Growth performance and feed utilization of Hubbard Classic chickens fed on boiled and sundried mango (*Mangifera indica* Linn.) seed kernel

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ABSTRACT

An investigation was undertaken to study the effects of feeding boiled mango seed kernel (BMSK) on the growth performance and feed utilization parameters of Hubbard broiler chicks with the objective of recommending the optimum level of mango seed kernel inclusion in broiler feed. The experiment was arranged in a completely randomized design with four treatments, each replicated three times with 13 birds each. One-hundred fifty-six-day-old chicks with uniform body weight (BW) were used and were distributed randomly to the four diets. The four treatment diets were control (T_1) (100% maize + 0% BMSK), T_2 (95% maize + 5% BMSK), T_3 (90% maize + 10% BMSK) and T_4 (85% maize + 15% BMSK). All the experimental chickens were weighted initially (initial BW) and lasted for 49 days during which growth performance traits were recorded. After 49 days, two birds from each replication were randomly selected and slaughtered to evaluate the effect of BMSK on the final body weight of the chicks. The results on average daily feed intake per bird for T_1 and T_2 were not significantly different, i.e., 71.4 and 70.8 g (P>0.05) but it was significantly higher than that of T_3 and T_4 which was 68.13 and 68.23 g. At the end of 7 weeks, the final BW of chicks fed on T_1 and T_2 were 2657 and 2644, not significantly different, but were significantly higher than that of T_3 and T_4 which were 2610 and 2603 g per bird, respectively. The Average daily BW gain (ADG) for the respective T_1 and T_2 was 53.4, 53.2 g and was significantly (P<0.05) higher than that of T_3 and T_4 which were 52.44 and 52.31 g per bird. The feed conversion ratio (g feed/g gain) for T_1 and T_2 was 1.36, 1.36 and was significantly higher than that of T_3 and T_4 which were 1.33 and 1.33 g per bird, respectively. Inclusion of mango seed kernel up to 15% in broiler nutrition has no detrimental effect, profitable and can be best alternative feed sources in broiler feed if treated well by using the best technical methods of anti-nutritional factors like boiling.

Keywords*:* Boiled Mango Seed Kernel; Broiler; Growth performance; Partial budgeting
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INTRODUCTION

Ethiopia has the largest livestock in Africa and owns about 70 million cattle, 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million mules, and about 8.1 million camels and 57 million poultry (chicken in Ethiopian condition) (CSA, 2021). Poultry production plays an important role in Ethiopia's economy (Nigussu et *al*., 2019). It renders a significant contribution to household income and food security particularly in providing animal protein to the people (Gondwe, 2004). The productivity of poultry industry in general and that of broiler in particular depends on the availability and the accessibility of the feed resources (Aberra *et al*., 2011). If there is a shortage of feed both in an amount and type on time, it is not possible to run poultry farming at all. In modern poultry farming feed plays a crucial role and determines the fate of the farm as core entity (El-Alaily *et al*., 1976).

Not only the availability and accessibility but also the poultry feed must be in a good quality for the normal functioning and profitability of the farm (Yibrehu Emshaw *et al.*, 2012).The feed must be free from any kind of detrimental factors and must contains all the necessary components and well balanced depending on the requirements of the chicken to sustain their productivity and to target the goal of the farm .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 (Atawodi *et al.*, 2008). For the economic efficiency of broiler farming, the feed ingredients of broiler diets are better needed to be a less agronomic problem, need less space and less competition between man and animal which may create a huge gap between the demand and the supply of the consumers (Odunsi and Farinu, 1997)

In Ethiopia, the productivity per unit of bird and the contribution of this sector to the national economy is relatively low due to the feed scarcity and the consequent high price of conventional energy and protein sources (Aberra *et al*., 2011, Nigussu *et al*., 2019). Unfortunately, there is also increasing competition between man and livestock especially poultry for available feedstuff, food, feed and industrial raw materials. Maize is the major energy source in chicken diets at the same time it is also used in human nutrition and creates competition between man and poultry (Bamgbose *et al.*, 2004). This results in high feed cost and unaffordable chicken products therefore, any effort to substitute maize in poultry feed will significantly reduce the cost of production (Bamgbose *et al*., 2004). On the other hand, many countries including Ethiopia is producing a huge amount of mango fruit that yields more than 60% of mango fruit waste like MSK. In the case of Ethiopia, the country is producing a huge amount of mango fruit (which was around 74076 ton in 2020/21)

and feeding the needs of the communities in high land and low land irrigated parts (CSA, 2021). However, there is a huge amount of mango seed kernel which is about 20% of the total production that are disposed in towns and cities and spoiling the area without mobilizing and using of it for any use (CSA, 2021). To solve the above feed crisis and pollution problem mango seed kernel is the best fit and can avail the crisis between both needs. The potential of this Mango seed kernel as animal feed especially as chicken feed have been elaborated on and discussed in detail so that it can help solve the scarcity created between animal and man in general and the poultry sector in particular (El-Alaily *et al*., 1976; Dhingra and Kapoor, 1985; Das *et al*., 1988). Mango seed kernel has been studied and found that it has a high amount of energy, and fat minerals but a lesser percent of crude protein and can easily be processed and used for poultry feed (Patel *et al*., 1971; El Alaily *et al*., 1976). Maize can be replaced with boiled mango seed kernel without any adverse effect if processed and managed for animal feed (Diarra and Usman, 2008).

Mango seed kernel also contains antioxidant vitamins which are used as helminthes in animal health and this suggests that mango seed kernel can be used as an alternative source of vitamins in chicken farming (El Alaily *et al*., 1976). Although Mango seed kernel is selected and used as chicken feed having that huge potential in it, it also contains ant nutrients such as tannins, trypsin inhibitors which make it unsafe and requires further processing and removing of them (Aregheore, 1992). Different processing methods have been suggested to remove these toxic substances from Mango seed kernel and some of them are, soaking, leaching fermentation and others (Aregheore, 1998). 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; Odunsi, 2005).

So, the general objective of the current study was to determine the level of BMSK replacement of maize in broiler's diets through evaluation of their growth performances and partial budgeting while the specific objectives were to recommend the optimum level of treated mango seed kernel inclusion in the broiler diets and to evaluate the growth performance of broiler chicks fed on treated mango seed kernel.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Modjo town on private commercial poultry farm which is located about 72 km South-East of Addis Ababa. The area has a latitude and

longitude of 8°39′N 39°5′E/ 8.650°N 39.083°E, respectively with an elevation of 1781 meters above sea level. The Modjo climate is mild generally warm and temperate with an average annual temperature of 20.1 °C and rainfall of around 863 mm per year and relative humidity of 59.9% (CSA, 2009/10).

Processing method of treating mango seed kernel as feed

The waste of mango fruit was collected from local fruit processing and juice houses in Addis Ababa and Hawassa cities. For the sake of minimizing contamination with other materials in fruit processing houses, wastes of mango were collected in clean plastic materials immediately after squeezing the juice. The collected by-products (wastes) were then spread evenly on plastic sheets and allowed to sundry. After the waste was completely dried in the sun, the seed kernel was obtained by mechanically hammering it with sharp knife and removing the hard seed coat.

The kernel was boiled in tap water at 100 $^{\circ}$C for 20 minutes and again washed with cold water then sun-dried until it has become completely dry to prevent the growth of molds (Mbajunwa, 1995; Teguia and Beynen, 2005; Dakare *et al*., 2012). Then the dried kernel was kept and tied in a clean plastic bag labeled- as boiled mango seed kernel (BMSK) to differentiate it from other feeds. Samples of both raw and BMSK were analyzed for proximate composition (AOAC, 1990) to use in the formulation of the experimental diets. Finally, the dried BMSK was mixed with other ingredients and grounded by a machine (mill) until it has the same size as others conventional poultry feed ingredients with correct sieve size for easily consumption for the chicks.

Experimental diet

Four diets, in which BMSK replaced maize at 0, 5, 10, and 15%, respectively were formulated for the experimental birds. Kernel and diet proximate composition were analyzed by method of AOAC (1990). All the four diets were nearly made to contain isonitrogenous with CP of 21-19% and isocaloric with ME of 2.818-2.918 MJ/kg DM both for starter and finisher broiler feeds.

Experimental Design and Ration Formulations

The experiment was organized in a completely randomized design (CRD) with four treatments each with three replications. One hundred fifty-six Hubbard broiler chicks were randomly assigned to the four treatment diets consisting of three replications (Table 1). Accordingly, maize of the control diet (T_1) was replaced by BMSK at levels of 5%, 10% and 15% for treatment 2 (T_2), treatment 3 (T_3) and treatment 4 (T_4), respectively.

Table 1. Experimental design of the feeding trial with Hubbard Classic.

Treatment diets	Proportions of diets
T_1: Control diet	100% maize + 0% BMSK
T_2: Diet with 5% BMSK	95% maize + 5% BMSK
T_3: Diet with 10% BMSK	90% maize + 10% BMSK
T_4: Diet with 15% BMSK	85% maize + 15% BMSK

Note: Number of replications per treatment = 3, number of birds per replication = 13, total number of birds per treatment = 39.

Table 2. Proportion of feed ingredients of starter and finisher rations of Hubbard broiler chicks.

Feed ingredients	Starter ration				Finisher ration			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
White maize	58.00	55.10	52.20	49.30	68.00	64.60	61.20	57.80
Soybean meal	19.50	19.50	20.00	20.00	18.00	18.00	18.00	18.00
Meat & bone meal	6.36	6.36	6.00	6.00	6.00	6.00	6.00	6.00
Noug seed cake	9.91	9.91	9.57	9.57	3.77	3.77	3.77	3.77
Wheat middling	4.00	4.00	4.20	4.20	2.00	2.00	2.00	2.00
Mango seed kernel	0.00	2.90	5.80	8.70	0.00	3.40	6.80	10.20
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Limestone	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DL-lysine	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
DL-methionine	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total	100	100	100	100	100	100	100	100

The proportion of feed ingredients that were used to formulate control and treatment starter and finisher rations of the chicks is presented in Table 2. The broiler starter and finisher feed ingredients that was used for the experiment were purchased from Debre Zeit local market and food oil producing factory around and then formulated by taking the proximate composition of major ingredients (maize, soybean meal, noug seed cake, wheat middling and BMSK) and balancing with the nutrient requirement of broiler chicks.

Chemical Analysis of Experimental Feeds

The nutrient compositions of feed ingredients and BMSK were analyzed at Ethiopian Institute of Agricultural Research head office (EIAR) laboratory, Addis Ababa, Ethiopia. Dry matter EE, CF and ash were determined according to AOAC (1990). The NFE was calculated indirectly by subtracting all other chemical compositions from 100 and the metabolizable energy (ME) values were also calculated indirectly

from the CP, CF and NFE adopting the equation proposed by Wiseman (1987). All samples were analyzed in duplicates.

Management of experimental animals

For the purpose of decreasing errors and balancing within and between all treatments, pens were properly cleaned, disinfected, well ventilated, and electrically heated before the arrival of the chicks. One-hundred fifty-six Hubbard unsexed day-old broiler chicks were purchased from Passion Farm P.L.C at Denkaka Modjo. All the chicks were vaccinated against Gomboroo, Newcastle disease (Lasota and HB1) on days 5, 21 and 28, respectively, by the health professionals and all other management practices such as removing dead chicks and monitoring their status, ventilating by removing the outer covering of the house during increased temperature and the reverse during decreased temperature, addition of fresh litter material and so on. Mortality was recorded as it occurred and expressed as percent mortality per treatment.

Birds were kept in 1 m × 1.5 m veneer partitioned deep litter floor housing, which was bedded with *teff* straw as a litter material at 7 cm depth. The chicks were weighed in a group containing 13 chicks per replication to determine the initial BW. The thirteen chicks were randomly distributed to each of the 12 replications making a total of 156 chicks and fed with the treatment diets. They were fed 2 times a day at 9:00 am and 2:00pm hours throughout the experimental period. The daily feed offer was given to the birds irrespective to the treatment diets at 30.7 g during the starter phase average (three weeks) and 106.3 g during the finisher phase average (four weeks). 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.

Growth performance measurements

The experiment was conducted for 7 weeks during which some growth performance measurements were considered. The refusals were collected, weighed and recorded every day. The feed refused was weighed after removal of the external contaminants. Body weight was measured at the start as initial BW and weekly per pen according to their pen identification numbers to calculate the BW changes and at the end of the experiment for final BW. The following formulae were used for the calculation viz. Feed intake (g/bird) = Total feed intake by the birds in one group (g) / Total no. of birds in that group and Feed conversion ratio = Average amount of feed consumed (g) / Average gain in body weight (g) Average daily BW gain (ADG) was calculated by dividing the weight difference between 2 consecutive weighings by the number of days in the week.

Partial budget analysis

A partial budget analysis to estimate the economic benefit of each treatment ration was done according to Upton (1979). To estimate the net gain or lose as a result of replacing BMSK for maize, the feed expenses were considered as a variable cost and sale of live chicks was considered as a return. The market price of each feed ingredient was registered at the time of purchase in Birr per kg and the average feed consumed by a bird per kg was calculated and then multiplied by the cost of the ingredient to get the cost of feed per head in Birr for each treatment. The calculation was done by using the formulae; Total Return (TR) was calculated as live weight in kg per chick and multiplied by the price of one kg live weight of a chick at Bishoftu during the experimental period. Net return (NR) = TR-TVC (Total Variable Cost, in this case feed cost). Change in total variable cost (ΔTVC) was calculated as total feed cost of treatments containing BMSK (termed as experimental ration) minus total feed cost of treatments without BMSK (the control diet). The change in TR (ΔTR) was calculated as the difference between total incomes from the respective experimental treatments minus total income of the control. Change in NR (ΔNR) was calculated as NR of the respective experimental treatments minus NR of the control experiment. The marginal rate of return (MRR) was calculated as: MRR = ΔNR/ΔTVC (Nigussu *et al*., 2019).

Data analysis

The collected data were subjected to analysis of variance (ANOVA) for CRD consisting of four treatments and replicated 3 times using the General Linear Models (GLM) in R software versions R3.40.7034.0. Since significant differences were observed in some of the parameters, Tukey's Honest Significant Difference test was used to separate means when the dietary treatment effect was significant according to the following model: $Yij = \mu + Ti + eij$ where Yij = observation; μ = overall mean; Ti = the effect of mango seed kernels (MSK) levels for i = 1–4, 1 = control ration contained 100% maize (0% MSK), 2 = replaced 5% of maize by BMSK, 3=replaced 10% of maize by BMSK and 4 = replaced 15% of maize by BMSK; and eij = the experimental error. All statements of statistical differences or not were based on $P<0.05$ or $P>0.05$ unless noted otherwise.

RESULTS

Chemical Composition of the Experimental Diets

The chemical composition of the starter and finisher ration used in the experiment, was summarized below in Table 3. The CP (% DM), ME (kcal/kg DM) and all others were formulated for both starter and finisher broiler diets depending on the nutrients requirement of broiler chicken referring to the already documented references.

Table 3. Chemical composition of treatment diets used in the starter and finisher rations.

Nutrient composition (%)	Starter ration				Finisher Ration			
	T_1	**T_2**	**T_3**	**T_4**	**T_1**	**T_2**	**T_3**	**T_4**
Dry Matter (%)	88.83	88.92	88.99	89.08	89.08	89.19	89.29	89.39
Crude protein (% DM)	20.63	21.00	21.00	21.00	18.2	18.2	18.2	18.2
Crude fiber (% DM)	4.60	5.00	5.00	5.00	3.49	3.55	3.60	3.66
Ether extract (% DM)	4.68	5.00	5.00	5.00	4.53	4.62	4.70	4.79
NFE (% DM)	48.68	47.37	47.28	47.28	56.56	56.46	56.32	56.20
Ca (% DM)	1.19	1.00	1.00	1.17	1.13	1.14	1.14	1.15
P (% DM)	0.79	1.00	0.80	0.66	0.72	0.72	0.72	0.72
ME (kcal/kg DM)	2817	2818	2815	2815	2913.4	2914	2914.5	2915.1

NFE= Nitrogen free extract; ME= Metabolizable energy; T_1: control diet; T_2: diet with 5% MSK; T_3: diets with 10% MSK; T_4: diets with 15% MSK

Effect of boiled mango seed kernel replacement for maize on feed intake, body weight and feed utilization of Hubbard broiler chicks

As indicated below (Table 4) there was a decrease in feed intake as the level of boiled mango seed kernel increased across the treatment. Higher (P<0.05) feed intake was recorded in chicks placed in control and T_2 diet. As indicated above from the analyzed composition of the diet (Table 3), a diet with 15% BMSK inclusion had a similar metabolizable energy with the rest one. The significantly lower (P < 0.05) feed intake in birds fed with 15% BMSK (Table 4) was also observed; however, the differences in the present study were non-significant (P>0.05) among the treatments.

The average initial BW of all groups are similar as planned and there was no significant (P>0.05) difference among treatments. The average final BW of chickens fed with control and 5% BMSK included diet was significantly (P<0.05) higher than those fed on 10% (T_3) and 15% (T_4) BMSK included diets but no (P>0.05) significant differences between those fed on 10% (T_3) and 15% (T_4) BMSK included

diets. As indicated in Table 4 chickens fed on the control and 5% BMSK (T_2) included diets had significantly (P<0.05) higher daily weight gain (ADG) than those fed on10% (T_3) and 15% (T_4) BMSK included diets. Among treatment groups, chickens fed on 10% (T_3) and 15% (T_4) BMSK included diets had lower ADG, but higher daily feed to gain ratio than those of control and 5% BMSK (T_2) included diet group (P<0.05).

The average FCR (g feed/g gain) of the chicken decreased as the boiled mango seed kernel inclusion increased in the diets (Table 4). Therefore, difference in FCR of treatment groups that fed on 10% BMSK and 15% BMSK inclusion levels were not different. Regarding mortality, the number of died chicks was very few in some of the treatments even zero in the other and this was 2.5%, 5%, and 2.5% in T_1, T_2 and T_4, respectively. However, no mortality was observed in those chickens fed on T_3 diets.

Table 4. Performances of chicken fed different levels of boiled mango seed kernel meal

Parameters	T_1	T_2	T_3	T_4	SEM	P value
Average initial BW (g/bird)	40.43	40	39.72	39.4	0.33	Non
Average final BW (g/bird)	2657^{a}	2644^{ab}	2610^{bc}	2603^{c}	7.67	**
Average daily feed intake (g/bird)	71.38^{a}	70.82^{a}	68.13^{b}	68.23^{b}	0.46	***
ADG (g/bird)	53.4^{a}	53.15^{ab}	52.44^{bc}	52.31^{c}	0.16	**
Daily FCR (g feed/g weight gain)	1.33^{b}	1.28^{d}	1.30^{c}	1.36^{a}	0.01	***
Average feed intake(g/bird)	3569^{a}	3541^{a}	3406^{b}	3411^{b}	23.01	***
Average weight gain (g/bird)	2616^{a}	2604^{ab}	2570^{bc}	2563^{c}	7.69	**
Feed conversion ratio	1.36^{a}	1.36^{a}	1.33^{b}	1.33^{b}	0.01	*
Mortality (%)	2.5	5%	0.00	2.5%	1.09	Non

T_1: control diet; T_2: diet with 5% MSK; T_3: diets with 10% MSK; T_4: diets with 15% MSK

Partial budget analysis

Cost-benefit analysis in terms of partial budget from Hubbard broiler chicks fed a ration containing an increasing level of BMSK replacing maize (Table 11). There was a significant (P<0.05) decrease in the cost of feed (Birr/kg) from the control to the treatment group. There was also a significant (P<0.05) decrease in the feed cost per weight gain from the control diet to the treatment diet. Regarding net return, 116.9, 116.9, 115.6 and 116.1 Birr per bird was obtained from the sale of the chick on control and 5%, 10% and 15% BMSK diets, respectively, for the 7 weeks of experimental period. The marginal rate of return of -0.21 for T_2, 0.62 and 0.19 for T_3 and T_4, respectively were also calculated.

Table 5. Expenses used in broiler experiment

Parameters	Treatment				SEM	P value
	T_1	T_2	T_3	T_4		
Total feed consumed/ head (kg)	3.57[a]	3.54[a]	3.41[b]	3.41[b]	23.01	***
Total feed cost/head (Birr)	48.06[a]	47.05[b]	46.26[c]	45.25[d]	0.31	***
Feed cost (Birr) /BW gain (g)/head	18.37[a]	18.07[b]	18[c]	17.66[d]	0.10	***
Total variable cost (feed cost Birr)	48.06	47.05	46.26	45.25	NA	NA
Δ*TVC* (Birr)	-	-1.01	-1.804	-2.81	NA	NA
Total revenue						
Chick sale (gross return) (TR) (birr)	164.73	163.93	161.8 2	161.39	NA	NA
ΔTR (Birr)	-	-0.8	-2.91	-3.34	NA	NA
Net Return (*NR*)/chick(birr)	116.7[b]	116.9[a]	115.6[d]	116.1[c]	0.15	***
ΔNR (Birr)	-	0.21	-1.11	-0.53	NA	NA
MRR (%)	-	-0.21	0.62	0.19	NA	NA

ΔTVC: Change in total variable cost; ΔTR: Change in total return; ΔNR: Change in net return; MRR: Marginal rate of return; Birr: Ethiopian unit of currency: chick sale= 62 Birr/kg live weight; T_1= 0% MSK; T_2= 5% MSK; T_3= 10% MSK; T_4= 15% MSK as replacement to maize, NA=not analyzed

DISCUSSION

As tried to see from the results, the requirement for both protein and energy levels for starter and finisher of the four diets were found within the recommended levels for broiler chicks. The metabolizable energy of all the treatment feeds is similar and showing that, the added BMSK contained similar content with that of maize and comparable in energy value. Congruent with this (Yibrehu Emshaw *et al*., 2012) found and recommended similar percent of Energy contents for the chicks fed on mango fruit waste. Similarly, the protein contents of BMSK and maize were equivalent and the current protein and energy balance was comparable and within the recommended range for the chicks. Congruent with this Olomu and Offiong (1978) recommended the ME of 2800-3000 kcal/kg as requirement of the chicks. Oluyemi and Robert (1988) also recommended similar percent of protein in tropics for better performance of the chicks. However, ME level of 2900 kcal/kg for both starter and finisher rations under local conditions was also recommended (Pfizer, 1996).

In the present study, there was a decreasing trend of feed consumption observed as the BMSK replacement for maize was increased in the ration. In agreement with the current report, Augustin and Ling (1987) reported a significant decrease of feed intake in chickens as the level of MSK increased. As indicated in the results of this

study the diet with increased BMSK inclusion had the decreased maize content and decreased palatability which might affect the consumption level of the chicks even though the balanced ration contains similar energy and protein across the treatment. Congruent with this report, Jansman *et al.* (1995) observed feed intake increased with decreased contents of ME of the feed and poultry consume feed to meet their energy requirement and *vice versa*. The lower feed intake in birds fed with 15% BMSK inclusion diet agrees with the findings of ME El-Alaily *et al.* (1976) who observed increased feed intake in lower ME content diets containing MSK in comparison to maize. Feed intake observations of the present study are in good agreement with earlier observations (Patle, 1980; Patil *et al.*, 1982).

As indicated above in the result section of this study, the average BW gain of chickens fed with control and 5% BMSK included diet was higher than those fed on 10% (T_3) and 15% (T_4) BMSK included diets but no difference in weight between those fed on 10% (T_3) and 15% (T_4) BMSK included diets and this was congruent with the findings of Yibrehu Emshaw *et al.* (2012) showing no significant difference in weight gain of birds fed 0 and 10% mango fruit waste at the expense of maize in the ration. Similar with the current findings (Kumar *et al*., 2010) was reported that, the weight gain of birds in all the treatment groups that fed on 0 -10% MSK level included diets was similar and has no significant difference. Similarly, chickens fed on the control and decreased BMSK (T_2) included diets had increased ADG than those fed on increased BMSK included diets and Similar results were observed by Ravindran and Sivakanesan (1996), who found a significant depression in performance of growing chicks fed diets containing 200 g MSK containing diet. The decreased BW gain in chickens fed on an increased MSK included diet might be due to the presence of some anti-nutritional factors especially tannin which might not completely removed through this processing methods which will need further combined techniques to do it.

Congruent with this findings Odunsi (2005) observed significant growth depression in broilers fed more than 10% raw MSK as a replacement for maize, while 20% replacement with soaked MSK had no adverse effects on broiler growth. Similarly, Joseph and Abolaji (1997) observed no adverse effects of feeding 10% raw or 20% boiled mango kernel as a replacement for maize on broiler performance (feed intake, weight gain and feed efficiency). Similarly, Patil *et al*. (1982) found depressed body weight gain and feed intake on broiler fed on increased MSK included diet which were due to the presence of TAN, TI and HCN that affect chick performance.

Among treatment groups, chickens fed on 10% (T_3) and 15% (T_4) BMSK included diets had lower ADG, but higher daily feed to gain ratio than those of control and 5% BMSK (T_2) included diet group. This agrees with the results of Yibrehu Emshaw *et*

al. (2012), showing chickens fed on increased MFW diet had the lowest ADG but higher feed to gain ratio than those of control diet. As stated above the BW gain of chickens fed on the control diet was higher and decreased with the increased level of MSK (15% BMSK) in the diet which might affect the feed intake as the level of BMSK inclusion increased across the treatment because the increased MSK diet might have low palatability and coarse structure after completely dried. Similar with the current result, Odunsi (2005) and Teguia (1995) reported a significant increase of BW and ADG in broiler chickens fed up to 10% MSK and then declined as the level of MSK inclusion increased in the ration.

The average FCR (g feed/g gain) of the chicken decreased as the BMSK levels were increased in the ration which is the sign of good performance quality of the chicks although Yibrehu Emshaw *et al.* (2012) reported FCR increased as the levels of MFW substitution increased. In contrast to the current result, Hussain *et al*. (1976) also reported that, the feed efficiency of chickens reduced as MSK inclusion increases in the feed factored by the presence of tannin in MSK. Best feed efficiency among different groups was noted in broiler fed on T_3 and (T_4) diets which has the lowest FCR that indicates best performance quality of the chicks fed on increased BMSK feed. Thus, increasing BMSK to 15% level in broiler ration decreased the amount of feed required for each amount of weight gain and decreased FCR of the chickens. The present findings are in good agreement with those of El Alaily (1976), who reported that, using the processed MSK has improved chick performance. Additionally, the decreased FCR obtained in this result reflected and justified that the treated and processed MSK has no adverse effect on the whole performance of the chicken and it can be substituted the maize with the specified amount.

There was the decline in slaughter weight of chicks across the treatment groups following the increase in level of MSK from 5%-15% in small amount. The reason for decline in slaughter weight as the level of MSK increases might be due to the presence of some anti-nutritional factors like tannin in MSK although some of them may be reduced through boiling as processing method (Dakare *et al*., 2012). This was supported by the findings of (Liener, 1979; Pusztai, 1991) who reported that, Raw MSK contained trypsin inhibitors (TI), tannins (TAN) and cynogenetic glucosides (HCN) at 29.5 $TlUg^{-1}$, 67.4 g kg^{-1} and 70.6mgkg^{-1}, respectively and these bioactive ANF could depress the performance of several animals if not treated well before provision. The current findings are in good agreement with the findings of Yibrehu Emshaw *et al*. (2012), who reported that chickens fed on increased levels of MFW had similar slaughter weight while those fed on diet without MFW (control) had significantly higher slaughter weight than those fed on diets with lower MFW inclusion.

The mortality observed also was very low and even zero in some of the treatment and this also shows the processing methods used above to remove the ANFs were

effective along with the correct biosecurity followed through the whole experimental period. The other reason might also since mango seed kernels contains some important anti-oxidant vitamins and feeding of boiled mango seed kernel may help reduce the risk of diseases and this is in good agreement with the findings of (El Alaily *et al*., 1976). This again was supported by the findings of Berardini *et al.* (2005) as MSK was used widely in Ayurvedic medicines for treatment of different ailments and this also helped prevent chick death throughout the experimental period.

There was a decrease in the cost of feed (Birr/kg) from the control to the treatment group due to the price of mango is much less than that of the maize and these current findings were in good agreement with the findings of Diarra *et al.* (2010). There was also a decrease in the feed cost per weight gain from control diet to treatment diets and this this was obtained because MSK is sold at cheaper rate than maize in the local market and this was in good agreement with the findings of Kumar *et al*. (2010). In line with the current results, Diarra *et al.* (2010) found that, the significant decrease in the feed cost per weight gain from control group to the treatment group with an increased MSK inclusion in the chicken diet.

In the present study, the net return from chicks fed on control diet was higher than that of the treatment groups and there was also a decrease in the net return from T_2 fed chicks to T_4 fed chicks as the level of BMSK inclusion increased from 5% through 10% to 15%. Accordingly, broiler chicks fed on treatment (ration containing 0% MSK and 5% BMSK included) diets returned a higher profit than those fed on ration containing 10% and 15% BMSK diets. The highest net return for T_1 (0% BMSK) in the current study might be due to the higher live BW of the chicks than the treatment groups. In addition, T_1 feed was free from anti-nutritional factors like tannin with compared to the treatment groups which might have suspected anti-nutritional factors including tannin even though not caused a deleterious health effect on the chicks' performance. From the MRR results we can see also minimal difference between the treatment groups. Therefore, under the condition of the current experiment, BMSK can replace maize economically up to 15% without affecting both Net Return and MRR from replacing BMSK by Maize in broiler feed.

CONCLUSION AND RECOMMENDATION

The increased level of boiled mango seed kernels up to 15 % by substituting the same amount of maize has minimal decline but no adverse effect on the feed intake of the chicks. Body weights of chickens fed on control and 15% BMSK diets showed slight difference but not exaggerated. Zero mortality was observed in all chickens fed

on both control and BMSK included diets. Thus, from this study, it can be concluded that, putting the cost of cereal-based poultry rations in considerations, BMSK could substitute up to 15 of maize in broilers ration without affecting the performance of animals. Moreover, since price of mango seed kernel is cheaper than the price of maize, using it as poultry feed would be beneficial to the poultry industry to minimize the production expenses associated with the high conventional feed costs. This can also help to reduce the competition between human and poultry for cereals in general and for maize in particular. Since there were slight differences observed between chicks fed on control and BMSK included diet which might be due to some anti-nutritional factors like tannin which might not completely removed through boiling as treatment methods used in this work, it may need further investigation in this regard.

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