Nigerian J. Anim. Sci. 2022, 24 (3): 174-182

Performance, carcass attributes and organ description of broiler chickens on dietary supplementation of *Moringa oleifera* leaf meal

Ogunsipe, M.H., Ayoola, M.A., Dada, O.A. and Oladepo, A.D.

Animal Production Unit, Department of Agricultural Science, Adeyemi Federal University of Education, Ondo, Nigeria

***Corresponding Author:** moogunsipe2009@gmail.com ogunsipemh@aceondo.edu.ng **Phone Number:** +234 8035284422*

***Target Audience:** Animal nutritionists, Animal scientists, Feed manufacturers, Poultry farmers, Researchers*

Abstract

The study aimed to assess the influence of Moringa oleifera leaf meal supplementation on the performance, carcass attributes and organ qualities of broiler chickens in a feeding trial that lasted for 42 days. A batch of 240 Arbor-Acre one-day-old broiler chicks were randomly distributed to 6 treatment groups of 40 broiler chicks in a completely randomized design, having 4 replicates of 10 chicks per replicate. Results revealed that Moringa oleifera leaf meal supplementation at 250 to 1000 mg/kg in broiler chicken diet as phytogenic feed supplement significantly ($p<0.05$), promoted weight gain, feed utilization, carcass and organ qualities of broiler chickens without compromising the organoleptic qualities of chicken meat compared with broiler chickens without Moringa oleifera leaf meal supplementation. The use of Moringa oleifera leaf meal as natural alternative to the synthetic antibiotic (Tylosin) similarly promoted ($p<0.05$) weight gain, feed utilization, carcass qualities, organ description and organoleptic qualities just as the synthetic antibiotic (Tylosin) in broiler chickens.

***Keywords:** Feed utilization, Moringa leaf meal, organoleptic qualities, weight gain*

Description of Problem

The efficacy of synthetic antibiotics as growth promoters, disease prevention and treatment of various ailments in livestock production cannot be underscored. However, excessive use of these modern antibiotics has been challenged to cause the development and spread of antibiotic-resistant bacteria (1). When bacteria become resistant to antibiotic, they survive the drug and continue to multiply resulting in hard to cure disease, thereby contaminating products and affecting the health of the consumers.

The call for leaf meals of phyto-constituent properties that can promote growth, maintain health status of livestock as well as safe guard the health of humans upon the consumption of livestock products have been proposed (2, 3, 4). Among leaves of phytonutrients and phytomedicine properties is *Moringa oleifera* leaf meal (MOLM). *Moringa oleifera* leaves have been reported for several phytomedical actions such as antifungal, antimicrobial, anti-atherosclerotic, anti-fertility, anti-diabetic, antiulcer, anti-hyperlopidemia, hepatoprotective, among others (5, 6). Niazimicin, a bioactive compound found in *Moringa oleifera* leaves has been reported for its anticancer potency (6, 7). The main flavonoid constituents present in *Moringa oleifera* leaves as antibiotic are myricetin, quercetin, kaempferol and chlorogenic acid (8, 9). These compounds have antibiotic and anti-inflammatory effects to promote growth, reduce the risk of chronic diseases, scavenge

free radicals, help in iron-chelating as well as reduce blood glucose and lipid metabolism (10, 11). The phytonutrient properties of *Moringa oleifera* leaf is evident in its richness in vitamins like beta-carotene, Vitamins A, B, such as B9, B6 and B3, as well as vitamins C, D and E (12), minerals such as calcium, potassium, zinc, magnesium, iron and copper (13), protein, amino acids, energy and moderate levels of phytochemicals (14). Until the present day, the application of *Moringa oleifera* leaf meal in broiler chickens to improve the production performance, carcass attributes, meat quality and health status has been limited. In view of this claim on the nutritional and medicinal properties of *Moringa oleifera* leaf, this study therefore, aims at confirming or falsifying the claim by assessing its (*Moringa oleifera*), leaf meal influence as a supplement on the performance, carcass attributes and organ description of broiler chicken.

Materials and Methods

Experimental site

Following the approval by the Animal Research and Ethics Committee of the Animal Production Unit of the Department of Agricultural Science, the experiment was carried out at the Poultry Section of the Teaching and Research Farm, Adeyemi Federal University of Education, Ondo, Nigeria. The experiment was conducted in March 10-April 20, 2021. The mean temperature is 28.21 ^{0}C with minimum and maximum temperature readings of 24.21 ^{0}C and 32.22 ^{0}C respectively and relative humidity of 86.33%. The total average annual precipitation is about 1,564 mm with precipitations of 100 and 146mm in the months of March and April, 2021 respectively.

Collection, processing and proximate determination of *Moringa oleifera* leaf meal

Following the identification of the plant by the Botanists in the University Horticultural Garden, the leaves were collected fresh from healthy trees from the University Horticultural Garden, dried under the shade, milled to produce leaf meal and stored at 4.4 °C prior use. The proximate composition was according to the methods of AOAC (15) (Table 1). Analysis was carried out thrice.

Table 1. Proximate composition (g/100g DM) and energy value of *Moringa oleifera* leaf (n=3)

Dry matter	89.80±7.04
Crude protein	23.71±2.19
Crude fibre	5.84±0.34
Ether extracts	6.13±0.32
Total ash	13.18±1.55
Carbohydrate	40.94±3.17
ME (kcal/kg DM)	3198.73±103.03

Experimental diets, design and management of birds

A basal diet was formulated for each of the phases; starter (age 1-21 d) and finisher (22-42 d) (Table 2). The basal diet was divided into six equal portions, designated diets 1-6, and supplemented as follows in each phase:

Diet 1: 0 mg/kg MOLM + 0 mg/kg antibiotic supplementation (+ve control).
Diet 2: 0 mg/kg MOLM + 200 mg/kg antibiotic (Tylosin) supplementation (-ve control)
Diet 3: 250 mg/kg MOLM supplementation
Diet 4: 500 mg/kg MOLM supplementation
Diet 5: 750 mg/kg MOLM supplementation
Diet 6: 1000 mg/kg MOLM supplementation

Table 2. Composition of diets (%) for broiler chickens

Ingredients	Starter Diet	Finisher Diet
Maize	55.15	58.65
GNC	10.15	9.50
SBM	15.20	12.50
Fish meal	5.00	3.50
Rice bran	5.25	5.45
Wheat offal	5.45	6.35
Limestone	2.00	2.50
DCP	0.50	0.40
Lysine	0.30	0.20
Methionine	0.25	0.20
Premix	0.35	0.25
Salt	0.40	0.50
Calculated composition		
Crude protein (g/100g)	23.12	21.07
Crude fibre (g/100g)	3.97	5.01
ME (kcal/kg DM)	2987.63	3109.83
Ca (g/100g DM)	1.01	0.97
Av. P (g/100g DM)	0.63	0.55
Lysine	1.15	0.96
Methionine	0.52	0.46

The design of the experiment was the completely randomized involving a total of 240 Arbor-Acre one-day-old broiler chicks that were randomly distributed to 6 treatment groups of 40 broiler chicks to a treatment of 4 replications of 10 chicks per replicate. The birds were raised on a wood shaving bedded floor pens under a hygienic management conditions. Each pen of 10 birds measures 210 x 105 cm with concrete floor of wood shavings litter. The experimental house was maintained at 32 ^{0}C ± 2 ^{0}C for the first 7 days, thereafter decreased by 2 ^{0}C every 7 days until a temperature of 26 ^{0}C was maintained throughout the experimental period. The birds were fed *ad libitum* with clean cool water supplied at all times.

Slaughtering, carcass evaluation, relative organ determination and organoleptic assessment

On 42nd day of the trial, the birds were weighed and 4 birds of similar body weights were selected from each replicate for carcass and organ weights determination. The birds were starved for 24 h period, stunned, slaughtered by severing the jugular vein to allow free flow of blood. Thereafter, the slaughtered birds were scalded (dipped in hot water at temperature of 60 ^{0}C), de-feathered and eviscerated. The cut parts were blotted with tissue paper, tagged and weighed. The organ weights were expressed as percentage of the slaughter weight while the carcass traits, dressed and eviscerated weights were expressed as percentage live weight, and the carcass yield as known as dressing percentage is the ratio of dressed carcass weight to the weight of the live animal, expressed as a percentage. Organoleptic studies on the experimental birds were carried out to determine the quality of the meat in terms of taste, colour, tenderness, aroma and juiciness. To determine this, samples were taken from the breast muscle of each replicate. The samples were thawed, washed with clean water and trimmed off of fats prior drying. Samples (breast muscle) of birds on control diets (diets 1 and 2) were cured with curry and salt, meat of birds on diet 3 were cured with 250 mg/kg MOLM and salt, meat of birds on diet 4 were cured with 500 mg/kg MOLM and salt, meat of birds on diet 5 were cured with 750 mg/kg MOLM and salt, and meat of birds on diet 6 were cured with 1000 mg/kg MOLM and salt. The salt and the powdery test ingredients were rubbed manually on the meat samples to ensure uniform blend. They were thereafter smoked in the drum kilns with charcoal for about 10 mins. Ten judges among the academic and non-academic staff of the Department of Agricultural Science,

Adeyemi Federal University of Education, Ondo were used for the organoleptic assessment. The judges were served cracker biscuit to neutralize their palate after each treatment before taking another treatment. A nine point hedonic scale from 1 (extremely dislike to 9 (extremely liked) as described by Larmond (16) was employed for sensory assessment.

Data collection and analysis

Data collected on performance traits, carcass attributes, relative organ weights and organoleptic properties were analyzed using the General Linear Model (GLM) of the SPSS (17) version 22. Differences in means where identified were separated using Duncan option of the software.

Results and Discussion

The nutritional profile of *Moringa oleifera* leaf (Table 1) shows high levels of protein, lipids, and possibly minerals (judging from the ash content) that are important in broiler production. The values obtained in the present study were within the values reported by previous studies (18, 19).

Table 3 reveals that weight gain and feed conversion ratio of broiler chickens in the two physiological stages (broiler starters and broiler finishers) were similar in birds fed antibiotic treated diets and dietary supplementation of MOLM (diets 2-6) but significantly ($p<0.05$) higher compared with birds on diet 1 (+ve control: 0 mg/kg MOLM + 0 mg/kg antibiotic supplementation). Feed consumption of the birds was not influenced across the dietary treatments. The similar weight gain and feed conversion ratio of birds on antibiotic treated diets and those on MOLM supplementation shows the efficacy of the bioactive compounds such as myricetin, quercetin, kaempferol and chlorogenic acid; the flavonoids constituents in *Moringa oleifera* leaf to function like the antibiotic (Tylosin) to promote growth and improve feed utilization (8, 9). The significant ($p<0.05$) improvement in weight gain and feed conversion ratio of broiler chickens on MOLM supplementation further attest to the phytonutrients and pharmacological potency of MOLM to accelerate growth (20, 21, 22). Also, the phytogenic property of *Moringa oleifera* leaf might be responsible for growth improvement by relieving the host animals from immune defense stress during critical situations and increase the intestinal availability of essential nutrients for absorption, thereby helping animals to grow better (23). Niaziridin, a bioactive component in *Moringa oleifera*, can improve the absorption of different vitamins, minerals, and other micro nutrients in gastrointestinal tract of the host (24), thus improving feed utilization and enhancing growth. The similarity in feed consumption of birds on dietary MOLM supplementation and those on the control diets shows that the birds were not averse to the leaf meal and that the quality of the feeds were not compromised at the level of dietary supplementation of MOLM. It also shows that the aromatic properties, phytogenic activities and possibly phytochemical constituents in *Moringa oleifera* leaf have no negative impact on feed palatability (25). Nkukwuma *et al*. (26) and Onunkwo and George (27) had earlier reported that supplementation of MOLM had no dire consequence on feed intake. The low percentage of deaths recorded in birds on dietary supplementation of MOLM and those on antibiotic treated diet compared with the control (diet 1) reflects the immune activity of MOLM to modulate the body defense system and promote the health status and overall wellbeing of broiler chickens. Niazimicin, a bioactive compound in *Moringa oleifera* has anticancer and

antimicrobial potency against bacterial (6, 7), and thus functioning as antibiotic.

Results on carcass evaluation and relative organ weights (Table 4) show that only the dressed carcass weight of birds on dietary supplementation of MOLM and antibiotic treated diets (diets 2-6) were significantly influenced ($p<0.05$). The relative organ weights of birds were similar across the dietary treatments. However, abdominal fat decreased significantly ($P<0.05$) in broiler chickens fed dietary supplementation of MOLM compared with those on control groups. The high carcass yield of broiler chickens on MOLM dietary supplementation could be attributed to the high growth rate of the birds on MOLM diets. The stability of the internal organs of birds on the test diets and the control groups suggest that MOLM did not compromise the weights of these organs. The result in this study is in line with substituting MOLM in place of oxytetracycline (1). The healthiness of the organs could have aided the digestion and supply of nutrients and subsequent utilization of the nutrients to promote better growth in broilers fed MOLM supplemented diets. The reduction in abdominal fat of birds on dietary supplementation of MOLM suggest that MOLM improved the activities of lipoprotein lipase (LPL) to break down fat for absorption in the intestine and thus play a significant role in reducing fat deposition.

Organoleptic result (Table 5) reveals that the appearance, colour and overall acceptance of broiler chicken meat were significantly ($p<0.05$) influenced by dietary supplementation of MOLM compared with birds on the control and antibiotic treated diets. The appearance score of the breast muscle of broiler chickens fed dietary supplementation of MOLM (diets 3-6) were Significantly ($p<0.05$), lower (6.00-6.17) compared with those on diets 1 and 2 (7.16 and 7.19) respectively. Colour score of breast muscle (4.83-5.92) and overall acceptance score of broiler meat (6.38-7.13) on MOLM supplementation (diets 3-6) were significantly ($p<0.05$), higher compared with those on diets 1 and 2 with scores 5.62 and 5.81, respectively. The body, legs, beaks, cut parts and feather of broiler chickens becomes more yellowish with increasing supplementation of MOLM in the diets. Other organoleptic properties assessed were similar. The higher preference by the panelists for breast muscle processed with curry and salt could be attributed to brighter colour of curry powder than MOLM. This present result supports the works on the appearance score of broiler thigh spiced with Dawadawa (*Parkia biglobosa*) (28). The overall acceptance score of meat from broilers processed with MOLM could be due to the higher scores recorded in flavour, tenderness and juiciness, as these are major sensory parameters to determine the quality of meat using foreign or local spices (29)

The yellowish colouration of the body, legs, beaks, cut parts and feather of broiler chickens on dietary supplementation of MOLM could be attributed to the high content of beta-carotene; a precursor of vitamin A and the possible efficient absorption and utilization of the pigment xanthophyll in MOLM.

Table 3. Performance of broiler chickens fed *Moringa oleifera* leaf meal supplemented diets

		Broiler starters						Broiler chickens			
Diets	**mg/kg MOLM**	**IW, g/b**	**FLW, g/b**	**AWG, g/b/d**	**AFC, g/b**	**FCR**	**Mortality (%)**	**FLW, g/b**	**AWG, g/b/d**	**AFC, g/b**	**FCR**
1	0+ve control	47.66	479.59^{b}	20.57^{b}	39.85	1.95^{b}	2.50	1780.06^{b}	41.37	98.97	2.39^{b}
2	0-ve control	47.64	518.75^{a}	22.43^{a}	39.51	1.76^{a}	0	1965.59^{a}	45.67	99.67	2.18^{a}
3	250	47.73	514.57^{a}	22.23^{a}	39.69	1.79^{a}	0.42	1955.73^{a}	45.43	99.60	2.20^{a}
4	500	47.54	512.62^{a}	22.15^{a}	39.75	1.79^{a}	0.42	1950.72^{a}	45.31	99.35	2.19^{a}
5	750	47.71	511.11^{a}	22.07^{a}	39.77	1.80^{a}	0	1976.45^{a}	45.92	99.77	2.17^{a}
6	1000	47.73	500.14^{a}	21.54^{a}	39.68	1.84^{a}	0	1959.33^{a}	45.51	99.53	2.19^{a}
SEM		0.19	7.11	0.34	0.23	0.03		10.94	0.26	0.26	0.01
P value		0.98	0.01	0.01	0.94	0.02		0.00	0.00	0.33	0.00

^{ab}Means with different superscript along the row are significant at $p<0.05$

Table 4. Carcass evaluation and organ weight (% body weight) of broiler chickens fed *Moringa oleifera* leaf meal supplemented diets

Diets	**mg/kg MOLM**	**LW (kg/b)**	**DCW (kg/b)**	**CY (% LW)**	**EW (kg/b)**	**EW (% LW)**	**LIV**	**GIZ**	**LUN**	**HRT**	**KID**	**SPL**	**PAN**	**ABF**
1	0+ve control	1.78^{b}	1.34^{b}	75.28	1.37	76.97	2.21	1.83	0.47	0.42	0.13	0.10	0.03	1.17^{a}
2	0-ve control	1.97^{a}	1.54^{a}	78.17	1.53	77.65	2.23	1.82	0.51	0.51	0.17	0.11	0.04	1.26^{a}
3	250	1.96^{a}	1.56^{a}	79.59	1.51	77.04	2.25	1.87	0.55	0.49	0.15	0.09	0.03	0.82^{b}
4	500	1.95^{a}	1.57^{a}	78.79	1.52	77.95	2.31	1.89	0.52	0.46	0.18	0.12	0.04	0.79^{b}
5	750	1.98^{a}	1.59^{a}	80.30	1.49	75.25	2.33	1.92	0.54	0.49	0.12	0.08	0.05	0.76^{b}
6	1000	1.96^{a}	1.58^{a}	80.61	1.51	77.04	2.41	1.93	0.56	0.41	0.16	0.09	0.04	0.73^{b}
SEM		0.01	0.03	0.18	0.01	0.04	0.02	0.03	0.01	0.06	0.02	0.02	0.01	0.29
P value		0.00	0.01	0.12	0.01	0.75	0.22	0.36	0.31	0.16	0.11	0.13	0.16	0.01

^{ab}Means with different superscript along the row are significant at $p<0.05$. MOLM: *Moringa oleifera* leaf meal, LW: Live weight, DCW: Dressed carcass weight, CY: Carcass yield, EW: Eviscerated weight, LIV: Liver, GIZ: Gizzard, LUN: Lung, HRT: Heart, KID: Kidney, SPL: Spleen, PAN: Pancreas, ABF: Abdominal fat

Table 5: Organoleptic properties of meat of broiler chickens on dietary supplementation of *Moringa oleifera* leaf meal

Diets	**mg/kg MOLM**	**Appearance**	**Aroma**	**Flavour**	**Colour**	**Juiciness**	**Tenderness**	**Overall acceptance**
1	0+ve control	7.16^{a}	4.12	5.75	3.44^{b}	4.48	5.63	5.62^{b}
2	0-ve control	7.19^{a}	4.24	6.17	3.52^{b}	4.69	5.41	5.81^{b}
3	250	6.15^{b}	4.81	5.87	4.83^{ab}	4.95	5.75	6.38^{a}
4	500	6.17^{b}	4.65	6.23	5.47^{a}	5.19	5.55	6.43^{a}
5	750	6.00^{b}	5.11	6.11	5.71^{a}	5.35	5.62	6.86^{a}
6	1000	6.12^{b}	5.32	5.94	5.92^{a}	5.41	5.81	7.13^{a}
SEM		0.51	0.64	0.47	0.16	0.24	0.18	0.23
P value		0.01	0.17	0.21	0.02	0.11	0.15	0.01

^{ab}Means with different superscript along the row are significant at $p<0.05$. MOLM: *Moringa oleifera* leaf meal

Conclusion and Application

1. The study revealed that supplementation of *Moringa oleifera* leaf meal up to 1000 mg/kg as antibiotic in place of Tylosin in broiler chicken diet promoted weight gain and feed utilization.
2. It also showed that *Moringa oleifera* leaf meal supplementation up to 1000 mg/kg promoted good carcass, organ qualities and better organoleptic attributes with decreased abdominal fat in broiler chicken meat.

3. The use of *Moringa oleifera* leaf meal as alternative to the synthetic antibiotic will help prevent the development and spread of resistant bacteria and thus safe guard public health upon the consumption of animal products.

References

1. Ologhobo, A.D., Akangbe, E. I., Adejumo, I. O. and Adeleye, O. (2014). Effect of *Moringa oleifera* leaf meal as replacement for oxytetracycline on carcass characteristics of the diets of broiler chickens. *Annual Research and Review in Biology*, 4(2): 423-431 www.sciencedomain.org. Date accessed 18/6/2022
2. Daramola, O.T., Oloruntola, O.D. and Ayodele, S.O. (2018). Nutritional evaluation of bitter leaf meal (*Vernonia amygadalina*): effects on performance, carcass and serum metabolites of broiler chickens. *Nigerian Journal of Animal Health and Production*, 20(2): 211-221
3. Ogunsipe, M.H., Oloruntola, A.D., Agbede, J.O. and Igbasan, F.A. (2020). Influence of *Azadirachta indica* L as phytogenic feed supplement on the growth performance and immunomodulatory response of broiler chickens. *Journal of Biology and Nature*, 12(1): 57-60
4. Gbore, F.A., Oloruntola, O.D., Adu, O.A., Olarotimi, O.J., Falowo, A.B. and Afolayan, E.O. (2021). Serum and meat oxidative of broiler chickens fed diets supplemented with garlic rhizome, moringa leaf meal and their composite. *Tropical Animal Health and Production*, 53: 26 https://doi.org/ 10.1007/s11250-020-02438-9
5. Upadhyay, P., Yadav, M.K., Mishra, S., Sharma, P. and Purohit, S. (2015). *Moringa oleifera*: A review of the medical evidence for its nutritional and pharmacological properties. *International Journal of Research in Pharmacy and Science*, 5(2): 12-16
6. Mownica, U., Yashodhara, V., Sushma, S. and Sapna, L. (2017). Phytonutrients and pharmacological significance of *Moringa oleifera*. *International Journal of Life Science and Scientific Research*, 3(5): 1387-1391 https://doi.org/10.21276/ijlssr.2017.3.5.21
7. Moharram, F.A., Marzouk, M.S., El-Toumy, S.A., Ahmed, A.A. and Aboutabl, E.A. (2003). Polyphenols of *Melaleuca quinquenervia* leaves-pharmacological studies of grandinin. *Phytotherapy Research*, 17(7): 767-773 DOI:10.1002/ptr.1214
8. Sultana, B. and Anwar, F. (2008). Flavonols (kaempeferol, quercetin, myricetin) contents of selected fruits, vegetables and medicinal plants. *Food Chemistry*, 108: 879–884. DOI: 10.1016/j.foodchem.2007.11.053
9. Coppin, J.P., Xu, Y., Chen, H., Pan, M.H., Ho, C.T., Juliani, R., Simon, J.E. and Wu, Q. (2013). Determination of flavonoids by LC/MS and anti-inflammatory activity in *Moringa oleifera*. *Journal of Functional Foods*, 5: 1892–1899. DOI: 10.1016/j.jff. 2013.09.010
10. Semwal, D.K., Semwal, R.B., Combrinck, S. and Viljoen, A. (2016). Myricetin: A Dietary Molecule with Diverse Biological Activities. *Nutrients*, 8(2): 90 doi: 10.3390/ nu8020090. PMID: 26891321; PMCID: PMC4772053
11. Vergara-Jimenez, M., Almatrafi, M.M. and Fernandez, M.L. (2017). Bioactive components in *Moringa Oleifera* leaves protect against chronic disease. *Antioxidants*, 6(4): 91 doi: 10.3390/antiox6040091

www.mdpi.com/journal/antioxidants. Date accessed 18/6/2022

12. Ross, I.A. (2003). Medicinal plants of the world. Chemical constituents, traditional and modern medicinal uses, Vol. 1. 2nd ed; Totawa: NJ: Human Press Inc. pp. 368
13. Fahey, J.W. (2005). *Moringa oleifera*: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. *Trees for Life Journal*, 1: 5 DOI: 10.1201/ 9781420039078.ch12 http://www.TFLJournal.org/article Date accessed 18/7/2022
14. Makkar, H.P.S. and Becker, K. (1997). Nutrient and anti-quality factors in different morphological parts of *Moringa oleifera* tree. *The Journal of Agricultural Science*, 128(03): 311-322 DOI:10.1017/s0021859697004292
15. AOAC. (2002). Official Methods of Analysis. Vol. 11. 17th ed. Association of Official Analytical Chemists, Washington DC, USA.
16. Larmond, E. (1977). Methods of sensory evaluation of food. Canada: *Department of Agriculture Publication*, 1284: 34-68
17. SPSS (2013). Statistical Package for Social Sciences. S.P.S.S. Base 22.0 User's Guide, Copyright ©2013. SPSS. Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL 60606-6412
18. Nweze, N.O. and Nwafor, F.I. (2014). Phytochemical, Proximate and Mineral Composition of Leaf Extracts of *Moringa oleifera* Lam. from Nsukka, South-Eastern Nigeria. *IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)*, 9(1): 99-103 www.iosrjournals.org Date accessed 18/7/2022
19. Debebe, M. and Eyobel, M. (2017). Determination of proximate and mineral compositions of *Moringa oleifera* and *Moringa stenopetala* leaves cultivated in Arbaminch Zuria and Konso, Ethiopia. *African Journal of Biotechnology*, 16(15): 808-818 DOI: 10.5897/AJB2017.15919 http://www.academicjournals.org/AJB Date accessed 18/7/2022
20. Ogbe A.O. and Affiku, J. P. (2012). Proximate study, mineral and anti-nutrient composition of *Moringa oleifera* leaves harvested from Lafia, Nigeria: potential benefits in poultry nutrition and health. *Journal of Microbiology, Biotechnology and Food Science*, 1(3): 296–308.
21. Mahfuz, S. and Piao, X.S. (2019). Application of moringa (*Moringa oleifera*) as natural feed supplement in poultry diets. *Animals*, 9(7): 431 https://doi.org/10.3390/ani9070431
22. Kirmani, N.R., Rizwan, D. and Banday, T.M. (2022). *Moringa oleifera*: The miracle tree and its potential as non-conventional animal feed: A review. *Agricultural Reviews*, 1: 1-11 DOI:10.18805/ag.R-2405
23. Windisch, W., Schedle, K., Plitzner, C. and Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science*, 86: E140–E148.
24. Stohs S.J. and Hartman M.J. (2015). Review of the safety and efficacy of *Moringa oleifera*. *Phytotherapy Research*, 29: 796-804. DOI: 10.1002/ptr.5325
25. Applegate, T.J., Klose, V., Steiner, T. Ganner, A. and Schatzmayr, G. (2010). Probiotics and phytogenics for poultry: Myth or reality? *Journal of Applied Poultry Research*, 19: 194 – 210.
26. Nkukwana, T.T., Muchenje, V., Pieterse, E., Masika, P.J., Hoffman, L.C. and Dzama, K. (2014). Effect of *Moringa oleifera* leaf meal on growth performance, apparent digestibility,

digestive organ size and carcass yield in broiler chickens. *Livestock Science*, 161: 139-146 https://doi.org/10.1016/j.livsci.2014.01.001

27. Onunkwo, D.N. and George, O.S. (2015). Effects of *Moringa oleifera* leaf meal on the growth performance and carcass characteristics of broiler birds. *Journal of Agriculture and Veterinary Science*, 8: 63–66.
28. Teye, G.A., Taeme, F., Bonsu, K.O. and Teye, M. (2013). Effect of Dawadawa (Parkia biglobosa) as a spice on sensory and nutritional qualities of meat products; A preliminary study. *International Journal of Current Research*, 5(02): 110-112
29. Adomeh, E.E. and Eguaoje, A.S. (2019). Performance and organoleptic qualities of broiler chickens fed and raised with varying levels of ginger and garlic mixture. *Nigerian Journal of Animal Science*, 21(2): 310-318.