

Effect of Substituting Commercial Feed with Mulberry Leaf Meal on Performance of Broiler Chickens

¹Muhammed Tilahun, ²MengistuUrge and ³MekonnenYirga

¹School of Veterinary Medicine, Wollo University, P.O. Box 1145, Dessie, Ethiopia

²School of Animal and Range Science, College of Agriculture and Environmental Sciences, Haramaya University, P.O. Box138, Dire Dawa, Ethiopia

³Department of Animal Science, College of Agriculture, Wollo University, P.O. Box 1145, Dessie, Ethiopia

Abstract: The study was conducted to evaluate the effect of substituting commercial broiler feed with mulberry leaf meal on feed intake, weight gain, feed conversion ratio and mortality. About 144 Cobb 500 broiler breed chicks were randomly distributed to 4 treatments in completely randomized design. Treatment diets were prepared by substituting 7.5, 15 and 22.5% of commercial broiler feed with mulberry leaf meal during the starter, grower and finisher phases. The average feed intake of broilers was affected ($p < 0.0001$) by treatment diets where substitution of mulberry leaf meal at 7.5% and above had decreased the feed intake. Analysis of variance revealed higher ($p < 0.0001$) weight gain in control group (M_0) as compared to the other treatments. Inclusion of mulberry leaf meal up to 15% has no adverse effect on the survival rate. This study has showed that mulberry leaf meal substitution at 7.5% and more seems to have good effect on broilers carcass quality and reduction of abdominal fat that can positively affect consumer's desire.

Key words: Feed intake, feed conversion ratio, mortality, weight gain, control, group

INTRODUCTION

The productivity of poultry in the tropics has been limited by scarcity and consequent high prices of the conventional chicken feed. The price of conventional protein feed resources is high and cannot permit profit maximization in poultry business. In view of this, current research interest in the poultry industry is aimed at finding alternatives to this elusive feed ingredient (Kamruzman *et al.*, 2012; Islam *et al.*, 2014). The list of possible feed alternatives includes mulberry leaves as a source of dietary protein for poultry operations. Mulberry leaves are rich in protein, minerals (Ca, P) and metabolizable energy with absence of or negligible anti-nutritional factors (Omar *et al.*, 1999; Srivastava *et al.*, 2006). The available information on the effect of mulberry leaf inclusion on the performance of broiler chicken is not available under Ethiopian condition. Therefore, the present experiment was undertaken with the objective of assessing the substitution of mulberry leaf meal in broiler diet on feed intake, weight gain, feed conversion ratio, carcass yield and mortality.

MATERIALS AND METHODS

Study area: The study was conducted at Kombolcha Agriculture Technical Vocational Education (ATVET)

College, South Wollo Zone, Amhara region, Ethiopia. Kombolcha is located 375 km North of Addis Ababa (Ethiopia) at 1350 masl, 11.1°N latitude and 39.40°E longitudes. The annual rainfall ranges between 750 and 900 mm with 8.6 and 30.8°C of minimum and maximum temperature, respectively.

Preparation of mulberry leaf meal: Seventy five days old fresh mulberry leaves re-growth of S30 and K1 varieties were collected. After harvesting, leaves were separated from their stems and dried 3 to 4 days under shade. Dried leaves were ground coarsely using hand mortar and pass through sieve, so as to be similar to the size of the commercial broiler ration.

Experimental chicks and their management: A total of 144 Cobb 500 day old commercial broiler chicks were purchased from Alema poultry farms, DebreZeit, Ethiopia. The birds were reared in a deep litter housing system and chicks were allocated at random into twelve pens. Routine vaccination against Newcastle and Gumborro were given as recommended by the manufacturers on the 1st, 14th, 21st and 28th day of age.

Feed preparation and feeding: Commercial starter and grower feed used in this study were obtained from Alema

Koudijs Feed PLC (a joint venture between De Heus Animal Nutrition BV and Alema Farms). Direct substitution of commercial broiler feed with Mulberry Leaf Meal (MLM) was used in this experiment. The MLM were prepared from the two varieties with equal amounts and then mixed thoroughly to the commercial broiler feed based on the treatment ratio. Feed and water were offered ad libitum during the starter (day 1-11), grower (day 12-21) and finisher (after 22 days) phases. Feed intake was measured on daily basis by taking the difference between the quantity of feed offered the previous day and the quantity of feed left the next morning.

Experimental design and treatments: Broilers were assigned to four treatment groups following the principles of Completely Randomized Design (CRD). Each treatment group has three replicates of twelve birds per pen. The treatments are MU0 = 100% Commercial broiler diet (Control); MU7.5 = 92.5% Commercial broiler diet +7.5% Mulberry leaf meal; MU15 = 85% Commercial broiler diet +15% Mulberry leaf meal; and MU22.5 = 77.5% Commercial broiler diet+22.5% Mulberry leaf meal.

Body weight measurement: All chicks are weighed on group base in each pen for the first two weeks of age. After two weeks, chick weight was taken individually before morning feeding on a weekly basis.

Carcass evaluation: At the end of the experiment, four broilers were randomly picked from each replication and slaughtered after being starved overnight for about 12 h, so as to allow the emptying of the crop and excretion of the undigested feed residue. After starvation, each bird were weighed, slaughtered, dressed, eviscerated and cut into parts to record pre-slaughter weight, dressing weight, eviscerated weight, carcass weight, breast weight, thigh and drumstick weight, liver, heart, gizzard, abdominal fat and intestine. Dressing, eviscerated and carcass percentage were calculated as percent of live weight. Dressing % was calculated as % of live weight after bleeding and de-feathering. Eviscerated % were measured by removing the viscera, head, shank, trachea, lungs but with giblets (heart, liver and gizzard) and skin and expressed as % of live weight. The carcass weight and % was taken into account without the gible. The abdominal fat, liver, leg, drum stick, thigh, heart, gizzard, intestine and breast weight were measured individually and equated with percent of live weight.

Chemical analysis: Feed samples of both commercial feed and mulberry leaf were analyzed to determine their Crude Fiber (CF), Ether Extract (EE), Nitrogen (N), Dry Matter (DM) and Ash contents using Proximate analysis

method of the AOAC (1990). Crude Protein (CP) was calculated by multiplying the nitrogen content of the feed with 6.25. Metabolizable Energy (ME) content of feed ingredients and experimental diets was determined using the method of Wiseman (1987) as follows: ME (kcal/kg DM) = 3951+54.4 EE-88.7 CF-40.80 Ash.

Statistical analysis: The model used for data analysis was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij} : An observation (experimental unit)

μ : Overall mean

T_i : Treatment effect ($i = 1-4$)

e_{ij} : Random error term

Experimental data were subjected to Analysis of Variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (2002) Version 9.0. Treatment means were separated using Tukey honestly significant difference test.

RESULTS AND DISCUSSION

The chemical compositions of experimental feeds and feed intake of broilers across experimental period are presented in Table 1-3. The crude fiber content of mulberry leaf meal (15.23% DM) was higher than the commercial feed used for starter, grower and finisher diets (5.5% DM), respectively. When the commercial feed was incrementally replaced by mulberry leaf meal, the crude fiber content of the mixture has been increased. Feed intake, body weight gain and feed conversion ratio of broilers across weeks and entire experimental period is indicated in Table 4-6. Substitution of mulberry leaf meal at 7.5% and above has decreased the feed intake and analysis of variance revealed higher weight gain in control group (M_0) as compared to the other treatments.

Death rate was recorded throughout the experimental period (Table 7) and results revealed that inclusion of mulberry leaf meal up to 15% has no adverse effect on the survival rate. Post mortem examination has revealed presence of watery fluid both in the abdominal cavity and pericardial sac. The color of liver was whitish due to lack of oxygen as the small heart and lung could not deliver the amount of oxygen required by muscle. With increasing level of mulberry leaf meal a decrease in weight and percentage of was observed (Table 8). Abdominal fat percentage and weight has progressively decreased as proportional mulberry supplement increases.

The crude protein content of mulberry leaf meal of this study (16.65%) is within the range of 15.31-30.91% as reported by Al-Kirshi *et al.* (2013), Guven (2012) and Iqbal *et al.* (2012).

Table 1: Chemical composition of commercial feed

Feed types	DM (%)	Ash (DM%)	EE (DM%)	CF (DM%)	CP (DM%)	ME (Kcal/Kg DM)
MU	89.35	21.00	2.69	15.23	16.65	1889.6
Starter diet	90.50	11.30	6.50	7.30	22.60	3196.1
Grower diet	90.40	10.70	7.20	7.10	21.40	3276.4
Finisher diet	90.20	9.30	8.00	6.90	20.00	3355.3

MU = Mulberry leaf meal, DM = Dry Matter; EE = Ether Extract, CF = Crude Fiber; CP = Crude Protein, ME = Metabolizable energy

Table 2: Chemical composition of experimental feeds for different phases of broiler growth (calculated)

Treatment	DM (%)	CP (DM%)	EE (%)	CF (%)	Ash (DM %)	ME (Kcal/Kg DM)
Starter						
MU0	90.50	22.60	6.50	7.30	11.30	3196.1
MU7.5	90.40	22.16	6.20	7.90	12.03	3098.1
MU15	90.30	21.71	5.93	8.49	12.76	3000.1
MU2.5	90.20	21.27	5.65	9.09	13.49	2902.1
Grower						
MU0	90.40	21.40	7.20	7.10	10.70	3276.4
MU7.5	90.30	21.00	6.68	7.70	11.48	3172.4
MU15	90.24	20.60	6.52	8.32	12.25	3068.4
MU22.5	90.16	20.30	6.19	8.93	13.02	2964.4
Finisher						
MU0	90.20	20.00	7.50	6.90	9.60	3355.3
MU7.5	90.12	19.75	7.14	7.52	10.46	3245.4
MU15	90.07	19.50	7.14	7.52	11.31	3135.4
MU22.5	90.00	19.25	6.42	8.78	12.17	3025.5

MU = Mulberry leaf meal; MU0 = 100% commercial broiler feed; MU7.5 = 7.5% substitution of mulberry leaf meal; MU15 = 15% substitution of mulberry leaf meal; MU22.5 = 22.5% substitution of mulberry leaf

Table 3: Chemical composition of commercial feeds (as manufacturer)

Feed types	CP (min.)	EE (min.)	CF (max.)	Ca (min.)	Moisture (max.)	ME (min.)
Starter	22	6.50	5.50	0.65	10	3050
Grower	19	9.00	5.50	0.65	10	3150
Finisher	18	8.00	5.50	0.75	10	3250

CP = Crude Protein; EE = Ether Extract; CF = Crude Fiber; Ca = Calcium; ME = Metabolizable Energy

Table 4: Feed intake of broilers across the experimental period

Age (week)	MU0 (%)	MU7.5 (%)	MU15 (%)	MU22.5 (%)	SEM	p-values
1	141.70 ^a	137.60 ^b	131.00 ^c	1210.00 ^d	0.54	<0.0001
2	526.60 ^a	486.90 ^b	452.70 ^c	436.10 ^d	2.58	<0.0001
3	1142.10 ^a	996.50 ^b	922.20 ^c	909.80 ^d	8.39	<0.0001
4	1920.60 ^a	1753.40 ^b	1654.00 ^c	1628.30 ^c	18.61	<0.0001
5	2852.10 ^a	2604.30 ^b	2539.30 ^{bc}	2505.00 ^c	29.84	<0.0001
6	3797.30 ^a	3508.70 ^b	3444.30 ^{bc}	3399.10 ^c	21.90	<0.0001

MU0 = 100% commercial broiler feed; MU 7.5 = 7.5% substitution of mulberry leaf meal; MU15 = 15% substitution of mulberry leaf meal; MU22.5 = 22.5% substitution of mulberry leaf meal for commercial broiler diet; SEM = Standard Error of the Mean

Table 5: Average weight gain of broiler across weeks and entire experimental period

Age	MU 0 (%)	MU 7.5 (%)	MU 15 (%)	MU 22.5 (%)	SEM	p-values
1	118.30 ^a	85.60 ^b	84.60 ^b	75.10 ^c	2.04	<0.0001
2	389.30 ^a	275.60 ^b	239.20 ^c	214.60 ^d	4.92	<0.0001
3	786.50 ^a	543.10 ^b	439.80 ^c	397.10 ^d	10.31	<0.0001
4	1245.50 ^a	841.70 ^b	712.50 ^c	624.90 ^d	17.66	<0.0001
5	1705.50 ^a	1109.70 ^b	925.80 ^c	820.00 ^d	23.11	<0.0001
6	2195.20 ^a	1568.10 ^b	1291.90 ^c	146.70 ^d	31.91	<0.0001
45 days	2451.30 ^a	1729.90 ^b	1434.20 ^c	1260.30 ^c	58.04	<0.0001

MU0 = 100% commercial broiler feed; MU7.5 = 7.5% substitution of mulberry leaf meal; MU15 = 15% substitution of mulberry leaf meal; MU22.5 = 22.5% substitution of mulberry leaf meal for commercial broiler diet; SEM = Standard Error of the Mean

Table 6: Feed conversion ratio of broilers fed diet containing different substitution level of mulberry leaf meal

Age	MU 0 (%)	MU 7.5 (%)	MU 15 (%)	MU 22.5 (%)	SEM	p-values
1	1.20 ^b	1.61 ^a	1.56 ^a	1.62 ^a	0.04	0.0002
2	1.35 ^d	1.76 ^c	1.90 ^b	2.03 ^a	0.02	<0.0001
3	1.45 ^d	1.84 ^c	2.10 ^b	2.29 ^a	0.03	<0.0001
4	1.54 ^d	2.08 ^c	2.32 ^b	2.60 ^a	0.04	<0.0001
5	1.67 ^d	2.35 ^c	2.74 ^b	3.06 ^a	0.06	<0.0001
6	1.73 ^d	2.23 ^c	2.67 ^b	2.97 ^a	0.04	<0.0001
45 days	1.73 ^d	2.20 ^c	2.57 ^b	2.90 ^a	0.06	<0.0001

^{a,b,c,d}Means within row with different superscript letters are significantly different (p<0. 01); MU0 = 100% commercial broiler feed; MU7.5 = 7.5% substitution of mulberry leaf meal; MU15 = 15% substitution of mulberry leaf meal; MU22.5 = 22.5% substitution of mulberry leaf meal for commercial broiler diet; SEM = Standard Error of the Mean

Table 7: Mortality rate of broilers fed different substitution level of mulberry leaf meal

Age	MU0 (%)	MU7.5 (%)	MU15 (%)	MU22.5 (%)
1	0	0	0	3
2	1	0	0	0
3	0	0	0	0
4	3	0	0	0
5	3	0	0	0
6	4	0	0	0
Entire period	11	0	0	0
Mortality rate	30.6%	0	0	8.3%

MU0 = 100%commercial feed; MU7.5 = 7.5% substitution mulberry leaf meal; MU15 = 15% substitution of mulberry leaf meal; MU22.5 = 22.5% substitution of mulberry leaf meal

Table 8: Carcass characteristics of broilers fed ration containing different substitution levels of mulberry leaf meal and commercial broiler feed

Parameters	MU 0 (%)	MU 7.5 (%)	MU 5 (%)	MU22.5	SEM	p-values
Slaughter weight (g)	2527 ^a	1788 ^b	1493 ^c	1327 ^d	46.70	<0.0001
Dressed weight(g)	2332 ^a	1661 ^b	1379 ^c	1217 ^d	44.10	<0.0001
Eviscerated wt. (g)	1983 ^a	1387 ^b	1145 ^c	992 ^d	38.90	<0.0001
Carcass wt. (g)	1897 ^a	1319 ^b	1083 ^c	933 ^d	38.20	<0.0001
Dressing (%)	92.30	92.80	92.40	91.80	0.44	0.44
Eviscerated (%)	78.50	77.50	76.70	74.80	0.88	0.085
Carcass (%)	75.10 ^a	73.70 ^a	72.60 ^{ba}	70.40 ^b	0.94	0.041
Breast weight (g)	640.00 ^a	410 ^b	337.20 ^c	273 ^c	21.40	<0.0001
Breast (%)	25.30 ^a	22.90 ^b	22.60 ^b	20.60 ^b	0.72	0.012
Leg weight (g)	504 ^a	350 ^b	307 ^b	249 ^c	15.30	<0.0001
T+DS (%)	19.90 ^a	19.60 ^a	20.50 ^a	18.80 ^a	0.54	0.227
Thigh (%)	10.70 ^{ab}	11.00 ^a	10.90 ^a	10.00 ^b	0.26	0.1077
Drumstick (%)	9.20	8.60	9.60	8.80	0.40	0.366
Liver (%)	1.50	1.62	1.64	1.71	0.06	0.3885
Abdominal fat wt.	34.00 ^a	9.30 ^b	3.70 ^c	1.20 ^d	0.70	<0.0001
Abdominal fat (%)	1.30 ^a	0.52 ^b	0.24 ^c	0.09 ^d	0.04	<0.0001
Gizzard (%)	1.20 ^c	1.57 ^b	1.95 ^a	2.05 ^a	0.08	0.0003
Intestinal (%)	3.10 ^c	4.10 ^b	4.60 ^a	4.80 ^a	0.10	<0.0001

^{a,b,c,d} Means with different superscript letters in rows are significantly different ($p < 0.01$); SEM = Standard Error of the Mean; MU0 = 100% commercial broiler feed; MU7.5 = 7.5% substitution of MLM; MU15 = 15% substitution of MLM; MU22.5 = 22.5% substitution of MLM; T = Thigh; DS = Drum Stick; AF = Abdominal Fat; Wt = Weight

A decrease in feed intake as the level of mulberry leaf increased may be due to both physical characteristics (semi-powdery nature and bulkiness) and bitter taste, which may affect the appetite of the birds and reduced the feed intake. The feed intake of broilers of this study is in line with Al-Kirshi *et al.* (2010) who have reported a significant reduction of feed intake during a 10% mulberry leaf meal substitution for commercial diet. Olmo *et al.* (2012) noted that inclusion of 10-30% mulberry foliage meal in the diets of hybrid broiler chicken significantly decreased feed intake. Udedibie and Opara (1998), Odunsi (2003) and Akande *et al.* (2007) also reported a reduction of feed intake with increased level of mulberry leaf meal in the diets of broilers and laying hens. In contrast, Kamruzzaman *et al.* (2012) and Lokaewmanee *et al.* (2009) had reported no adverse effect in feed intake up to 9 % inclusion of mulberry leaf meal in the ration. From weight gain perspective, Chowdary *et al.* (2009) has reported that highest body weight gain was observed in 10% mulberry leaf meal inclusion. On the contrary, Olmo *et al.* (2012) and Has *et al.* (2013) concluded that inclusion of 10% of mulberry foliage leaf reduced body weight gain. Kamruzzaman *et al.* (2012) has also showed that inclusion of mulberry leaf meal up to 9% has no adverse effect on

body weight. The present experiment has showed that an increase in the level of mulberry leaf meal substitution at 7.5% and above has reduced weight gain accordingly. This might be due to the insoluble fiber percentage that has probably exceeded the consumable threshold for broilers leading to decreased feed intake and inability to utilize the diet as a result of poor digestion and absorption. It could be also the bitter and astringent test of mulberry leaves (Ly *et al.*, 2001) affecting the palatability as well the appetite of birds (Behnke, 2001). Feed conversion ratios of the present experiment was high in broilers fed mulberry leaf substituted diets (>7.5%) and is in agreement with Olmo *et al.* (2012) who found that inclusion of 10, 20 and 30% mulberry leaf meal in the diet of broilers result in higher feed conversion ratio. On the contrary Kamruzzaman *et al.* (2012) and Machi (2000) found no detrimental effect on feed conversion ratio after feeding up to 9% level of mulberry leaf meal. The present piece of work revealed that inclusion of mulberry leaf meal in broilers diets up to 15% has no adverse effect on their survival rate and in agreement with Simol *et al.* (2012) who reported that there is no adverse effect on the survival rate of broilers up to 30% mulberry leaf meal substitution. From carcass characteristics perspectives our findings are in line with Olmo *et al.* (2012) who found

that substitution of mulberry leaf meal at 10, 20 and 30% progressively decreases the weight of carcass, breast, thigh, leg and abdominal fat. Ayerza *et al.* (2002) and Aguilar *et al.* (2011) also found that inclusion of foliage mulberry leaf meal in broilers diets has decreased abdominal fat weight.

Based on the result of this experiment, it can be concluded that mulberry leaf meal substitution to commercial broiler diets at 7.5% and more had negative effect on growth performance and carcass characteristics, no adverse effect on the survival of the broilers and seems to have a good effect on reduction of abdominal fat that can positively affect consumer's desire. Therefore, further study is required to understand the optimum level of substitution and know its effect on meat quality and reductions of mortality.

ACKNOWLEDGEMENTS

The researchers would like to express their gratitude to head of Kombolcha Collage of Agriculture for allowing the poultry farm and the necessary facilities relevant to their work.

REFERENCES

- AOAC., 1990. Official Methods of Analysis. 13th Edn., Association of Official Analytical Chemists, Washington, DC., USA.
- Aguilar, Y.M., O.M. Yero, M.I.V. Navarro, C.A.B. Hurtado, J.A.C. Lopez and L.B.G. Mejia, 2011. Effect of squash seed meal (*Cucurbita moschata*) on broiler performance, sensory meat quality and blood lipid profile. *Revista Brasileira Ciencia Avicola*, 13: 219-226.
- Akande, T.O., M.K. Adeyeri, O.G. Longe and A.A. Odunsi, 2007. Response of laying chickens to graded levels of *Tephrosia bracteolata* leaf meal fed with soyabean meal or full fat soyabean meal. *Livestock Res. Rural Dev.*, Vol. 19, No. 8.
- Al-Kirshi, R.A., A. Alimon, I. Zulkifli, S. Atefeh, M.W. Zahari and M. Ivan, 2013. Nutrient digestibility of mulberry leaves (*Morus alba*). *Ital. J. Anim. Sci.*, Vol. 12. 10.4081/ijas.2013.e36
- Al-Kirshi, R.A., A.R. Alimon, I. Zulkifli, A. Sazili, M.W. Zahari and M. Ivan, 2010. Utilization of mulberry leaf meal (*Morus alba*) as protein supplement in diets for laying hens. *Italian J. Anim. Sci.*, 9: e51-e51.
- Ayerza, R., W. Coates and M. Lauria, 2002. Chia seed (*Salvia hispanica L.*) as an ω -3 fatty acid source for broilers: Influence on fatty acid composition, cholesterol and fat content of white and dark meats, growth performance and sensory characteristics. *Poult. Sci.*, 81: 826-837.
- Behnke, K.C., 2001. Processing factors influencing pellet quality. *Feed Tech.*, 5: 4-4.
- Chowdary, N.B., M.V. Rajan and S.B. Dandin, 2009. Effect of poultry feed supplemented with mulberry leaf powder on growth and development of broilers. *J. Life Sci.*, 3: 51-54.
- Güven, I., 2012. Effect of species on nutritive value of mulberry leaves. *Kafkas Univ. Vet. Fak. Derg.*, 18: 865-869.
- Has, H., V.D. Yuniyanto and B. Sukanto, 2013. The effectivity of fermented mulberry leaves with rumen liquor as broiler feed on final body weight, dry matter and crude fiber digestibility and metabolic energy. *Anim. Prod.*, 15: 173-179.
- Iqbal, S., U. Younas, K.W. Chan, R.A. Sarfraz and M.K. Uddin, 2012. Proximate composition and antioxidant potential of leaves from three varieties of Mulberry (*Morus sp.*): A comparative study. *Int. J. Mol. Sci.*, 13: 6651-6664.
- Islam, M.R., M.N. Siddiqui, A.B.M. R. Bostami, M.Z. Rahman, A. Khatun and A.S. Selim, 2014. Dietary effect of mulberry leaf (*Morus alba*) meal in the growth performance and serum cholesterol content of broiler. *SAARC J. Agric.*, 12: 79-89.
- Kamruzzaman, M., M.S. Rahman, M. Asaduzzaman and M.Z. Rahman, 2012. Significant effect of mulberry leaf (*Morus alba*) meal in the reduction of egg-yolk cholesterol. *Bangladesh Res. Publ. J.*, 7: 153-160.
- Lokaewmanee, K., S. Mompanuon, P. Khumpeerawat and K. Yamauchi, 2009. Effects of dietary mulberry leaves (*Morus alba L.*) on egg yolk color. *J. Poult. Sci.*, 46: 112-115.
- Ly, J., T. Chhay, C. Phiny and T.R. Preston, 2001. Some aspects of the nutritive value of leaf meals of *Trichanthera gigantea* and *Morus alba* for Mong Cai pigs. *Livest. Res. Rural Dev.*, Vol. 13,
- Machii, H., 2002. Evaluation and Utilisation of Mulberry for Poultry Production in Japan. In: *Mulberry for Animal Production*, Sanchez, M.D. (Ed.). Food and Agriculture Organization, Rome, Italy, ISBN: 9789251045688, pp: 241-248.
- Odunsi, A.A., 2003. Assessment of lablab (*Lablab Purpureus*) leaf meal as a feed ingredient and yolk colouring agent in the diet of layers. *Int. J. Poult. Sci.*, 2: 71-74.
- Olmo, C., Y. Martinez, E. Leon, L. Leyva and M. Nunez *et al.*, 2012. Effect of mulberry foliage (*Morus alba*) meal on growth performance and edible portions in hybrid chickens. *Int. J. Anim. Vet. Adv.*, 4: 263-268.
- Omar, S.S., C.M. Shayo and P. Uden, 1999. Voluntary intake and digestibility of mulberry (*Morus alba*) diets by growiang goats. *Trop. Grasslands*, 33: 177-181.
- SAS., 2002. SAS user's guide, release 9.0. SAS Institute Inc., Cary, North Carolina, USA.

- Simol, C.F., A.A. Tuen, H.H.A. Khan, J.K. Chubo, P.J.H. King and K.H. Ong, 2012. Performance of chicken broilers fed with diets substituted with mulberry leaf powder. *Afr. J. Biotechnol.*, 11: 16106-16111.
- Srivastava, S., R. Kapoor, A. Thathola and R.P. Srivastava, 2006. Nutritional quality of leaves of some genotypes of mulberry (*Morus alba*). *Int. J. Food Sci. Nutr.*, 57: 305-313.
- Udedibie, A.B.I. and C.C. Opara, 1998. Responses of growing broilers and laying hens to the dietary inclusion of leaf meal from *Alchornea cordifolia*. *Anim. Feed Sci. Technol.*, 71: 157-164.
- Wiseman, J., 1987. Feeding of Non-Ruminant Livestock. Butterworth Co. Ltd., London, UK., Pages: 208.