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The Effect of Dietary Inclusion of Mango (*Magnifera indica L.*) Fruit Waste on Feed Intake, Growth and Feed Efficiency of Cobb-500 Broiler Chickens

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Abstract

Animal response trials aimed at investigating the effect of different levels of mango fruit waste (MFW) on growth performance and carcass characteristics of Cobb-500 broiler chickens were carried out. One-hundred sixty day-old chicks with similar body weight were randomly distributed to four treatment diets each with four replications. The four treatments were T_1 (100% maize + 0% MFW), T_2 (90% maize + 10 % MFW), T_3 (80% maize + 20% MFW) and T_4 (70% maize + 30% MFW). The experiment was conducted for 7 weeks, during which feed intake and body weight were measured. At the end of the experimental period, 2 chicks from each replication were randomly selected and slaughtered to evaluate the effect of MFW on carcass yields. The average individual daily feed intake was 65.3, 65.6, 70.8 and 66.9 g for T_1, T_2, T_3 and T_4, respectively. At the age of 7 weeks, chicks fed on T_1, T_2, T_3 and T_4 diets had individual body weights of 1178, 1165, 1066 and 860 g, respectively. Average daily individual weight gain for the respective T_1, T_2, T_3 and T_4, was 21.0, 17.6, 16.0 and 13.7 g. The feed conversion ratio (g feed/g gain) was 3.49, 3.96, 4.50 and 5.23 g for T_1, T_2, T_3 and T_4, respectively. The dressing percentage of T_1, T_2, T_3 and T_4 was 58.6, 62.1, 65.1 and 65.9, respectively. No significance differences were observed in all carcass traits between chickens fed on control diet and treatment diets. Chickens fed on control diet had significantly higher abdominal fat than those of treatment diets. Higher mortality rate was noted in T_1 (10%) followed by T_2 (2.5%). No mortalities were observed in those chickens fed on T_3 and T_4 diets. Mango fruit waste can be incorporated up to 20% of the diets of grower broiler chickens without affecting nutrient intake and growth.

Key words: Mango Fruit Waste; Maize; Cobb-500 Broiler Chickens; Growth Performance; Carcass Traits

Introduction

Poultry production plays a major role in bridging the protein gap in developing countries where average daily consumption is far below recommended standards (Onyimonyi et al., 2009). The back yard poultry rearing is an integral part of rural farming system in Ethiopia. The egg and meat are very significant source of high quality protein, vitamins and minerals in human diet. However, the productivity of poultry in the tropics has been limited by scarcity and consequent high prices of the conventional protein and energy sources. Since feed cost is the prime input in commercial poultry production representing 70-85% of the total cost of poultry production, attention should be directed in the utilization of low cost, good quality feed ingredients to reduce the feed cost. Moreover, the conventional feed resources for chicken production are mainly cereal based which competes with human food. Both energy and protein sources are especially limiting factors in poultry feed production in the tropics (Atawodi et al., 2008). This necessitates investigations of potentials of some unconventional feed resources that are cheaper, locally available and have comparative nutritional value as the conventional sources. Possible sources of cheap energy source to poultry are fruit and other agro industrial wastes (Ravindran and Blair, 1991).

Various investigations have shown that mango fruit waste is one of the wastes that can be used as poultry ration. Normally, it is produced for human consumption as raw or juice products. During the processing of ripe mango, its peel and seed are generated as waste, which is approximately 40-50 % of the total fruit weight. According to recent study by Sruamsiri and Silman (2009), mango fruit wastes (peel and seed) contained 3827 to 4070 kcal/g dry matter gross energy and 76% nitrogen free extract. Moreover, mango is an excellent source of vitamin A and C, as well as a good source of potassium, beta-carotene and fiber. Thus, it can be used as an alternative feed resource in poultry rations by replacing expensive energy feed sources. Several researchers reported that the treated (de-oiled, soaked or boiled) mango seed kernel has been successfully used to replace maize in levels up to 15-20% in poultry diets (Ravindran and Sivakanesar 1996) and Odunsi (2005). Therefore, if this waste is processed and used in a commercial way, it will produce a very important feedstuff as a source of energy in poultry diets. This study was thus undertaken to evaluate the effect of substituting maize by dried ground mango fruit waste in broilers diet using Cobb-500 broiler chicks.

Materials and Methods

Description of the study area

The feeding trial was conducted at Debrezeit Agricultural Research Center which is about 50 km South-East of Addis Ababa. It is located in the northeast periphery of Debrezeit town at an altitude of 1900 m.a.s.l. It has a mean annual rainfall of 850 mm and mean temperature of 17^{0}C.

Feed preparation from mango fruit waste

The mango fruit waste (MFW) was collected from local fruit processing and juice houses around Addis Ababa, Debre Zeit and Adama cities. For the sake of minimizing contamination with other materials in fruit processing houses, wastes of mango were collected by clean plastic materials immediately after squeezing the juice. The MFW was then spread evenly on plastic sheets and allowed to sundry. The seed kernel was obtained after removing the hard seed coat. The sun dried feed was grounded by locally available material (hand mortar) until it has the same size as other conventional poultry feed ingredients. Finally, the seed kernel and pulp were mixed at equal proportion and the feed material were then bulked and put in plastic bags until needed for use.

Experimental design and ration formulations

The experiment was organized in a completely randomized design (CRD) with four treatments each with four replications. One hundred sixty unsexed broiler chicks were randomly assigned to the four treatment diets consisting of four replications (Table 1). Accordingly, maize of the control diet (T_1) was replaced by mango fruit waste (MFW) at levels of 10%, 20% and 30% for treatment 2 (T_2), treatment 3 (T_3) and treatment 4 (T_4), respectively.

Table 1. Experimental design of the feeding trial with Cobb-500 broiler chickens

Treatment diets	Proportions of diets	Replications	Birds per replication	Total birds
T_1	100% maize + 0% MFW	4	10	40
T_2	90% maize + 10 % MFW	4	10	40
T_3	80% maize + 20% MFW	4	10	40
T_4	70% maize + 30% MFW	4	10	40
Total			40	160

MFW= Mango fruit waste

Proportion of feed ingredients used to formulate control and treatment starter and finisher rations of Cobb-500 broiler chickens is presented in Table 2. The broiler starter and finisher feed ingredients used for the experiment was purchased from Debrezeit local market and formulated by taking the nutrient composition of each ingredients and balancing with the nutrient requirement of broiler chicks.

Table 2. Proportion of feed ingredients (% as feed basis) of starter and finisher rations of Cobb-500 broiler chickens (n= 4 replications of 10 birds each)

	Starter ration				Finisher ration			
Feed ingredients	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Maize	49.00	44.10	39.20	34.30	58.25	52.42	46.60	41.0
MFW	0.00	4.90	9.80	14.70	0.00	5.83	11.65	17.25
Noug cake*	24.50	24.50	24.50	24.50	21.00	21.0	21.0	21.0
Soybean toasted	23.75	23.75	23.75	23.75	18.0	18.0	18.00	18.0
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L-Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100

MFW= Mango fruit waste
**Guizotia abyssinica*

Experimental animals and their management

The pens were properly cleaned, disinfected, well ventilated, and electrically heated using 250 watt infrared light bulbs and 100 watt red painted lump before the arrival of the chicks. Two-hundred Cobb-500 unsexed day-old broiler chicks were purchased from Alema Farm P.L.C. The chicks were vaccinated against Gomboroo, Lasota and HB1 on days 7, 21and 28, respectively. Mortality was recorded as it occurred and expressed as percent mortality. They were kept in 1.50 m x 1.65 m wire-mesh partitioned deep litter floor housing, which was covered with teff (*Eragrostis tef*) straw litter material at 12 cm depth. The chicks were leg-tagged and weighed individually to determine initial body weights. Ten chicks were randomly distributed to each of the 16 replications making a total of 160 chicks and fed *ad libitum* with formulated control ration for one week (adaptation period). They were fed twice a day at 0800 and 1600 hours throughout the experimental period. Water was available at all times. Feed was offered in plastic plate and round feeders, whereas water was provided in plastic fountains. Vitamin premix was given through drinking water according to the recommendations given by the health professionals.

The refusals were collected, weighed and recorded every day and sample taken for chemical analysis per replicates. The feed refused was weighed after removal of the external contaminants. The birds were fed on starter diet until the age of 3 weeks and on finisher diet up to the end of the experiment (at age of 7 weeks). The feed offered was adjusted for losses due to mortality and culling. Body weight was measured individually according to their identification number at weekly interval.

The daily as well as total feed consumption of the birds were calculated as the difference between the amount of feed offered and refused. The dry matter (DM) and crude protein (CP) intakes were computed by subtracting DM and CP refused from those offered. Similarly, the metabolisable energy (ME) intake was computed by subtracting ME refused from those offered. The daily feed gain ratio (feed conversion ratio) of individual birds was determined as the ratio of daily feed intake to daily body weight gain.

Carcass yield characteristics

At the end of the feeding trial (7 weeks), 2 randomly selected chicks from each replicate were starved for 12 hours and weighed immediately before slaughter. After bleeding, the body was scaled in hot water for a minute and the feather was manually plucked. Then, the birds were eviscerated and carcass cuts were determined according to the procedure described by Kubena et al. (1974) and Kekeocha (1985).

While cutting the total carcass, the breasts, thighs, drumsticks, wings, back, neck, gizzard and liver were separated as most important edible parts and their yield were categorized as carcass weight. Dressing percentage was then calculated as the proportion of carcass weight to slaughter weight multiplied by 100. Abdominal fat was determined to assess the effects of MFW substitution on fat deposition. Fat around the proventriculus, gizzard, the abdominal wall and the cloacae was collected and weighed using sensitive balance. The edible offal (giblets), which included the heart, gizzard and liver were also weighed.

Chemical analysis

The nutrient compositions of feed ingredients and MFW were analyzed at the National Veterinary Institute (NVI), Debre Zeit, Ethiopia. Dry matter (DM), crude fiber (CF) and ash were determined according to AOAC (1990). Nitrogen was determined by kjeldhal procedure and crude protein (CP) was calculated by multiplying N content by 6.25. The metabolizable energy (ME) values were calculated indirectly from the ether extract, CF and ash adopting the equation proposed by Wiseman (1987). Calcium was determined by atomic absorption spectrometer and phosphorus by spectrophotometer after dry ashing. All samples were analyzed in duplicates.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) for completely randomized designs consisting of four treatments by 4 replications using the General Linear Models (GLM) Procedure of Statistical Analysis System (SAS, 2004). When significant differences were observed, treatment means were compared with Duncan's Multiple Range Test. All statements of statistical differences were based on $p<0.05$ unless noted otherwise.

Results and Discussion

Chemical composition of the feeds

The chemical analysis results of starter and finisher diets used in the experiment are presented in Tables 3 and 4, respectively. The protein and energy levels of the four diets used in the study were within the recommended levels for broiler chicks. Babatunde and Fetuga (1976), Fetuga (1984) and Oluyemi and Robert (1988) recommended the protein requirement for broilers raised in the tropics at 23-24% for starter and 19-20% for finisher broiler chickens. In addition, Pfizer (1996) formulated the protein requirement of starter and finisher broiler birds as 23% and 21% in the tropics, respectively. An ME requirement of 2800-3000 kcal/kg has been recommended by Olomu (1976), Olomu and Offiong (1978) and Fetuga (1984) for optimal performance of broilers. Pfizer (1996) however, recommended ME level of 2900 kcal/kg for both starter and finisher rations under local conditions.

The fat content of treatment diets was higher in refusal than in offered ration. This shows that the chicks consume selectively, by consuming the feed with less fat content. This phenomenon was also observed from the physical composition of the ration in which the refusals contained more soybean ingredient than that of offered.

The MFW alone was analyzed for its chemical composition (Table 3) and the results were 6.67% CP, 91.8% DM, 68.1% NFE and 3160 kcal ME per kg DM. In agreement with the current results, El Alaily et al. (1976) reported 6.74 % CP, 91.55 % DM, 77.46% NFE, and 3154 kcal ME per kg DM for MFW. Similarly, Odunsi (2005) reported 6.2% CP, 13.6 % fat, 2.23% ash, 4.64% crude fibre, 67.4% NFE, which were comparable with the current findings.

Table 3. Chemical composition (on DM basis, %) and metabolizable energy (kcal/kg) content of experimental diets used in the starter ration of Cobb-500 broiler chickens

Nutrients	Offered				Refused				MFW	Maize
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4		
DM	91.9	92.7	92.5	92.6	92.3	92.2	92.6	92.0	91.8	91.0
Ash	8.26	8.43	7.75	8.01	10.8	10.5	10.1	11.0	11.0	-
CF	10.3	10.4	10.5	10.3	10.5	11.4	12.1	11.5	9.34	2.00
CP	22.2	23.0	22.1	23.1	22.2	22.0	21.1	20.6	6.67	8.80
EE	8.59	8.59	9.07	9.21	11.0	10.1	10.1	9.44	3.68	-
NFE	42.5	42.3	43.1	41.3	37.6	37.8	38.9	39.4	68.1	79.1
Ca	1.11	1.03	0.95	1.20	1.16	1.18	1.15	1.24	0.21	0.03
P	0.56	0.63	0.53	0.57	0.53	0.62	0.54	0.58	0.21	0.27
ME	3166	3154	3162	3215	3171	3036	2993	2988	3160	3417

MFW= Mango fruit waste; DM= Dry matter; CF= Crude fiber; CP= Crude protein; EE= Ether extract; NFE= Nitrogen free extract; Ca= Calcium; P= Phosphorous; ME= Metabolizable energy

However, the NFE content reported by the same author was higher (77.5%) than the current result (68.1%). Naveen et al. (2006) reported 3.8 % CP, 84.3 % DM and 79.0 % NFE in which the CP and DM values were much lower than found in the current study. The chemical composition of Maize was also analyzed to compare its nutrient content with MFW. Accordingly, maize contained higher CP (8.8 %), NFE (79.1%) and ME (3417 kcal/kg) than MFW. On the other hand, MFW had higher Ca and CF contents than Maize.

Table 4. Chemical composition (on DM basis, %) and metabolizable energy (kcal/kg) content of experimental diets used in the finisher ration of Cobb-500 broiler chickens

Nutrients	Offered				Refused			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Dry matter	93.7	93.8	94.1	93.7	92.4	92.8	92.7	92.2
Ash	9.33	7.17	7.78	7.37	13.0	13.1	12.4	10.7
Crude fiber	10.5	12.3	11.6	8.64	11.5	11.2	13.4	10.9
Crude protein	18.1	17.9	17.8	19.4	22.0	21.1	21.4	20.4
Ether extract	5.52	6.45	4.91	5.11	8.32	8.73	9.38	8.19
NFE	50.2	50.1	51.9	53.4	37.5	38.5	36.1	42.2
Calcium	1.67	1.19	1.21	1.17	3.31	3.11	3.05	3.20
Phosphorous	0.45	0.52	0.48	0.45	0.45	0.42	0.48	0.43
ME	2946	2923	2870	3162	2847	2848	2772	2971

NFE= Nitrogen free extract; ME= Metabolisable energy

Effect of mango fruit waste on nutrient intakes, body weight and feed utilization

As presented in Table 5, no significant differences were observed in average daily feed intake among all treatment diets. This is in good agreement with the results of Reddy (1975) and Odunsi (2005) who reported that mango fruit waste has been successfully used to replace maize up to a 20% level in poultry diets without affecting feed consumption. However, Augustin and Ling (1987) reported a significant decrease of feed intake in chickens as the level of MFW increases. Chickens fed on T_4 had significantly higher intakes of CP and ME during the experimental period than those of the control diet. However, chickens fed on T_2 and T_3 diets had similar protein and energy intakes with those of the control diet (T_1).

The average individual body weight of chickens fed with T_1 and T_2 diets was similar, but was significantly ($P<0.05$) higher than those of T_3 and T_4. As indicated in Table 5 and Figure 1, chickens fed on control diet (T_1) had significantly ($P<0.05$) higher daily weight gain and abdominal fat than those of treatment diets. The increase in total body weight gain in chickens fed on control diet may be due to increase in abdominal fat weight. Among treatment groups, chickens fed on T_4 diet had the lowest daily body weight gain and higher feed to gain ratio than those of control diet.

Table 5. Least square means of feed intakes, feed utilization and body weight gains of Cobb-500 broiler chickens fed on different levels of mango fruit waste

Parameters	T_1	T_2	T_3	T_4	SEM
Feed intake (g/bird)	65.3	65.6	70.8	66.9	2.01
Protein intake (g/bird)	12.1^{b}	12.7^{ab}	12.5^{ab}	13.3^{a}	0.36
ME intake (kcal/kg DM)	1943^{b}	2023^{ab}	2076^{ab}	2144^{a}	51.8
Body weight (g/bird)*	1178^{a}	1165^{a}	1066^{b}	860^{c}	31.2
Daily weight gain (g/bird)	21.0^{a}	17.6^{b}	16.0^{c}	13.7^{d}	0.36
Daily feed gain ratio (g feed/g weight gain)	3.49^{d}	3.96^{c}	4.50^{b}	5.23^{a}	0.11

^{a,b} Means within a row with different superscripts are significantly ($P<0.05$) different
ME= Metabolizable energy; DM= Dry matter; SEM=Standard error of the mean
*Measured at 7 weeks of birds' age

The present findings are in good agreement with those of El Alaily (1976), who reported that, using the processed MFW, where various toxins were removed, has improved chick performance. Similarly, Teguia (1995) and Odunsi (2005) reported a significant increase of body weight and body weight gains in broiler chickens fed up to 10% MFW and then declined. Feed conversion ratio decreased as the levels of MFW substitution increased. According to Reddy (1975), MFW flour was successfully used to replace maize up to a 20% level in poultry diets without affecting efficiency of feed utilization.

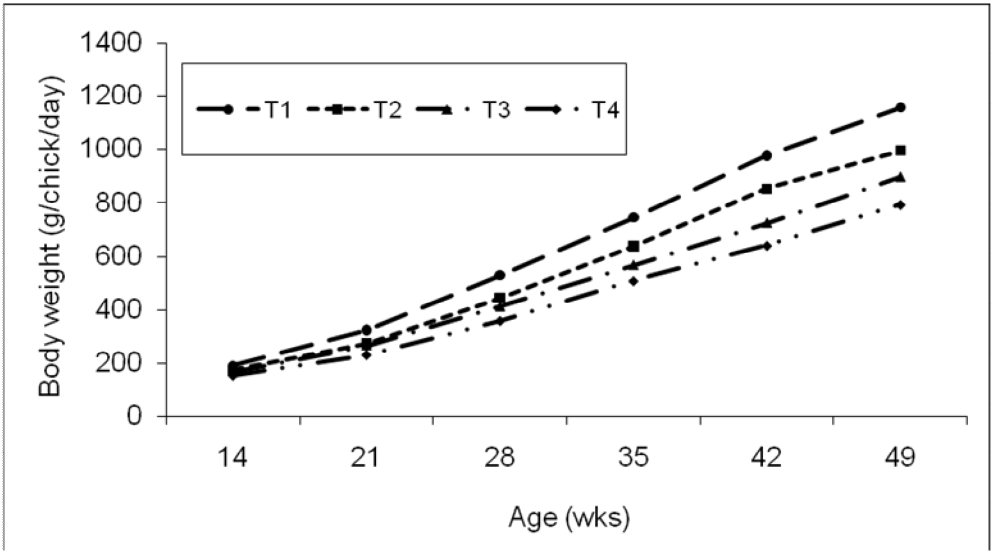

Figure 1. Pattern of body weight development of Cobb-500 broiler chickens fed various levels of mango fruit waste

Carcass yield parameters

As presented in Table 6, birds fed on the control diet had significantly ($P<0.05$) higher slaughter weight than those of treatment diets. Among treatment groups, chickens fed on T_3 and T_4 had similar slaughter weight while those on control diet (T_1) had significantly ($P<0.05$) higher slaughter weight than those of T_2. Nevertheless, the weights of carcass, breast, thighs, drumsticks and dressing percentages did not differ significantly ($P>0.05$) between chickens fed on treatment and control diets, which are in line with the findings of Odunsi (2005). In agreement with the present finding, Okeudo et al. (2005) observed no significant differences in dressing percentage in broiler chicks fed on palm kernel cake. Similarly, Maigualema and Gernat (2003) found no significant differences in dressing percentage by feeding tilapia byproduct for broilers, which is in agreement with the present work.

Scanes et al. (2004) and Maigualema and Gernat (2003) observed 70% dressing percentage for broiler chickens, which is in good agreement with the present study. Similarly, Tegene and Asrat (2010) reported comparable dressing percentage of 67% for Rhode Island Red unsexed chickens fed on fishmeal upto 12 weeks of age. On the other hand, Negussie (1999) observed dressing percentage of 63% for Rhode Island Red chickens kept on choice feeding of energy or protein feeds under intensive and semi intensive management conditions in the central highlands of Ethiopia. Chickens fed on control diet had significantly ($P<0.05$) higher abdominal fat weight than those fed treatment diets. However, birds fed on 10, 20 and 30% MFW diets had similar abdominal fat weights.

Table 6. Least square means of major carcass components of Cobb-500 broiler chickens fed different levels of mango fruit waste

Carcass parameters	T_1	T_2	T_3	T_4	SEM
Slaughter weight (g)	1100^a	990^b	903^c	872^c	28.8
Carcass weight (g)	760	712	634	608	18.3
Breast (g)	258	258	257	253	1.98
Thighs (g)	96.7	95.9	90.2	104	4.27
Drumsticks (g)	90.8	88.6	89.4	87.4	2.79
Dressing percentage	69.1	71.9	70.2	69.7	1.59
Abdominal fat (g)	30.0^a	19.0^b	19.4^b	20.6^b	1.47

^{a,b,c} Means within a row with different superscripts are significantly ($P<0.05$) different
SEM= Standard error of the mean

Mortality

The mortality rate in T_1 and T_2 was 10 and 2.5%, respectively. However, no mortality was observed in those chickens fed on T_3 and T_4 diets. This may be due to the fact that Mango peel contains substances that may have antioxidant properties, polyphenols and mango xanthone, any of which may counteract free radicals in various disease mechanisms as reported by Rodríguez (2006) and Rocha et al. (2007). The kernel of the mango fruit is used widely in Ayurvedic medicines for treatment of different ailments (Berardini et al., 2005).

In summary, the fed intake of birds was not affected by increased level of mango fruit waste up to 20% by substituting the same amount of maize. Body weights of chickens fed on control and 10% mango fruit waste diets was similar. Although not significant, with increasing level of mango fruit waste, the dressing percentage of chickens considerably increased. No mortalities were observed in those chickens fed on 20% and 30% level of mango fruit diets. Thus, from the present study, it can be concluded that, considering the cost of cereal based poultry rations, mango fruit waste could substitute upto 10 of maize in broilers ration without affecting the performance of animals. Moreover, since price of mango fruit waste is cheaper than the price of maize, its utilization as poultry feed would be beneficial to the poultry industry to minimize production expenses associated with high conventional feed costs. This can also reduce the competition between human and poultry for cereals in general and for maize in particular.

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