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Feed Intake and Growth Performance of Indigenous Chicks Fed Diets with *Moringa oleifera* Leaf Meal as a Protein Supplement During Early Brooding Stage

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Abstract: The high cost of conventional feed ingredients in poultry diets has necessitated the investigation into unconventional readily available feedstuffs. The study was designed to investigate the effects of feeding different levels of *Moringa oleifera* leaf meal (MOLM) on feed intake and growth performance of indigenous chicks. Eighty four unsexed indigenous chicks were assigned to four treatment diets, with each treatment being replicated three times. The dietary treatments were as follows; control diet (T_1) without MOLM and diets containing MOLM were at the rate of 5% (T_2), 10% (T_3) and 15% (T_4) to supplement the CP of the control diet. Chicks fed on 0% MOLM had a higher average weekly feed intake than the other three treatments (T_2, T_3 and T_4). The highest weight gain was experienced between weeks 4 to 6 except for treatment 3 that had its peak weight gain on week 5. FCR was similar for all dietary treatments. Weekly live bird weight (WLBW) advantage of chicks fed 0% MOLM diet was maintained followed by those fed diet containing 5% MOLM. The chicks on 10 and 15% MOLM diet recorded similar, but significantly ($p<0.05$) lower WLBW from the 5 to 8th week than chicks on 0-5% MOLM. The study recommended MOLM inclusion levels of 5% in chicken diets during early brooding stage.

Key words: Indigenous chicks, *Moringa oleifera*, brooding, feed intake, growth rate

INTRODUCTION

The major constraint towards increased animal protein supply in sub-Sahara Africa has remained the exorbitant and ever-increasing cost of commercial poultry feeds arising mainly from the high cost of feedstuffs and ingredients. The impact of indigenous chickens in improving the nutritional status, income, food security and livelihood of smallholders is significant owing to their low cost of production (FAO, 1997). Indigenous chickens contribute to the overall well-being of the households through employment creation and income generating (Moreki *et al.*, 2010). Indigenous chickens convert kitchen leftovers and wastes into valuable and high quality protein (Doviet, 2005). Rural people have very few alternative animal protein sources available to them, including chicken and eggs (Odunsi, 2003). Therefore indigenous chickens could be particularly important in improving the diet of young children, old people and HIV/AIDS infected and affected households especially in the sub-Saharan Africa (Alam, 1997).

Indigenous chickens are identified and named according to their phenotypic appearance. The common phenotypes being frizzled feathered, naked neck, barred feathered, feathered shanks, bearded and dwarf sized (Muchadeyi, 2007). The birds are hardy and survive under marginal conditions with minimal inputs. They scavenge for food and may occasionally benefit from kitchen left overs/wastes. Indigenous chicken productivity in developing nations such as Zimbabwe is very low mainly due to, poor nutrition, diseases and poor management. Supplementation of high protein feed, provision of housing and disease control was found to improve productivity of chickens (Tadelle *et al.*, 2003; Kingori *et al.*, 2007).

Greater than 90% of small holder farmers in Zimbabwe rear indigenous chickens (Agricultural Research Council, 1999) which contributes a valuable source of animal protein to most households. Indigenous chickens constitute a vital pillar of food security improvement, socio-cultural and economic development for most rural people. Indigenous chickens have a special cultural value, contribute to household income and droppings provide a rich source of nitrogen which can be used for top dressing in crops. The need for high quality protein is constantly increasing among chicken consumers owing to increasing standards of living and improved incomes resulting from urbanization (FAO, 2002). Indigenous chickens, under free range production system, are now widely kept in rural and urban areas (Moreki *et al.*, 2010). According to FAO

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(1986) indigenous chickens constituted 70% of the total African chicken population. The key challenge associated with indigenous chicken production is the high mortality rate which could reach as high as 80-90% within the first two weeks after hatching, due to diseases and predation (Wilson *et al*., 1987). The other major limiting factor of indigenous chicken production, among other factors is feed in terms of both quantity and quality (Mohamed and Abate, 1995). The nutritional status of indigenous laying hens from chemical analysis of crop contents indicated that protein was below the requirement for optimum egg production and the deficiency is more serious during the dry seasons (Alemu and Tadelle, 1997; Kingori *et al*., 2007). Other constraints to indigenous chicken production include poor extension services and inadequate credit facilities, availability of few or limited research activities, lack of organized marketing system, seasonal fluctuation of price and lack of processing facilities.
Chickens reared under a free-range system do not receive sufficient feed but survive through scavenging. Both energy and protein nutrients are found limiting as the food available on the range contains a lot of crude fiber (Kingori *et al*., 2007). Grain supplementation with maize and sorghum is common among small holder farmers, but leaving out a protein source. There is therefore the need to evaluate those non-conventional feed ingredients that are available at village level and that can be used in place of soybeans or sunflower to supplement protein. The objective of the study was to investigate the effects of feeding different levels of *Moringa oleifera* leaf meal (MOLM) on feed intake and growth performance of indigenous chicks.

MATERIALS AND METHODS

Study site: The study was carried out in the Animal House of the Department of Animal Science, University of Zimbabwe, which is situated in Harare. The site lies on 17°51'50 S and longitude 31°1'47 E, receives an average rainfall that ranges between 600 and 800 m/annum. Summer and winter temperatures average is around 28 and 17°C, respectively.

Experimental design: The experimental design was a randomized complete block design with the tier level of the cages being the blocking factor. Eighty four unsexed indigenous chicks were assigned to the four dietary treatments, with each treatment being replicated three times with seven chicks. The dietary treatments were; the control diet (T_1) without MOLM and diets containing MOLM at the rate of 5% (T_2), 10% (T_3) and 15% (T_4).

Experimental diets: The *Moringa* leaves used for this study were collected from Agro-ecological region 2 of Mashonaland Central province in Zimbabwe. The area lies on latitude 17°30 S and longitude 31°33 E and the soils are moderately well drained heavy grey clays with a soil pH of 5.5 ($CaCl_2$). The area receives an average rainfall that ranges between 600 and 800 m/annum. Summer and winter temperatures average is around 28 and 20°C, respectively.
Branches bearing leaves were cut from the Bindura University's experimental site at Astra campus where they were spread evenly under a semi-open shed for 6 days. The branches and twigs were then hand removed through shaking and the dry soft crispy leaflets of the leaves were retrieved while still retaining the greenish coloration. The leaves were thinly spread out during the drying process in order to facilitate even drying. The air dried leaves were then processed into leaf meal by grinding through a 4 mm screen. The leaf meal was packaged in plastic bags of 20 kg and stored until use. The other ingredients, yellow maize and soya bean cake were bought from Bindura University and Magobo commercial farm, respectively.
Samples of the various ingredients including *Moringa* leaf meals were subjected to proximate analysis. Based on the analysis results of the different ingredients, four iso-nitrogenous and iso-energetic diets were formulated to contain respectively 0, 5, 10 and 15% of *Moringa* leaf meal (MOLM) in a partial substitution to soya bean cake. The diet with 0% inclusion level was the control which was the commercial chick starter feed. Diets based on *Moringa* leaves, 5, 10 and 15%, were supplemented with major vitamins and trace minerals bought from Agri-foods Pvt. (Ltd) Harare. The ingredients composition and calculated nutrient content of the experimental diets are presented in Table 1 and 2, respectively.

Management of chicks and data collection: The experimental cages, watering and feeding troughs were thoroughly cleaned and disinfected with appropriate disinfectants two weeks before the commencement of the experiment. On arrival the chicks received anti-stress tablets in the drinking water and were adapted to their new environment and to feed by dipping their beaks in feed and water. After the acclimatization the, chicks were distributed to their corresponding four treatment diets of 0, 5, 10 and 15% *Moringa* inclusion levels, respectively. The chicks were fed an experimental chick starter diet from first day to eight weeks. Wood shavings were placed in the trays for droppings in order to absorb any fecal moisture that could attract flies.
An initial measured amount of feed, 33 g/chick/day, was offered to birds. On each subsequent day, feed refusals in each cage were collected, weighed and recorded at 2pm. Daily offer of each replicate was a top up of refusals to 33 g/bird/day and fresh clean water was provided *ad libitum*. Mortality and abnormality was recorded throughout the experimental period. The birds were weighed at the beginning of the study and thereafter they were weighed weekly before feeding in

Table 1: Percentage composition of chick starter diets

	Level of Moringa leaf meal in the diets			
Feed ingredients	T_1 (0%MOLM)	T_2 (5% MOLM)	T_3 (10% MOLM)	T_4 (15% MOLM)
Yellow maize	74.3	71	69	67
Soya cake	23.7	22	19	16
MOLM	0	5	10	15
Additives	2	2	2	2
Total	100	100	100	100

Table 2: Calculated nutrient content of chick starter mash

Nutrient	T_1 (0% MOLM)	T_2 (5% MOLM)	T_3 (10% MOLM)	T_4 (15% MOLM)
CP (%)	18	18.32	18.20	18.07
Fibre (%)	3.1	3.3	3.4	3.5
ME (MJ/kg)	13.4	13.65	13.91	14.1

order to determine the growth rate. Weight gain was calculated as final weight minus initial weight and Feed Conversion Ratio (FCR) as feed intake divided by weight gain.

Statistical analysis: Data were subjected to analysis of Variance (ANOVA) for completely randomized block designs using the General Linear Models (GLM) procedure of Statistical Analysis System (SAS, 2010). Significant means were separated using the Tukey's studentized range (HSD) test. All statements of statistical differences were based on $p<0.05$ unless noted otherwise.

The following mathematical model was used:

$$Y_{ijk} = \mu+T_i+B_j+e_{ijk}$$

where:

Y_{ij} is the record on the j^{th} bird from the i^{th} dietary treatment

μ is the general mean common to all observations

T_i is the effect of the i^{th} dietary treatment (I = 1,2,3,4)

B_j is the fixed effect of block (j = 1, 2, 3)

e_{ijk} are the random effects peculiar to each treatment

RESULTS

Nutrient composition: The nutrient contents of the four experimental diets are presented in Table 3.

The diets were close in terms of their nutrient contents. As for DM, ash, calcium and phosphorous, the nutrient contents were similar.

Feed intake: Chicks given a diet with 0% MOLM had a higher ($p<0.05$) weekly feed intake than the other three treatments (T_2, T_3 and T_4). Weekly feed intake for treatments T_3 and T_4 were similar ($p>0.05$) and were lower than that for T_2 treatment (Fig. 1).

Weekly FCR/chick: The FCR patterns for treatment 1 to 3 were almost similar. T_4 experienced a negative FCR between eleven days and thirteen days. T_1 and T_2 maintained a fairly constant FCR from week 3 to week 8. There was more variation in FCR in T_3 and T_4.

Weekly body weight gain: There were fluctuations in weekly body weight gain as chicks suffered weight losses at some stages of growth. All treatments experienced some weight losses during the first week and gained some weight, except for treatment 4, between week 2 and 3 (Fig. 2).

The effects of *Moringa oleifera* leaf meal inclusion in the diets on weekly live body weight (WLBW) of growing indigenous chicks as illustrated in Fig. 2, shows that from the 1st to 4th week of age, the WLBW of chicks in all dietary treatments increased similarly, with no significant ($p>0.05$) differences in chicks fed different diets. From the 5th week until the end of the experiment (8 weeks old), the WLBW advantage of birds fed 0% MOLM diet was maintained followed by those fed diet containing 5% MOLM. The chicks on 10 and 15% MOLM diet recorded similar but significantly ($p<0.05$) lower WLBW from week the 5 to 8th week than chicks on 0-5% MOLM.

Feed had a significant effect ($p<0.05$) on weekly weight gain and feed intake (Table 4). T_1 had a significantly higher weight gain compared to T_2, T_3 and T_4. Similarly, there was a significant difference in weekly feed intake from T_1 when compared with the rest of the other three treatments. There was however no significant difference in FCR amongst the three treatments, T_1, T_2 and T_3. However, the FCR from T_4 was significantly lower than the rest of the treatments.

Stage of growth had a significant effect ($p<0.05$) on weekly weight gain. The rate of weekly weight gain from week one to week four was lower than that of week five to seven where birds had greater weight gain. The rate of weight gain slowed down during week eight. Weekly feed intake was almost similar throughout except for week four to five which had a significantly high ($p<0.05$) feed intake compared to the rest of the weeks. There was no significant difference in weekly FCR throughout the growth period of eight weeks.

DISCUSSION

Nutrient composition of experimental diet: The CP content of *Moringa oleifera* that was used in the experimental diet (28%) was slightly lower than CP

Table 3: Chick starter mash nutrient composition

Sample code	Dietary treatments	Nutrient values					
		DM	ASH	CP	CF	Calcium	Phosphorus
T_1	(0%MOLM)	89.56	5.10	19	4.63	0.29	0.38
T_2	(5%MOLM)	90.39	5.52	19.30	2.06	0.34	0.46
T_3	(10%MOLM)	91.85	6.35	19.36	4.45	0.46	0.50
T_4	(15%MOLM)	88.1	6.37	20.15	4.12	0.71	0.72

Table 4: Effects of feed on performance of indigenous chicks fed on four graded MOLM supplements

Parameters	0% MOLM (SE)	5% MOLM (SE)	10% MOLM (SE)	15% MOLM (SE)
Average weekly weight gain (g)	52.47^{a} (6.467)	27.38^{b} (4.497)	18.35^{b} (4.7710)	15.55^{b} (5.286)
Average weekly FCR (FI/WG)	4.53^{a} (3.205)	4.47^{a} (3.12)	2.82^{a} (3.13)	-6.14^{b} (3.151)
Average weekly feed intake (g)	170.7^{a} (11.734)	117.48^{b} (8.16)	97.75^{b} (8.657)	93.25^{b} (9.592)

NB: ^{ab}Means in the same row with different superscripts are significantly different at $p<0.05$

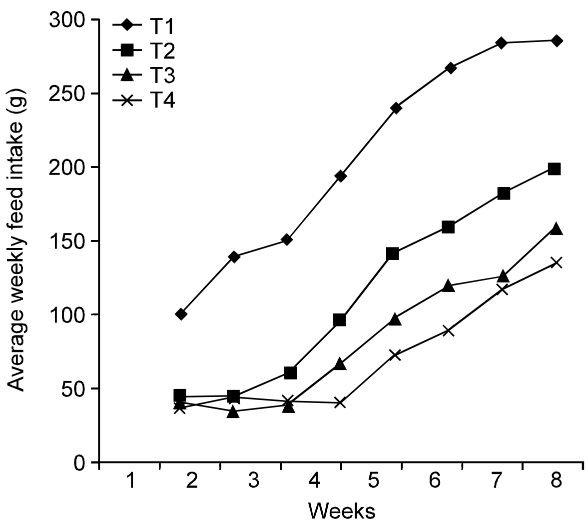

Fig. 1: Average weekly feed intake/chick

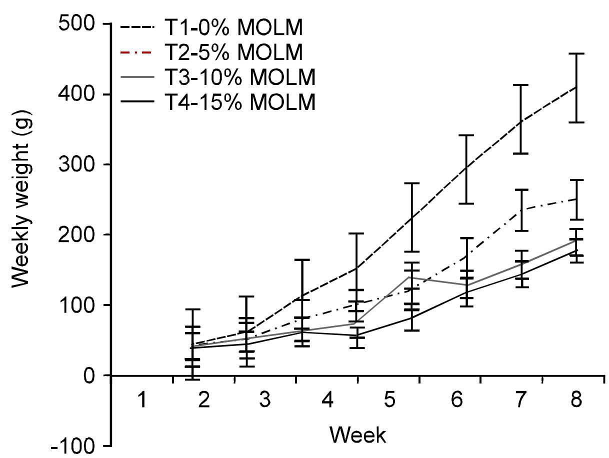

Fig. 2: Weekly total weights per treatment

values found by Soliva *et al.* (2005) of 32.1% of CP for *M. olifera* leaves. The CP contents for the diets varied between 19 to 20.15%. As for DM, ash, calcium and phosphorous, the nutrient contents were similar for all treatments.

Feed intake: Feed intake was significantly higher in treatment one which had 0% MOLM than in the other three treatments (T_2, T_3 and T_4). That was in contrast to findings by Kakengi *et al.* (2007) who reported that dietary *M. olifera* leaf meal levels of up to 5% did not show any significant effect on feed intake. The variance in intake between this study and other studies could be attributable to the fact that the MOLM CP content used in this study was slightly lower than the one used in by Kakengi *et al.* (2007) and that could have had an influence on the feeding centres of chicks. Weekly feed intake for treatments T_3 and T_4 were similar since they fell within the same range. That agrees with Kakengi *et al.* (2007) who observed, in related studies, no difference in feed intake in layer hens fed diets containing 10 and 20% levels of *M. oleifera* leaf meal, but rather increased feed intake was noted in both inclusion rates. There was however increased feed intake for all treatments as from week five. That could have been a sign that chicks had acclimatized to the feed and also that MOLM have low anti- nutritional factors and toxic substances that could reduce feed intake over time. The leaves of *M. oleifera* are reported to have negligible amounts of tannins (14 g/kg DM) and condensed tannins were not detectable (Makkar and Becker, 1996). The measured levels of tannins in MOLM diet was 1.3 to 2.7%. Moreover cyanogenic glycoside and glucosinolates were not detected in leaves of *M. oleifera* (Makkar and Becker, 1997).

Average weekly weight gain: Significant differences in weekly weight gain were observed between chicks fed on diet with 0% MOLM and the rest of the treatments. T_2, T_3 and T_4 did not show significant differences in weekly weight gain. The findings of the present study agreed with those of Du *et al.* (2007) who reported no significant difference in growth performance of 3 weeks old broilers (Arbor Acres) that were fed on diets supplemented with 5, 10 and 20% levels of *M. oleifera* leaf meal. There was show ever fluctuations in weekly weight gain which indicated weight losses at some stages of growth. All chicks suffered some weight losses during the first week and showed an upward weight gain, except for treatment 4, between week 2 and 3. The insignificant discrepancies observed in the weekly weight gain of chicks fed on diets containing MOLM leaf meal supplements might be explained, according to Makkar and Becker (1997), by the presence of high pepsin soluble nitrogen (82-91%), low acid detergent insoluble protein (1-2%) and low anti-nutritional factors (1.3 to 2.7% tannins) in *Moringa* leaf meal. That suggests that the protein in *Moringa oleifera* leaf is readily available to most animals and more suitable to monogastric animals (Kakengi *et al*., 2003). Some steep weight gain was experienced between weeks 4 to 6 except for T_3 on 10% MOLM. The rapid weight gain may be attributed to increased voluntary feed intake.

Weekly FCR: There was no significant difference in weekly FCR throughout the brooding period for eight weeks. The FCR patterns for T_1, T_2, T_3 and T_4 were almost similar despite the fact T_4 experienced some negative FCR between eleventh and thirteenth day of growth. Insignificant variation in FCR might also be due to the influence of other substances such as the high levels of vitamins in MOLM diet, which help to improve the efficiency of feed utilization of chicks (Coon, 2002). Related to findings of this study, Nworgu and Fasogbon (2007) observed increased FCR in growing pullets fed diets containing 2, 4 and 6% *C. pubescens* leaf meal. Reduced FCR were recorded in diets containing greater than 20% leaf meal as was reported by Kakengi *et al*. (2007) that low feed utilization was noted in layers fed 20% levels of *M. oleifera* leaf meal. That could be attributed to reduced voluntary feed intake with increasing inclusion levels of leaf meals that tends to contain high energy levels. That is in line with Makkar and Becker (1996, 1997) who indicated that voluntary feed intake is explained firstly by ME content and secondly by the palatability of diets. Voluntary feed intake being primarily energetic in poultry, *Moringa oleifera* leaf meal based diets are more energetic and are therefore less consumed than control diets. The slight ant nutritional factors give a slight bitter taste with increased leaf meal inclusion and therefore reduce palatability and subsequent voluntary feed intake.

Weekly total weights: Total weekly weight gain during the first four weeks was significantly different from week five to seven, but similar to week eight. There was gradual growth rate during the first four weeks as chicks partitioned their nutrients towards skeletal development instead of putting much weight through muscle development. A steep growth rate was observed from week five to week seven, which was followed by a reduced growth rate in week eight. However, weekly feed intake was almost similar throughout the growth period. That helps to explain the reason for an almost sigmoid growth curve that was obtained. The weekly total weights obtained at week eight in 0 and 5% MOLM of 400 and 200 g are closer to 505 and 296 g live weight obtained at week eight in indigenous chickens in Senegal by Missohou *et al*. (2002).

Conclusions: Indigenous chicks fed on *Moringa oleifera* leaf meal at an inclusion level of 5% and 10% performed equally well when compared to chicks fed on conventional feed up to four and half weeks. After four and half weeks, the conventionally fed chicks outperformed T_2, T_3 and T_4. Treatment 2 gave a better performance than T_3 and T_4, therefore 5% MOLM could be fed to indigenous chicks and give good chick growth performance.

Recommendations: Indigenous chicks fed MOLM diet containing 5% inclusion level performed equally well in terms of feed intake and growth performance when compared to those fed on conventional diet containing soyabean only as protein source. The study therefore recommends a 5% MOLM inclusion level in indigenous chicks' diet.

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