007). The variation in the proximate composition might have resulted from the type of pasture consumed by the animals and the processing methods. The crude protein content of the diets (above 20%) was sufficient to meet the requirement of finisher broilers in a tropical environment as reported by Aduku (1993) and NRC (1994).

Body weight

The body weights of the birds have been presented in Table 3. The initial bodyweight (g) at 1st week of age was 147.67±8.55, 146.74±5.68, 146.89±4.55, 147.12±6.55 and 146.48±8.55, respectively for T1, T2, T3, T4 and T5 groups. The final bodyweight (g) of the birds at 6 weeks of age was 1992.55±11.31, 1974.87±12.59, 1998.25±13.29, 1949.22±15.14 and 1980.58±12.65 respectively for T1, T2, T3, T4 and T5 groups. The final body weight at 6 weeks of age was highest in T3 (1998.25±13.29 g) and lowest in T4 (1949.22± 15.14 g). However, the values did not differ significantly among the

various treatment groups which indicates that HSM could be incorporated safely upto 10% level with or without enzyme supplementation.

In agreement with the findings of the present study Onu and Madubuike (2010) reported that there was no significant difference in body weight gains of the birds fed HSM diets without enzyme supplementation and the control group. The comparable weight gain of the bird fed HSM diet without enzyme supplementation to that of the control could probably be due to increased availability of nutrients and adequate dietary fibre level. Crude fibre activates the intestine which causes more occurrences of peristaltic movement, more endogenous enzyme production, resulting in efficient digestion of nutrients (Esonu *et al.*, 2006). Enzyme supplementation non-significantly ($P>0.05$) improved the body weight gains of the birds at the various levels. However, Onu and Madubuike (2010) reported significantly higher body weight gain in 5% HSM with enzyme supplementation than without enzyme supplementation.

Feed consumption

The cumulative feed consumption of the birds in different treatment groups has been presented in Table 3. The cumulative feed consumption was ranged from 3301.07 ±3.69 in T4 to 3319.11±3.25 in T1 groups. However, the cumulative feed consumption did not differ significantly among the treatment groups. The average daily feed intake per bird was recorded as 79.02, 78.83, 78.95, 78.59 and 78.67 g, respectively for T1, T2, T3, T4 and T5 groups. There was no significant ($P>0.05$) difference in daily feed intake among the groups. Tufarelli *et al.* (2007) and Teimouri *et al.* (2005) also observed that feed intake of birds' increases as the fibre content of the feed increases. Therefore, the birds on lower energy and higher fibre diets were expected to consume more, but this was not observed in this experiment. Onu and Madubuike (2010) also observed non-significant differences in total feed intake and daily feed intake while incorporated HSM in the diet of broilers at different levels. However, Onu and Otuma, (2008) reported significantly higher feed consumption in heat treated sheep droppings supplemented groups than control group Onu, (2007) also reported significantly higher total feed intake and daily feed intake of the birds when diets supplemented with HSM. Ahaotu *et al.* (2013) reported significantly ($P<0.05$) higher feed consumption at 10% 15% heat treated

Table 1: Chemical composition of heat-treated sheep manure.

Nutrients	Value
Dry matter (%)	90.15±1.85
Organic matter (%)	71.88±1.62
Crude protein (%)	15.24±1.23
Ether extract (%)	4.22±0.86
Crude Fibre (%)	17.09±0.92
Total ash (%)	28.12±1.32
NFE (%)	35.33±1.28
ME (Kcal/kg)*	1565.33
Calcium (%)	1.15±0.08
Phosphorus (%)	0.48±0.03

*Calculated as per Wiseman (1989).

Table 2: Chemical composition of experimental diets incorporated with heat treated sheep manure.

Parameters	T1 (Control)	T2 (SM 5%)	T3 (SM 5% + enzyme)	T4 (SM 10%)	T5 (SM 10% + enzyme)
Dry matter	90.21	90.48	90.73	90.58	90.45
Crude protein	21.42	21.06	21.02	20.95	20.94
Ether extract	4.38	4.35	4.37	4.41	4.42
Crude fibre	4.77	5.21	5.14	5.82	5.83
Total ash	7.13	8.06	8.53	9.25	9.28
NFE	62.30	61.32	60.94	59.57	59.53
ME (Kcal/kg)*	2883.98	2827.44	2825.34	2747.73	2745.49

goat manure in the diet of broiler without enzyme supplementation but enzyme supplementation reduced the feed consumption.

Feed conversion ratio

The cumulative feed conversion ratio was recorded to be 1.79 ± 0.083 , 1.81 ± 0.075 , 1.79 ± 0.078 , 1.83 ± 0.078 and 1.80 ± 0.082 respectively for T1, T2, T3, T4 and T5 groups (Table 3). However, no significant ($P > 0.05$) differences were observed among them.

Although non-significant ($P > 0.05$) differences were observed in cumulative feed conversion ratio among the groups. However, slightly poor feed conversion ratio observed in birds fed 10% HSM without enzyme supplementation, suggested that the nutrients were not efficiently digested and utilized by the birds. This is supported by Onu and Madubuike (2010) who reported that the feed conversion ratio of the birds fed 5% and 10% HSM diets without enzyme compared favourably with the control but the birds fed 15% HSM had significantly ($P < 0.05$) lowered feed conversion ratio. They also reported that the groups on enzyme supplemented diets had significantly superior

($P < 0.05$) feed conversion ratio when compared to the unsupplemented groups at the various levels of HSM inclusion. The improved feed conversion and protein efficiency ratios of enzyme supplemented groups is in line with the conclusion of Alam *et al.* (2003) and Choct (2004) who indicated an enhancement in the utilization of nutrients resulting from the elimination of the negative effects of fibre on nutrient utilization. Exogenous enzymes greatly improved the feed conversion ratio of broiler chicks fed enzyme supplemented diets (Jackson *et al.*, 2004; Zou *et al.*, 2006; Onu *et al.*, 2011). However, Onu (2007) reported that FCR was significantly ($P < 0.05$) depressed at 10% and 15% level heat treated sheep dropping in the diet of broiler. Ahaotu *et al.* (2013) reported significantly ($P < 0.05$) poor FCR at 10% 15% heat treated goat manure in the diet of broiler without enzyme supplementation but enzyme supplementation improved the FCR. However, at 5% level they are non significant irrespective of enzyme supplementation.

Protein intake

The average daily protein intake per bird was recorded to be 16.92, 16.60, 16.60, 16.46 and 16.47 g respectively for

Table 3: Performance of broiler chicken fed sheep manure based diets supplemented with enzymes.

Parameters	T1 (Control)	T2 (SM 5%)	T3 (SM 5% + enzyme)	T4 (SM 10%)	T5 (SM 10% + enzyme)
Initial body weight at 1 st week (g)	147.67 \pm 8.55	146.74 \pm 5.68	146.89 \pm 4.55	147.12 \pm 6.55	146.48 \pm 8.55
Final body weight at 6 weeks (g)	1992.55 \pm 11.31	1974.87 \pm 12.59	1998.25 \pm 13.29	1949.22 \pm 15.14	1980.58 \pm 12.65
Total body weight gain (g)	1844.88 \pm 11.31	1827.26 \pm 12.59	1851.25 \pm 13.29	1805.22 \pm 15.14	1834.58 \pm 12.65
Average daily body weight gain (g)	43.90	43.54	44.07	42.98	43.64
Cumulative feed consumption (g)	3319.11 \pm 3.25	3311.27 \pm 3.99	3316.20 \pm 2.64	3301.07 \pm 3.69	3304.98 \pm 2.99
Average daily feed consumption(g)	79.02	78.83	78.95	78.59	78.67
Feed conversion ratio	1.79 \pm 0.083	1.81 \pm 0.075	1.79 \pm 0.078	1.83 \pm 0.078	1.80 \pm 0.082
Av. Daily protein intake (g)	16.92	16.60	16.60	16.46	16.47
Protein efficiency ratio (PER)	2.59	2.62	2.65	2.61	2.65
Survivability (%)	97.6	95.24	97.6	97.6	97.6

Rows bearing no superscript do not differ significantly ($P < 0.05$).

Table 4: Economics of broiler chicken fed sheep manure based diets supplemented with enzymes.

Parameter	T1 (Control)	T2 (SM-5%)	T3 (SM-5% + enzyme)	T4 (SM-10%)	T5 (SM-10% + enzyme)
A. Cost of feed/bird (Rs.)	119.48	113.25	113.41	106.95	107.08
B. Cost of sheep manure (Rs.)	-	Nil	Nil	Nil	Nil
C. Cost of chick (Rs.)	40	40	40	40	40
D. Cost of medicine/vaccine (Rs.)	6.15	6.15	6.15	6.15	6.15
E. Cost of enzyme (Rs.)	0	0	0.44	0	0.44
F. Total cost of production/bird (Rs.) (A+B+C+D+E)	165.63	159.40	160.00	153.10	153.67
G. Return/bird (@ Rs. 95/kg)	189.29	187.61	189.83	185.17	188.15
H. Profit per bird (Rs.) (G-F)	23.66	28.21	29.83	32.07	34.48
I. Cost of production/kg live weight (Rs.)	89.78	87.23	86.42	84.80	83.76
J. Profit/kg (Rs.)	11.87	14.28	14.93	16.45	17.41
K. Benefit cost ratio (B:C)	1.14	1.17	1.19	1.20	1.22
Feed cost as % of total cost	73.04	71.17	70.88	69.86	69.68
Cost of feed/kg weight gain	64.76	61.97	61.26	59.24	58.36
Cost savings (%)	00	4.30	5.40	8.52	9.88

T1, T2, T3, T4 and T5 groups (Table 3) and Protein efficiency ratio (PER) was found to be 2.59, 2.62, 2.65, 2.61 and 2.65 which was also differed non significantly among them. There was no significant ($P>0.05$) difference in daily protein intake among the groups. Protein efficiency ratio (PER) was found to be differed non- significantly among the groups. Onu (2007) also reported non-significant differences in PER of the birds when diets supplemented with HSM which is lower than the present study. However, lower values of PER than the present study with significant ($P<0.05$) differences was observed by several workers (Onu and Otuma, 2008; Onu and Madubuike, 2010; Onu *et al.*, 2011) when incorporated with Heat treated sheep droppings in the diet of broilers at different levels with or without enzyme supplementation. Ahaotu *et al.* (2013) reported significantly ($P<0.05$) reduced PER as the level of heat treated goat manure increased without enzyme supplementation in the diet of broiler but with enzyme supplementation it was comparable with control group.

Economics

The feed is the single largest input which alone accounted 73.04, 71.17, 70.88, 69.86 and 69.68% of the total cost of production for T1, T2, T3, T4 and T5 groups, respectively (Table 4). The cost of savings over control was 4.30, 5.40, 8.52 and 9.88 % for T2, T3, T4 and T5 groups respectively (Table 4). The total cost of production and cost of savings increased linearly as the level of HSM increased in the diet. Similar results obtained by Onu (2007) who reported 5.45, 9.51 and 8.72% savings over control when fed 5, 10 and 15% sheep manure based diets. Onu and Otuma (2008) also reported 5.05 and 6.50% savings when fed 7.5 and 15% heat-treated sheep dropping in the diets of broiler finisher chicks.

The cost of production/kg of broiler (Rs.) was highest in T1 (Rs. 89.78) and lowest in T5 groups (Rs. 83.76). The return/bird (Rs.) was 189.29, 187.61, 189.83, 185.17 and 188.15 respectively for T1, T2, T3, T4 and T5 groups. The Profit per bird (Rs.) was highest in T5 (Rs. 34.48) and lowest in Control group (Rs. 23.66). The return per bird was highest in T3 (Rs. 189.83) and lowest in T4 group (Rs. 185.17) and the profit per bird (Rs.) was highest (Rs. 34.48) in T5 and lowest (Rs. 23.66) in Control group. The profit/kg live bird was highest (Rs. 17.41) in 10% HSM supplemented with enzyme (T5) group and lowest (Rs.11.87) in control group. The feed cost, cost of production/kg live weight and cost of production/kg weight gain reduced as the level of HSM increased in the diet. This could be attributed to the partial replacement of the more expensive feed with HSM that did not cost anything. The profit per bird, profit per kg and benefit cost ratio increases as the level of HSM increased in the diet irrespective of enzyme supplementation. Several workers also reported gradual reduction in cost of production per kg weight gain in broilers as the level of HSM increased in the diet (Onu *et al.*, 2007; Onu and Otuma, 2008). Nwakpu *et al.* (2014) also reported similar results while heat-treated

small ruminants dropping were used as an alternative feedstuff in weanling pig diets.

Enzyme supplementation further reduced the cost of production per kg live weight over the control. Enzyme supplementation reduced feed cost per kg live weight gain and subsequently improved cost of saving on the production of the birds may probably be due to better digestion, absorption and utilization and improved feed conversion efficiency that resulted to the weight gains of the broilers. Similar results have been reported in earlier studies by many workers (Ajaja *et al.*, 2003; Onu *et al.*, 2006; Ani and Omeje, 2007).

The benefit cost ratio was calculated to be 1.14, 1.17, 1.19, 1.20 and 1.22 for T1, T2, T3, T4 and T5 groups respectively.

CONCLUSION

From the present study, it is evident that HSM is an excellent source of nutrients that can be incorporated in the diet of broiler chicken without affecting the performance of birds. It can be used in the diet of broiler for reduction in cost of feed. The HSM can be used upto 10% level safely for economic broiler production to maximize the profit. This low quality waste can be efficiently used as alternative feed ingredient for production high quality animal protein at much cheaper price.

ACKNOWLEDGEMENT

The authors are highly thankful to Director, Research, SKUAST-Kashmir for providing necessary facilities to carry out the study in time.

REFERENCES

- A.O.A.C. (1990). Official Methods of Analysis. 14th edn. Association Official Analytical Chemists, Washington D.C.
- Abeke, F.O., Oguadupe, S.O., Adeyina, I.A., Abubakar, B.Y., Oni, O.O. and Nwagu, B.I. (2003). Response of laying hens to dietary levels of heat treated sheep manure. *Tropical J. Anim. Sci.* 6: 111-116.
- Abeke, F.O., Ogundipe, S.O., Sekoni, A.A., Bale, J.O., Adeyinka, I.A. and Oni, O.O. (2008). Effects of dietary levels of heat treated sheep manure (HSM) on the performance and egg quality parameters of laying hens. *Nig. J. Anim. Prod.* 35(1): 56-62.
- Aduku, A.O. (1993). *Tropical Feedstuff Analysis Table*. Department of Animal Science, Faculty of Agriculture Ahmadu Bello University, Zaria.
- Ahaotu, E.O., Okonkwo, J.C., Onu, P.N. and Okonkwo, V.N. (2013). Performance and Economic Analysis of Broiler Chicks Fed Enzyme Supplemented Heat Treated Goat Manure-Based Diets. *GRA- Global Research Analysis*. 2(8): 14-17.
- Ajaja, K., Agbede, J.O. and Aletor, V.A. (2003). Influence of Roxazyme Supplementation on the Utilization of Wheat Offal or Rice by Broilers. *Proceedings of the 8th Annual Conference Animals Science Association of Nigeria*, Minna. pp. 32-34.

- Alam, M.J., Howlader, M.A.R., Pramanik, M.A.H. and Haque, M.A. (2003). Effect of exogenous enzyme in diet on broiler performance. *Int. J. Poult. Sci.* 2(2): 168-173.
- Ani, A.O. and Omeje, O.D. (2007). Effect of Supplementation with Enzyme on Growth Performance of Broiler Chicks fed Diets Containing Raw Bambara Nut (Voandoeia Subterranea) Waste. Proceedings of the 32th Annual Conference of the Nigerian Society for Animal Production, Calabar, Nigeria. pp. 278-281.
- BIS. (1992). Bureau of Indian Standard of Poultry Feed. Manik Bhawan, Bahadur Shah Zafer Marg, New Delhi.
- Choct, M. (2004). Proc. xxii World Poultry Congress, Turkey. 126-130.
- Esonu, B.O., Ogbonna U.D., Anyanwu G.A., Emenalom O.O., Uchegbu, M.C., Etux, E.B. and Udedibie, A.B.I. (2006). Evaluation of performance, organs characteristics and economic analysis of broiler finisher fed dried rumen digesta. *International Journal of Poultry Science.* 5(12): 1116-1118.
- Galassi, G., Crovetto, G.M., Rapetti, L. and Tamburini, A. (2004). Energy and nitrogen balance in heavy pigs fed different fibre sources. *Livest. Prod. Sci.* 85: 253-262.
- Gracia, M.I., Aranibar, M.J., Lazaro, R., Medel, P. and Mateos, G.G. (2003). Alfa-amylase supplementation of broiler diets based on corn. *Poultry Science.* 82: 436-442.
- Hajati, H. (2010). Effect of enzyme supplementation on performance, carcass characteristics, carcass composition and some blood parameters of broiler chicken. *Ame. J. Anim. Vet. Sci.* 5(2): 155-161.
- Jackson, M.E., Geronian, K., Knox, A., McNab, J. and McCartney, E. (2004). A dose-response study with the feed enzyme β -mannanase in broilers provided with corn-soybean meal based diets in the absence of antibiotic. *Poultry Science* 83: 1992-1996.
- Kanengoni, A.T., Dzama, K., Chimonyo, A.M., Kusina, J., Maswaure, S.M. (2002). Influence of level of maize cob meal on nutrient digestibility and nitrogen balance in Large White, Mukota and LW \times M F1 crossbred pigs. *Anim. Sci.* 74: 127-134.
- Len, N.T. (2008). Evaluation of fibrous feeds for growing pigs in Vietnam: Effects of fibre level and breed. Ph.D thesis, Department of Animal Nutrition and Management, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Uppsala.
- NRC. (1994). Nutrient Requirements of Poultry. Ninth Revised edition, National Academy Press, Washington DC, USA, pp. 19-34.
- Nwakpu, P.E., Ogbu, C.C. and Uchewa, E.N. (2014). Evaluation of heat-treated small ruminants dropping as an alternative feedstuff in weanling pig diets. *Global Journal of Agriculture and Food Sciences Research.* 1(2): 43-52.
- Onu, P.N., Nwakpu, P.E. and Chukwu, L.O. (2006). Performance of broiler chicks (*Gallus domesticus*) fed maize offal-based diets supplemented with roxazyme G. enzyme. *International Journal of Poultry Science.* 5(7): 610-613.
- Onu, P.N. (2007). The influence of heat- treated sheep manure on the performance, carcass characteristics and economics of production of starter broilers. *J. Anim. Vet. Adv.* 6(11): 1323-1327.
- Onu, P.N. and Madubuike, F.N. (2010). Performance and carcass properties of finisher broilers fed Exogenous enzyme supplemented sheep manure based diets. *Indian J. Anim. Res.* 44 (2): 94-99.
- Onu, P.N., Madubuike, F.N., Onu, D.O. and Ekenyem, B.U. (2011). Performance and economic analysis of broiler starter chicks fed enzyme supplemented sheep manure-based diets. *ARNP Journal of Agricultural and Biological Science* 6(1): 14-19.
- Onu, P.N. and Otuma, M.O. (2008). Utilization of heat treated Sheep dropping in the diet of broiler finisher chicks. *International Journal of Poultry Science.* 7(2): 169-173.
- Partanen, K., Jalava, T. and Valaja, J. (2007). Effects of a dietary organic acid mixture and of dietary fibre levels on ileal and faecal nutrient apparent digestibility, bacterial nitrogen flow, microbial metabolite concentrations and rate of passage in the digestive tract of pigs. *Animal.* 1(3): 389-401.
- Singh, R.A. (1990). Poultry Production. 3rd Ed., Kalyani Publishers, 1/1 Rajinder Nagar, Ludhiana-141008, New Delhi, India.
- Snedecor, G.W. and Cochran, W.G. (1994). Statistical Methods. 8th Edn., Affiliated East West Press Pvt. Ltd., New Delhi.
- Talapatra, S.K., Ray, S.C. and Sen, K.C. (1940). Estimation of phosphorus, chlorine, calcium, 419 magnesium, sodium and potassium in foodstuffs. *Indian J. Vet. Sci. Anim. Husb.* 10: 243-246.
- Teimour, A., Rezae, M., Pourreza, J., Sayyahzedeh, H. and Walldrop, P.W. (2005). Effect of diet dilution in the starter period on the performance and carcass characteristics of broiler chicks. *International Journal of Poultry Science.* 4(12): 1006-1011.
- Traits, J. and Wright, A.J. (1990). Effect of sugar bit-fabric and wheat bran fibre on iron and zinc absorption in rats. *British Journal of Nutrition.* 64: 547-552.
- Tufarelli, V., Dario, M. and Laudadio, V. (2007). Effect of xylanase supplementation and particle-size on performance of guinea fowl broilers fed wheat based diets. *International Journal of Poultry Science.* 4: 302-307.
- Wiseman, J. (1987). Feeding of Non-ruminant Livestock. Butterworths, London, UK, pp. 9-13.
- Zanella, L., Sakomura, N.K., Silversides, F.G., Figueirido, A. and Pack, M. (1999). Effect of enzyme supplementation of broiler diets based on corn and soybean. *Poultry Science.* 78: 561-568.
- Zou, X.T., Qiao, X.J. and Xu, Z.R. (2006). Effect of β -mannanase (Hemicell) on growth performance and immunity of broilers. *Poultry Science.* 85: 2176-2182.