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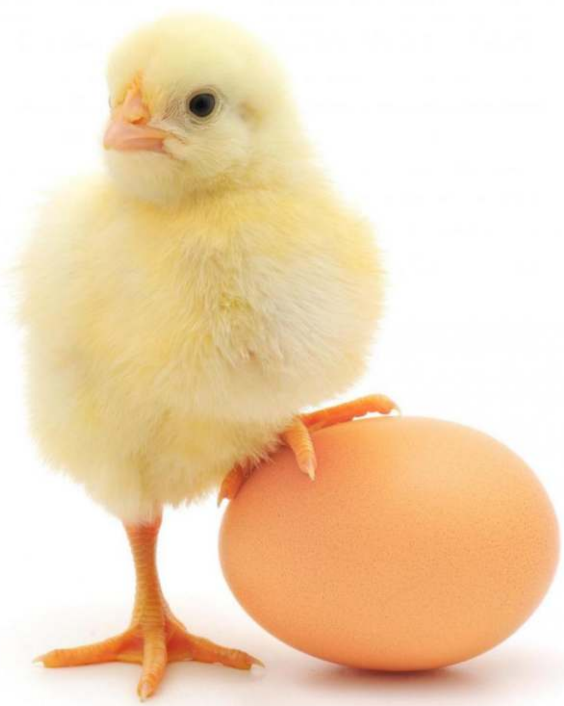

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Performance of Broiler Chickens Fed on Mature *Moringa oleifera* Leaf Meal as a Protein Supplement to Soyabean Meal

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Abstract: An exploratory study investigating the effects of supplementing soyabeans with *Moringa oleifera* leaf meal, as a protein source in poultry production was done at Bindura University Farm. Five different graded levels of *Moringa oleifera* meal were used in formulating the diets. Ration formulation using soyabean, yellow maize and *Moringa oleifera* meal as ingredients for broiler starter (20% Crude Protein) and broiler finisher (18% Crude Protein) diets was done using the Pearson Square Method. Twenty-five day old Habbard chicks were randomly allocated to the five treatment diets T1 (0% *Moringa oleifera* meal), T2 (25% *Moringa oleifera* meal), T3 (50% *Moringa oleifera* meal), T4 (75% *Moringa oleifera* meal) and T5 (100% *Moringa oleifera* meal) in a completely randomized design. Birds were managed under the dip litter system with five compartments each with five birds for a period of 6 weeks. Weekly weight gain, feed intake and feed conversion ratio were recorded throughout the period. Evisceration of carcasses was done after 6 weeks and the different body parts were weighed and recorded. Proximate analysis of *Moringa oleifera* meal, broiler starter and broiler finisher diets were done and the results were tabulated. Statistical analysis was done using Genstat Software Version 12. No significant differences were noted in the amount of feed taken by broiler birds under different treatments of *Moringa oleifera* meal, however significant differences in feed conversion ratios were noted. It was therefore concluded that inclusion of *Moringa oleifera* meal as protein supplement in broiler diets at 25% inclusion level produces broilers of similar weight and growth rate compared to those fed under conventional commercial feeds ($p>0.05$).

Key words: *Moringa oleifera*, broilers, protein, weight, carcass

INTRODUCTION

Soya bean has been the major protein feed source of choice for poultry farmers. When intensive poultry production was introduced in Zimbabwe, fishmeal was used as the main protein source. However this became expensive as fishmeal was imported and this led to development of soya bean meal as a substitute for fishmeal. In Zimbabwe poultry producers use cereals as energy sources and oilseeds like sunflower and soya bean, as a protein sources. In most developing countries, the major sources of protein in commercial poultry production are Fishmeal (FM) and oil seed cakes. However, these are usually scarce, expensive and used extensively by other livestock and humans. Nutrition accounts for 60-70% of the total production cost in modern poultry production systems (Smith, 1990). Further, feeding has a great effect in poultry growth, egg production and meat quality. This situation has created a need to look for cheap, locally available and less competitive substitutes to some ingredients of poultry feeds and in particular, sources of protein. There is continued scarcity and consequent high prices of conventional protein (soyabeans) and energy sources for livestock in tropics (D'Mello *et al*., 1987) and this hinders poultry production.

The use of leguminous Multipurpose Trees (MPTs) and shrubs has been suggested to be a viable alternative source of proteins, vitamins and minerals for poultry feeding (Church, 1991). Plant leaves are commonly processed into Leaf Meals (LMs) for use as poultry feed. A review of available literature shows that *Leucaena leucocephala*, *Gliricidia sepium*, *Sesbania sesban*, *Manihot esculenta* have been widely used in feeding non-ruminants and especially poultry resulting in improvement of their productivity (Lopez, 1986; D`Mello *et al*., 1987). However, the uses of LMs are limited by their high fibre contents and in some cases, presence of toxic factors or metabolic inhibitors. *Moringa oleifera*, known as the drumstick tree, has been under investigation in Zimbabwe for both human nutrition and immune boosting properties. Research done in Gambia and India have shown that *Moringa oleifera* leaves can be used for livestock nutrition strategies. Young leaves are used by farmers in India as cattle fodder to improve milk yields (Bostock-Wood, 1992) and in Zimbabwe as animal feed (Clarke, 1994).

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Moringa oleifera leaves are packed with nutrients important both for humans and animals (Nautiyal and Venhataraman, 1987). A crude protein percentage of 25-27% is suggestive that the leaves are a good source of protein for livestock. The high proportion of this protein is available in the intestines (Makkar and Becker, 1997). The presence of adequate levels of essential amino acids, (higher than the levels present in the FAO reference protein) and low levels of anti-nutrients indicate their nutritional quality. The high pepsin soluble nitrogen (82-90%) and the low acid detergent insoluble protein (1-2%) values for the meal suggest that most of the protein in the meal is available to most animals (Makkar and Becker, 1997). Makkar and Becker (1997) also concluded that the amino acid profile of *Moringa olefera* leaves is comparable to that of soya bean meal. Research have indicated that Moringa leaves have negligible tannins; saponin content is similar to that present in soya bean meal and trypsin inhibitors and lectins were not detected (Makkar and Becker, 1997).

Moringa tree is native to the sub-Himalayan regions of the northwest India. It is now indigenous to many countries in Africa, Arabia, South Asia, the Pacific and the Caribbean islands and South America (Fordl *et al*., 2001). Moringa is being cultivated in several relatively remote parts of Zambezi valley and it has naturalized in these areas of Zimbabwe. Moringa is well known for its multipurpose attributes, wide adaptability and ease of establishment. The tree is fast growing and high yielding, initial trial in Nicaragua have shown a high biomass production of up to 120 tonnes dry matter/ha/year in 8 cuttings after planting one million seeds/hectare (Makkar and Becker, 1997). The tree bears for 30-40 years. The drought tolerant nature of the tree makes it particularly suited to those marginal areas where the cost associated with cultivation and harvesting of other commercial crops like soyabeans is high. The tree is resistant to most pests and diseases, thus making it a cheap source of feed for animals.

Moringa tree is drought tolerant, it is resistant to most diseases and pests, it has a high biomass yield per hectare, it can grow well in marginal areas and it has a high protein value which can support livestock production. All these facts make it a cheap feed source compared to soyabeans, which is a cash crop and it is expensive to produce by the small-scale farmer in marginal areas. Under such conditions, *Moringa oleifera* becomes the crop of choice to explore in broiler production.

The main objective of this study was to evaluate broiler performance in terms of growth rate and feed conversion ratio when fed on mature *Moringa oleifera* leaf meal as a protein supplement and to determine ideal inclusion levels of this leaf meal in a broiler diet. It also aimed at establishing the effect of feeding mature *Moringa oleifera* on carcass yield of broilers. The mostly used parameter to measure growth in farm animals is therefore an increase in weight gain over time. Growth rate therefore is defined as the time taken to reach mature body weight. Using conventional feeds, Ross and Enriquez (1969), reported that meat-line breeds birds would reach 2 kgs in 6 weeks and to produce 1kg carcass weight, broilers require 2-3 kg of balanced feed. Plant leaves are commonly processed into leaf meals for non-ruminant animals. Among the leaf meals, leucaena (*Leucaena leucocephala*) and cassava (*Manihot esculenta*) leaf meals are most popular (Limcango-Lopez, 1990). Other species reported on are, *Trema orientalis*, *Morus indica*, *Moringa oleifera* and *Sesbania rostrata*. In China, pine needles are some of the main leaf fodders. The leaf meal is produced industrially and used widely in animal feed, especially for pigs and poultry, mainly to supplement vitamins and trace minerals (Zaichun, 1990).The use of leaf meal as feed is limited by its high fibre content and, in some cases, the presence of toxic factors or metabolic inhibitors. Consequently, levels higher than 5-10% have detrimental results on survival and production (Yoshida, 1944; Ross and Enriquez, 1969; Sazon, 1988; Cariaso, 1988).

MATERIALS AND METHODS

Study site: The experiment was carried out at the Research Farm Unit of the Bindura University of Science education, Bindura, Zimbabwe. The farm is in natural region 2a, receiving annual rainfall of 750-1000 mm. Mild temperatures are recorded in winter, ranging from 15-25 degrees Celsius on average. The project was carried out during winter season.

Experimental procedure: Twenty five Harbbad day old chicks were used in the study. A Completely Randomised Design (CRD) was used whereby day old chicks were randomly allocated to 5 treatments (diets)containing 0%, 25%, 50%, 75% and 100% *Moringa oleifera* Leaf Meal (MOLM) supplement. Diets were formulated using Soya beans, Maize and mature *Moringa* leaves at different graded levels. Moringa provenances from Mtoko and Shamva districts of Zimbabwe were used since they are more commonly grown by farmers. Premixes common to poultry production were added, that is vitamins, monocalcium phosphate, salt and limestone flour. During the first 3 weeks of brooding life, heat was supplemented by use of a heater. An Ox tetracycline was administered from day one up to the end of brooding period as prophylactic measure.

Lighting systems were natural during the day and artificial at night, using 60 watts electric bulb. Ventilation was also natural, achieved by opening and closing windows. Hansen sacks curtains were used to prevent birds from draughts. Feed and water were supplied

Table 1: Ingredient composition of a broiler starter diet formulated

	Composition of broiler starter and finisher diets formulated with inclusion of MOLM (%)									
	Broiler starter					Broiler finisher				
Ingredients g/kg	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Yellow maize	548.0	52.0	480.0	405.0	355.0	617.5	583.5	514.5	425.5	455.5
Soyabean cake	412.0	328.0	242.0	190.0	-	344.0	285.0	226.0	138.0	-
MOLM	-	107.0	238.0	365.0	605.0	-	93.0	221.0	398.0	506.0
Premixes										
Vitamins	5.5	5.5	5.5	5.5	5.5	4.0	4.0	4.0	4.0	4.0
Alt	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Monocalcium phosphate	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Limestone flour	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Total	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

ad lib. Broiler starter, 20%crude protein, was given for 3 weeks, by the end of the 3rd week broiler finisher containing 18% crude protein was gradually introduced and supplied through up to slaughter. Weighing of birds was done with an electro scale (Salter Industrial Measurements West Bromwich, West Midlands).

Moringa oleifera leaves were harvested from a farm in Shamva district of Zimbabwe. Branches were cut from the mature Moringa trees over twelve months old, spread out and dried under the shade for a period of 7 days. Thereafter, branches were threshed carefully to separate leaves from twigs before pounding. The dried leaves were pounded to make a leaf meal. The leaf meals were stored in the nylon bags during entire period of the study to avoid any possible contamination from foreign material. Yellow maize was harvested and grounded using a hammer meal and incorporated into the diet. Soya beans was harvested, sent to an oil extracting company and the cake was used as a protein source in the diet.

The premixes were purchased from Agri-foods manufacturing company.

Ration formulation of experimental diets: Crude protein value for *Moringa* was based on proximate analysis (Table 3) and that of Maize and Soyabeans were based on figures from literature (McDonald *et al*., 1995). The following steps were taken in formulating the experimental diets.

- 5% of the ration was reserved for supplements of limiting amino acids, minerals and vitamins (premix).
- Manipulated the levels of inclusion of protein sources (*Moringa oleifera* leaf meal and Soya beans meal) to meet the protein requirements (using Pearson's Square method).
- Included the energy sources to meet the desired level of metabolisable energy.

The diets were made iso-nitrogenous and iso-energetic to produce broiler starter and finisher with 20% and 18% crude protein respectively.

Data analysis: Growth rate (weight) and feed intake data were subjected to the analysis of variance using the one-way ANOVA with weeks as a blocking factor. Genstat Version 12.1 Software was used to do the statistical analysis. The individual treatment means were compared using the LSD test procedure at 5% level.

RESULTS

Nutrient composition of diets: In both starter and finisher diets, it could be observed that increasing the level of MOLM in diet was followed by an increase in Ash, crude fiber and ether extract. However the reverse was the case with crude protein and nitrogen free extract, which tend to decrease with increasing levels of MOLM. For the starter diets Ash content increased from 53.02-107.42 g/kg; ether extract values declined from 49.58-31.31 g/kg; crude fiber levels increased from 124.92-206.60 g/kg and Nitrogen Free Extract (NFE) values declined from 576.13-435.94 g/kg for T1 (0%MOLM) and T2 (100% MOLM) diets respectively. For the finisher diets Ash content increased from 60.49-111.48 g/kg; ether extract increased from 33.07-48.32 g/kg; crude fiber values increased from 133.00-201.32 g/kg and NFE values declined from 568.93-458.42 g/kg T1 (0%MOLM) and T2 (100%MOLM) diets respectively.

Proximate analysis of harvested *Moringa oleifera* leaf meal was done and the results given in Table 3.

Weight: Final live weight per bird at six weeks ranged from 1750.55-1306.71 g for T1 and T5 diets respectively. Both total weight gain and daily live weight gain per bird followed a similar trend. The values ranged from 1664.44-1222.03 g and from 29.72-21.82 g/day for T1 (0%MOLM) and T5 (100%MOLM) diets respectively. From the results, the performance of birds fed T1

Table 2: Nutrient composition of broiler diets containing varying levels of MOLM

	Proximate composition of broiler diets containing different % of MOLM									
	Treatments									
	Broiler starter					Broiler finisher				
Item (g/kg)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Ash	53.02	65.87	77.52	91.00	107.42	60.49	70.86	85.24	94.34	111.48
Ether extract	31.31	35.26	38.75	43.57	49.58	33.07	35.81	38.97	43.53	48.32
Crude protein	214.62	215.60	208.72	202.54	200.46	204.51	200.46	198.74	190.93	180.46
Crude fibre	124.92	142.79	158.25	179.60	206.60	133.00	145.46	159.42	179.61	201.32
Nitrogen free extract	576.13	540.48	516.76	483.29	435.94	568.93	547.41	482.37	491.59	458.42
Gross energy	3063.78	3066.78	3069.78	3080.72	3107.50	3063.78	3066.78	3069.78	3080.72	3107.50

Table 3: Nutrient composition of mature *Moringa oleifera* leaf meal used in the diets

Items	Values
Crude protein	251 g/kg
Ash	150 g/kg
Ether extracts	54 g/kg
Nitrogen free extracts	106 g/kg
Crude fibre	225 g/kg
Gross energy	18.7 MJ/kg

Table 4: Average live weight (grams) of birds for each treatment for the 6 week period

Treat	Mean	SD	SE Mean
T1 (MOLM 0%)	473.5[a]	411.2	69.51
T2 (MOLM25%)	503.0[a]	457.4	77.32
T3 (MOLM50%)	389.8[b]	321.0	54.26
T4 (MOLM75%)	323.3[c]	258.4	43.68
T5 (MOLM100%)	238.3[d]	222.7	37.64
LSD (5%) = 50.632			
ESE = 18.126			

*Means with the same superscript are not significantly different (p>0.05)

(0%MOLM) and T2 (25% MOLM) diets did not significantly differ (p>0.05). The data of weight of birds was tested for normality using Shapiro-Wilk test. The results showed that the data was normal (p<0.001). Therefore an analysis of variance was done using weeks as a blocking factor. Means were compared using LSD at 5% level.

Analysis of variance showed that there were significant differences between the weight of birds amongst the five treatments (p<0.01). More variability in the weight of birds was being explained by the different weeks (week factor). The least significance of the difference between the means of weight of birds among the five treatments at 5% level is 50.632.

Feed intake: The highest feed intake was recorded in birds offered 25% MOLM diet.

Carcass characteristics: Different carcass parts, liver, head, neck, wing, back, thighs, shanks, breast, gizzard and lung, were weighed and exposed to significant tests. The general trend was that treatment five, with 100% inclusion level of MOLM, was significantly different from the rest of the treatments (p>0.05). The breast part showed more variability and the head had minimum variation.

Table 5: Average feed intake (grams) for 6 weeks for the 5 treatments

Treat	Total	Mean	Median	SD
T1 (0%MOLM)	1834	52.40[a]	50.60	31.23
T2 (25%MOLM)	1838	52.53[a]	50.90	30.94
T3 (50%MOLM)	1680	48.01[b]	47.60	27.72
T4 (75%MOLM)	1545	44.13[c]	45.30	27.45
T5 (100%MOLM)	1307	37.33[d]	37.10	24.10
LSD (5%) = 1.553				
ESE = 0.787				

*Means with the same superscripts are not significantly different (p>0.05)

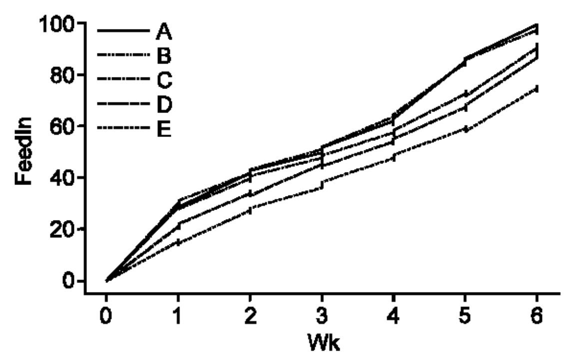

Fig. 1: A composite graph for feed intake of birds for each treatment over 6 week period.
A = FeedInFeed inatake v Wk [Treatment 1 (0%)]
B = FeedInFeed inatake v Wk [Treatment 2 (25%)]
C = FeedInFeed inatake v Wk [Treatment 3 (50%)]
D = FeedInFeed inatake v Wk [Treatment 4 (75%)]
E=FeedInFeed inatake v Wk [Treatment 5 (100%)]

DISCUSSION

The diets used in the study were formulated to provide 20%CP and 18%CP for the starter and finisher diets respectively. The protein levels of the five diets were

Table 6: Mean weight (g) of different broiler carcass parts for each treatment (% MOLM inclusion levels)

	Carcass parts									
Treatment	Back	Gizzard	Shanks	Head	Thigh	Liver	Neck	Wing	Lung	Intestine (L)
T1 (0%)	179.8	40.20	60.2	30.30	260.2	20.10	79.70	140.0	0.1	12.06
T2 (25%)	150.2	40.00	60.2	40.36	260.2	20.24	99.40	140.2	0.1	12.00
T3 (50%)	134.0	30.00	60.0	30.06	210.2	20.08	60.06	120.2	0.1	12.00
T4 (75%)	149.8	40.02	50.1	30.02	219.8	20.06	79.86	129.8	0.1	12.00
T5 (100%)	80.4	30.00	30.0	30.06	130.4	10.70	40.20	70.40	0.1	12.00

Intestine (L): Intestine (Length)

within the recommended levels for broiler chicks as reported by McDonald *et al*. (1995) who put the protein requirements for broilers raised in the tropics at 20-22% for starter and 18-20% for finisher. Nutrient composition of diets in this study showed an increasing trend in ash, Crude Fiber (CF) and Ether Extract (EE) and a decreasing trend of Crude Protein (CP) and Nitrogen Free Extract (NFE). This is in sharp contrast to similar studies by Kakengi *et al*. (2007) which showed a decreasing trend of Crude Fibre (CF) and Ether Extract (EE).

There were no significant differences in feed intake of broilers fed with different *Moringa oleifera* leaf meal inclusion levels, however significant differences were noted in feed conversion ratio as evidenced by the variation in weight gained in different treatments. Feed intake increased as MOLM inclusion increased probably due to increased bulk and metabolizable concentration. Similar findings were reported by Olugbemi *et al*. (2010) in his study of effect of MOLM inclusion in cassava based diets to broiler chickens. This finding is also supported by results from studies of substitution sunflower seed meal with MOLM in diets of laying hens by Kakengi *et al*. (2007) that indicated significant progressive increase in feed intake were on birds fed 10% and 20% MOLM levels. The results show that there was no significant difference in mean feed intake between T1 (0% MOLM) and T2 (25% MOLM) as demonstrated by Kakengi *et al*. (2007) where dietary treatments did not show any significant effect on feed intake and dry matter intake up to 5% MOLM.

Final weight and weight gained declined as MOLM level increased. This is also in line with findings from a study by Olugbemi *et al*. (2010) in inclusion MOLM to cassava based diets fed to broiler chickens. In the study of supplementing soyabean meal with MOLM, mean weight of broilers was significantly different for T3 (50%MOLM), T4 (75%MOLM) and T5 (100%MOLM). However, there was no significant difference in the mean weight of broilers between T1 (0%MOLM) and T2 (25%MOLM). Significant weight gain differences were noted between treatment five and treatment one and between treatment two and five. The difference could be due to high fibre levels that were in treatment five with 100%MOLM in the diet as protein source. The findings agree with literature that monogastrics cannot utilise high crude fibre diets efficiently.

The birds were experiencing yellow colouration of body parts which was mainly attributed to the presence of xanthophylls and carotenoid pigments in MOLM as in other tree and shrub leaf meals as outlined by Austic and Neishen (1990). A mortality rate of 40% was recorded in T5 (100%MOLM) which shows that at very high levels MOLM becomes detrimental to birds. Significant difference on carcass yield between the different treatments on birds fed on different *Moringa oleifera* leaf meal inclusion levels was also noted upon evisceration.

It can be recommended from this study that MOLM can be supplemented to soya bean meal at 25% inclusion level in broiler chickens. Similar recommendations were made by Kakengi *et al*. (2007) that in areas where MOLM can be obtained for free and quality of eggs fetch higher premium complete substitution (20%) with MOLM of sunflower meal in laying birds is recommended.

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