OPEN ACCESS Freely available online

Poultry, Fisheries & Wildlife Sciences

Research Article

Effects of Replacing Maize with Boiled Mango (*Mangifera indica*) Seed Kernel on Feed Intake, Body Weight Gain and Feed Conversion Ratio of Cobb 500 Broiler Chicken

Selassie Admasu[1], Zewdu Wondifraw[2*], Melese Gash[2]

[1]*Department of Animal Science, Mekedela University, Ethiopia;*[2]*Department of Animal Science, College of Agriculture and Natural Resources, Debre Markos University, Debre Markos, Addis Ababa, Ethiopia*

ABSTRACT

This study was conducted to evaluate effects of replacing maize with Boiled Mango Seed Kernel (BMSK) on feed intake, body weight gain and feed conversion ratio of Cobb 500 broiler chicken. A total of 180 unsexed day-old broiler chicks (Cobb 500) were randomly distributed to four dietary treatment groups in a completely randomized design. Each treatment was replicated thrice with 15 birds per replicate. The experimental diets were formulated to contain 0% BMSK+100% maize (T1), 40% BMSK+60% maize (T2), 60% BMSK+40% maize (T3) and 80% BMSK +20% maize (T4) for 48 experimental days. Feed intake, body weight change, Feed Conversion Ratio (FCR) and mortality data were recorded. Feed offered and refused was determined daily, while body weight data was collected on weekly bases. The overall mean of daily Dry Matter Intake (DMI) were 73.8, 74.4, 64.1 and 60.9 g for T1, T2, T3 and T4, respectively. The DMI was the highest (P<0.001) in T1 and T2 as compared to T3 and T4 in the entire experimental period. The overall mean of daily body weight gain was 33.9, 34.7, 27.9, and 24.6 g for T1, T2, T3 and T4, respectively. Birds fed T1 and T2 diets were the highest (P<0.05) in body weight gain, but T4 had the lowest body weight gain performance. The overall mean of FCR were 2.18, 2.15, 2.29 and 2.48 for T1, T2, T3 and T4, respectively in the entire experimental period. The economic efficiency of treatment diets was 2.42, 2.76, 2.65 and 2.54 for T1, T2, T3 and T4, respectively. In conclusion, BMSK can be used as energy source for replacing maize up to 40% as confirmed and indicated in T2 both in starter and finisher broiler diets without adverse effects on broilers performance.

Keywords: Boiled mango seed kernel; Broiler; Feed intake; Feed conversion ratio; Maize.

INTRODUCTION

The livestock sector plays a significant economic role in most developing countries and is essential for the food security of the rapidly growing population. Poultry as one segment of livestock production plays an important economic, nutritional, and socio-cultural role in the livelihood of rural households in many developing countries. However, there are several challenges limiting the profitability of poultry production systems in Ethiopia. According to Dessie et al. [1] poultry feed is one of the most critical constraints to poultry production under both small holder and large-scale systems in Ethiopia. The feed is a single largest item of expenditure costing nearly 70-75% of the overall cost of poultry production [2,3]. The shortage and too expensive cost of commercial energy sources like maize and sorghum for poultry rations have been the main causes of the high cost of poultry products especially in developing countries. In broiler production, corn accounts for about 55% of the feed [4].

Inadequate knowledge, non-availability of alternative and cheaper feed resources, competition between man and poultry for most of the conventional feedstuffs have been identified as the root causes of feed limitation in poultry production [5]. Attention should be directed in the utilization of low cost, highly

*Correspondence to: Zewdu Wondifraw, Department of Animal Science, College of Agriculture and Natural Resources, Debre Markos University, Debre Markos, Addis Ababa, Ethiopia, Tel: 251910172313; Email: zewduwondifraw@gmail.com

Received: February 28, 2020; **Accepted:** May 13, 2020; **Published:** May 19, 2020

Citation: Admasu S, Wondifraw Z, Gash M (2020) Effects of Replacing Maize with Boiled Mango (Mangifera indica) Seed Kernel on Feed Intake, Body Weight Gain and Feed Conversion Ratio of Cobb 500 Broiler Chicken. Poult Fish Wildl Sci 8:211. doi: 10.35248/2375-446X.20.8.211.

available and good quality feed ingredients to reduce the feed cost. To step down the problem of higher and unstable price situation and save the collapse of the poultry industry, there is need to broaden the energy source bases by assessing non-conventional feedstuffs.

Various investigations have shown that Mango Seed Kernel (MSK) is one of the wastes that can be used as ingredient for poultry ration [6]. The world production of mango is estimated to be 42 million tons per year [7]. Mango consists about 33-85% edible pulp, 9-40% inedible kernel, and 7-24% inedible peel [8]. Because of this, a huge amount of waste is produced during processing, which cause a serious disposal problem. According to report of FAO [7], 3.78-16.8 million tons of MSK could be produced from 42 million tons production of mango per year in the world.

Mango seed kernel is a good source of carbohydrates (58-80%), with moderate quantities of protein (6-10%), fat (6-16%) and it is a good source of vitamins and minerals [9,10]. The major problem affecting the nutritional value of MSK is that it contains various anti-nutritional factors [9]. Amongst these factors, tannins are largely responsible for the poor nutritional value of MSK [11]. But drying, soaking, and boiling have been reported to be simple means of detoxifying these feed sources to reduce the presence of anti-nutrients and toxic components [10]. So, 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 without food competition with humans. But there is lack of information about usefulness of mango seed kernel waste as alternative energy source in poultry diet mainly in Ethiopian condition. Therefore, the current study was designed to evaluate the effects of substituting maize with BMSK on feed intake, body weight change, feed conversion ratio and economic efficiency of Cobb 500 broiler chicken.

Materials and Methods

Description of the study area

The study was conducted in Mekane Selam town of Borena district in South Wollo Zone, Ethiopia. Mekane Selam is in 191 km West of Dessie town, 288 km South-East of Bahir Dar capital of Amhara region and 467 km North of Addis Ababa. The geographical coordinates of the district lie within 10°34' to 10°53'N latitude and 38°28' to 38°54'E longitude. The altitude of the district ranging from 1000 to 4000 meters above sea level. The total annual rainfall varies from 889 mm to 1500 mm per year and minimum and maximum annual temperature of the district ranged from 14 to 21°C, respectively.

Collecting and processing of Mango Seed Kernel (MSK)

Fresh mango seeds were collected from different juice houses in Dessie and Kompolcha towns. The kernel was obtained by cutting seed with an axe and then the fresh kernel was cut into small sizes. It was soaked in water for 24 hours and boiled in tap water at 100°C for 30 minutes, to reduce anti-nutritional factors. After boiling, MSK was sun dried for three days by sparsely spreading on canvas. It was frequently stirred manually to facilitate better drying and every evening it was put indoors to minimize reabsorption of moisture.

Experimental chicks and their management

Before the commencement of the actual experiment, the experimental house was cleaned and disinfected with 37% concentrate formalin solution before two weeks to the entrance of chicks. The experimental house was divided into 12 separate pens with the area of 1.05 m^2 (0.07 m^2/bird) and 1.8 m^2 (0.12 m^2/bird) for starter and finisher phases, respectively and covered with six cm depth of wheat straw. Waterers and feeders were thoroughly cleaned and disinfected, then provided for each pen. Each pen was electrically heated with 200-watt electric lamp. The brooder temperature was adjusted with 35°C in the first seven days of age and 2°C temperature was reduced in each week until the temperature reaches 22°C.

One hundred eighty-day old broiler chicks were bought from Alema farm PLC, Debre-Zeit. All broiler chicks were weighed and randomly distributed to four treatment rations, using Completely Randomized Design (CRD). Experimental chicks were offered their respective rations twice per day at 7:00-7:30 AM and 6:00-6:30 PM and fed for 1-24 and 25-48 days starter and finisher ration, respectively. Standard vaccination schedule was done, and strict sanitary measures were followed during the experimental period depending on the veterinarians' guideline. Daily chick mortality was recorded until the end of the experiment in each replication and treatment.

Experiment layout

Day old experimental chicks (Cobb 500) were randomly distributed to four dietary treatment groups in a CRD. Each treatment was replicated thrice with 15 birds per replicate. The control diet (T1) was formulated by using maize as the major energy source without Boiled Mango Seed Kernel (BMSK) and other treatment diets (T2, T3 and T4) were formulated using different levels of BMSK meal to partially replace maize in the ration

Experimental diet and ingredients

The feed ingredients used in the formulation of experimental diets were maize (Zea mays), Soybean Meal (SBM) (Glycine max), Wheat Middling (WM), Noug Seed Cake (NSC) (Guizotia abyssinica), Boiled Mango Seed Kernel (BMSK), methionine, lysine, bone meal, limestone and salt. The ingredients namely: maize, SBM, NSC, BMSK and salt were milled to pass through 3- and 4-mm sieve size for starter and finisher diets, respectively. Those ingredients were mixed with other ingredients using mixer machine. The rations were formulated based on the chemical analysis results of the ingredients. The experimental rations were formulated to be iso-caloric and iso-nitrogenous with 3000 kcal ME/kg DM and 22% CP for starter and 3200 kcal ME/kg DM and 20% CP for finisher phase to meet broiler requirements [12]. The rations were prepared based on 36% maize inclusion level in the control group of the broilers diet. Therefore, both starter and finisher experimental rations were formulated as: T1=0% BMSK+100% maize; T2=40% BMSK

+60% maize; T3=60% BMSK+40% maize; T4=80% BMSK +20% maize (Table 1).

Table 1: Proportion of feed ingredients and calculated nutrient composition of diets by treatment in starter and finisher phases.

	Starter phase				Finisher phase			
Ingredient (%)	**T1**	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**
Maize	36	21.6	14.4	7.2	36	21.6	14.4	7.2
BMSK	0	14.4	21.6	28.8	0	14.4	21.6	28.8
Wheat middling	13.5	13.5	13.5	13.5	27	27.2	27.4	27.6
Soybean meal	24.5	24.2	24	23.5	24	23.8	23.6	23.4
Noug seed cake	22.5	22.8	23	23.5	9.5	9.5	9.5	9.5
Lysine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bone meal	1	1	1	1	1	1	1	1
Lime stone	1	1	1	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100	100	100
Calculated nutrient composition								
CP (%DM)	22.47	22.36	22.3	22.22	20.55	20.45	20.35	20.26
ME (kcal/kg)	3056.8	3056.8	3056.5	3054	3178.2	3180.8	3182.3	3183.8

Note: T1=Diet containing 0% BMSK+100% Maize, T2=Diet containing 40% BMSK+60% Maize, T3=Diet containing 60% BMSK+40% Maize, T4=Diet containing 80% BMSK+20% Maize, BMSK=Boiled Mango Seed Kernel, CP=Crude Protein, Dry Matter, ME=Metabolizable energy, kcal=kilo calorie

Measurements

Experimental chicks were weighed individually throughout the experimental period in weekly interval bases in the morning before feed offering. The average weight was obtained after dividing the total weight of birds in a pen by the number of birds within the pen. The feed offered and refused were weighed and recorded every day to estimate the feed intake of birds for each replicate and treatment. Feed intake was determined as the difference of the quantity of feed offered and refused. The dry matter and nutrients (CP, ME, CF, and Ca) intakes were determined after the nutrient content of formulated rations and refusals were analyzed in the laboratory. Dry matter and nutrient intakes were calculated by the difference of offered and refused on dry matter basis. Average total feed intake per bird in each replicate was obtained by dividing total feed intake in the replicate to the number of birds within a replicate, and the actual daily feed intake was obtained by dividing average total feed intake to the total growth period. Feed conversion ratio (FCR) was calculated by dividing feed consumed in dry mater basis (g) to the live weight gain (g). Similarly, nutrient conversion ratio was calculated as ratio of total nutrient intake (g) to mean body weight gain.

Economic efficiency

To calculate the economic efficiency of broiler production, the amount of feed consumed during the entire experimental period and the final live body weight were considered. An economic evaluation of experimental diets was performed as the feed cost needed to obtain one kilogram of live body weight. The economic efficiency was calculated by the proportion of net revenue and feed cost for total gain [13].

Chemical analysis

Representative samples from each feed ingredients used for the experiment were analyzed before formulating the actual dietary treatments. Samples from each mixed ration were taken to evaluate the nutrient contents, and refusal sample from each treatment of starter and finisher phase were taken to calculate dry matter and nutrient intake. The feed chemical analysis was done in Debre Birhan Agriculture Research Center. The feed samples were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Crude Fiber (CF), ash and Ca using the proximate analysis method of the AOAC [14]. The N content was analyzed in laboratory by Kjeldhal procedure of nitrogen analysis and Crude Protein (CP) was calculated by the formula CP=N x 6.25. Metabolisable Energy (ME) of ingredients and experimental rations was calculated by indirect methods as follows:

ME (kcal/kg DM)=3951 + 54.4 EE - 88.7 CF - 40.8 ash [15]

Statistical analysis

Data was subjected to Analysis of Variance (ANOVA) for Completely Randomized Design (CRD) consisting of three replications per treatment using the General Linear Model (GLM) procedure of statistical analysis system [16] version 9.4. When F-test declare significance difference at ($P<0.05$), further group mean separation among treatment means was done using Tukey test. The statistical model used for data analysis was:

$Y_{ij} = \mu + t_i + e_{ij}$,

Where: Y_{ij}=the response variable

μ =overall mean

t_i=treatment effect

e_{ij}=random error

Results and Discussion

Chemical composition of feed ingredients

Chemical composition of feed ingredients (mango seed kernel, maize, wheat middling, soybean meal and noug seed cake) used for starter and finisher ration formulation are presented in Table 2. The result of laboratory analysis showed that the dry matter (DM), crude protein (CP) and metabolizable energy (ME) contents of boiled mango seed kernel (BMSK) were comparable to that of maize. However, ether extract (EE) and ash contents of BMSK obtained in the study were higher than maize. Dry matter and CP contents of BMSK in the current study are in line with the report of Diarra et al. [10], who noted 90.21% DM and 7.72% CP. The CP, CF, and ash contents of BMSK are higher than the value of Nzikou et al. [17], who reported 6.36%, 2.02% and 3.2% for CP, CF, and ash, respectively. The EE content of BMSK is lower than the report of Jadhav and Siddiqui [18], who noted 9.0% EE. Metabolisable energy content of the current study is in line with 3502.24 kcal/kg DM which was reported by Diarra et al. [10]. The chemical composition of BMSK in the current study showed some variations from the reports of some authors which might be due to variety of mango, growing environment, handling, and processing methods [10,19].

Table 2: Chemical composition of feed ingredients used to feed formulation (%DM).

	Chemical composition (%)						
Ingredient	**DM**	**Ash**	**CP**	**CF**	**EE**	**Ca**	**ME(Kcal/kg DM)**
BMSK	92	4.73	8.98	3.98	5.08	0.32	3681.22
Maize	91	2.04	8.44	4.25	2.14	0.26	3696.02
Wm	90.5	3.49	17.41	7.83	2.35	0.12	3296.29
SBM	94	5.58	40.23	7.56	2.01	0.68	3073.74
NSC	95	8.37	31.23	18.71	7.73	0.37	2370.95

Note: DM: Dry Matter; CP: Crude Protein; CF: Crude Fiber; EE: Ether Extract; Ca: Calcium; ME: Metabolizable Energy; Kcal: Kilo Calorie; BMSK: Boiled Mango Seed Kernel

Chemical composition of mixed diets and refusals

The nutrient composition of formulated rations and refusals in starter and finisher phases are presented in Table 3. The CP and ME contents of mixed rations in the current study are almost in line with the recommended levels of 22% and 20% CP for iso-nitrogenous, and 3000 and 3200 kcal/kg DM for iso-caloric requirement of broilers during the starter and finisher phases, respectively. Crude protein and energy contents of mixed diets were slightly higher than refused and crude fiber in both phases and ether extract content of treatment diets in finisher phase were higher in refusal than in offered ration.

Table 3: Chemical composition of mixed diets and refusals by treatment in starter and finisher phases

	Starter phase				Finisher phase			
Chemical composition (%)	**T1**	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**
DM (%)	92.54	92.6	93	92.94	91.91	91.2	91.88	92
CP (%DM)	21.98	22.25	22.36	22.18	20.23	20.29	20.26	20.54
ME (Kcal/kg)	3076.2	3087.1	3087.2	3060.7	3223	3218.4	3203.4	3213.1
Ash (%DM)	7.29	7.46	6.76	7.56	6.19	6.32	6.65	6.76
EE (%DM)	3.14	3.32	3.35	3.41	3.11	3.28	3.4	3.42
CF (%DM)	8.43	8.34	8.56	8.65	7.27	7.37	7.45	7.31
Ca (%DM)	1.25	1.2	1.22	1.27	1.1	1.06	1	1.03
Refusal chemical composition								
DM (%)	92.95	93	92.92	93.37	91.77	91	90.98	91.2
CP (%DM)	21.35	21.53	21.8	21.45	20.12	19.96	19.81	19.9
ME (Kcal/kg)	2939.8	2944	2950.8	2953.2	3070.9	3082.4	3066.6	3069.7
Ash (%DM)	8.41	8.27	8.28	8.45	7.24	7.1	7.74	7.05
EE (%DM)	3.43	3.22	3.25	3.51	4.24	4.37	4.2	4.1
CF (%DM)	9.64	9.53	9.46	9.51	9.19	9.21	8.98	9.21
Ca (%DM)	1.2	1.13	1.15	1.02	1.07	1.03	1.02	1.01

Note: T1=Diet containing 0% BMSK+100% Maize, T2=Diet containing 40% BMSK+60% Maize, T3=Diet containing 60% BMSK+40% Maize, T4=Diet containing 80% BMSK+20% Maize, BMSK=Boiled Mango Seed Kernel, DM=Dry Matter, ME=Metabolisable Energy, CP=Crude Protein, Kcal=Kilo Calorie, EE=Ether Extract, CF=Crude Fiber

Dry matter and nutrient intake of Cobb 500 broilers

The mean daily dry matter and nutrients intake of Cobb 500 broilers during the starter and finisher phases as well as the whole experimental period are presented in Table 4. The result showed that significant differences ($P<0.001$) for total and daily DMI, and nutrients intake of broiler chickens were observed among treatment diets during the starter phase, finisher phase and entire experimental period. Birds fed in T1 and T2 got the highest ($P<0.001$) DM and nutrients intake than birds in T3 and T4 across all experimental periods. However, there was no significant difference ($P\geq0.05$) of DM and nutrient (CP, ME, CF, and Ca) intake between T1 and T2. The lowest ($P<0.001$) DM and nutrient intake of broilers was found in T4 followed by T3 during starter and finisher phases, and the entire experimental period.

The decreased in DM and nutrient intake of broilers with increasing of BMSK replacement level to 60% and 80% on groups fed T3 and T4 across all experimental periods might be due to the depressed feed intake in case of higher tannin contents in BMSK [11]. Tannins are known for their astringent taste [20], suggesting a reduction in the palatability of the diets, because 0.5% tannic acid in diets reported to reduce feed intake of chickens [21]. The present finding agrees with the finding of Diarra et al. [22], who reported that dry matter intake was significantly improved up to 40% BMSK substitution of maize in broiler ration and declined at 60% substitution level. Similarly, Diarra et al. [10] noted that the dry matter and nutrients intake were decreased with increased of BMSK above 50% in the rations at entire experimental period. The current result is also in agreement with Diarra and Usman [6], who reported that feed and nutrients intake was decreased when MSK increased in broiler rations. Unlike the current finding, Amao and Siyanbola [23] reported adverse effect on feed consumption of broiler chickens was occurred when broilers fed 30% heat treated MSK as replacement of maize.

Table 4: The average DM and nutrient intake of Cobb 500 broilers during starter phase, finisher phase and entire experimental period.

	Experimental diets					
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**P**
Starter phase (1-24 days)						
Total DM intake (g/bird)	1078.6[a]	1071.9[a]	968.8[b]	908.4[c]	5.821	0.001
Daily DM intake (g/bird)	44.9[a]	44.7[a]	40.4[b]	37.9[c]	0.243	0.001
Daily CP intake (g/bird)	10.2[a]	10.3[a]	9.3[b]	8.7[c]	0.113	0.001
Daily ME intake (Kcal/bird)	144.4[a]	144.3[a]	130.1[b]	119.9[c]	1.571	0.001
Daily CF intake (g/bird)	4.1[a]	4.0[a]	3.8[b]	3.6[c]	0.03	0.001
Daily Ca intake (g/bird)	0.60[a]	0.60[a]	0.50[b]	0.48[c]	0.006	0.001
Finisher phase (25-48 days)						
Total DM intake (g/bird)	2465.3[a]	2498.4[a]	2110.1[b]	2013.2[c]	17.905	0.001
Daily DM intake (g/bird)	102.7[a]	104.1[a]	87.9[b]	83.9[c]	0.747	0.001
Daily CP intake (g/bird)	20.9[a]	21.5[a]	18.2b	17.8[b]	0.366	0.001
Daily ME intake (Kcal/bird)	346.7[a]	349.2[a]	293.7[b]	281.6[c]	3.705	0.001
Daily CF intake (g/bird)	7.7[a]	8.0[a]	5.2[b]	4.3[c]	0.22	0.001
Daily Ca intake (g/bird)	1.2[a]	1.2[a]	0.9[b]	0.8[c]	0.006	0.001
Entire experimental period (1-48 days)						
Total DM intake (g/bird)	3543.9[a]	3570.3[a]	3078.9[b]	2921.6[c]	20.167	0.001
Daily DM intake (g/bird)	73.8[a]	74.4[a]	64.1[b]	60.9[c]	0.419	0.001
Daily CP intake (g/bird)	15.6[a]	15.9[a]	13.8[b]	13.2[c]	0.141	0.001
Daily ME intake (Kcal/bird)	245.6[a]	246.8[a]	211.9[b]	200.8[c]	2.289	0.001
Daily CF intake (g/bird)	5.9[a]	6.0[a]	4.5[b]	4.0[c]	0.113	0.001
Daily Ca intake (g/bird)	0.88[a]	0.89[a]	0.71[b]	0.67[c]	0.005	0.001

Note: [abc]Means within the same row with different superscript letters are significantly different (P<0.05), T1=Diet containing 0%BMSK+100% Maize, T2=Diet containing 40% BMSK+60% Maize, T3=Diet containing 60% BMSK+40% Maize, T4=Diet containing 80% BMSK+20% Maize, BMSK=Boiled Mango Seed Kernel, SEM=Standard Error of the Mean, DM=Dry Matter, ME=Metabolisable Energy, kcal=Kilo Calorie, CP=Crude Protein, CF=Crude Fiber

Body weight change and mean mortality of Cobb 500 broilers

The body weight changes and mean mortality of broilers during the starter phase, finisher phase and the whole experimental period are presented in Table 5. Mean initial body weights of day-old chicks were similar ($P \geq 0.05$) among all treatment groups. The highest (p<0.001) final weight, total and daily weight gain were observed on birds in T1 and T2 compared to birds in T3 and T4 across all experimental periods. Significantly the lowest (P<0.001) final weight, total and daily weight gain were found in T4 in starter and finisher phase, and entire experimental period. There was significant difference (P<0.001) between T3 and T4 in case of final weight, total and daily weight gain across all experimental period. The reason of the highest weight gain in T1 and T2 might be due to the highest DM and nutrient intake in T1 and T2 across all experimental periods. On the other hand, the lowest (P<0.001) weight gain of birds in T3 and T4 is presumably with fairly rich content of tannins in mango seed kernel, which progressively lead to less feed utilization efficiency and reduce body weight gain when included as a major component (when tannin content reach 0.5%) in the diet of broilers [24].

The current result is in line with the report of Joseph and Abolaji [25], who found higher weight gain on birds fed from 0% to 36% BMSK substitution of maize diets than 46% BMSK substitution. Similarly, Abdulahi [26] reported lower weight gain on 60% BMSK substitution of maize compared to control group in starter phase. Also, similar result is reported by Amao and Siyanbola [23], who noted body weight gain was not affected by 30% heat treated MSK substitution in finisher diet. However, this result disagrees with the report of Diarra et al. [22], who noted that total and daily weight gain of broilers were significantly improved on the 60% BMSK substitution of maize compared with 0%, 20% and 40% substitution levels. Mortality in each replication was recorded in the entire experimental period. Totally 8 birds were died in experimental period. However, mortality mean had no significant difference (P ≥ 0.05) among all treatment groups across all experimental periods.

Table 5: Average body weight changes and mean mortality of Cobb 500 broilers in starter phase, finisher phase and entire experimental period.

	Experimental diets					
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**P**
Starter phase (1-24 days)						
Initial body weight (g/bird)	45.9	45.8	45.4	45.4	0.274	0.165
Final body weight (g/bird)	646.0^{a}	641.3^{a}	551.0^{b}	454.0^{c}	3.128	0.001
Total body weight gain (g/bird)	600.2^{a}	595.9^{a}	505.1^{b}	408.6^{c}	3.049	0.001
Daily body weight gain (g/bird)	25.0^{a}	24.8^{a}	21.0b	17.0c	0.127	0.001
Mean mortality	0.33	0.33	0.67	0.67	0.577	0.802
Finisher phase (25-48 days)						
Initial body weight (g/bird)	646.0^{a}	641.3^{a}	551.0^{b}	454.0^{c}	3.128	0.001
Final body weight (g/bird)	1672.0^{a}	1710.0^{a}	1387.0^{b}	1225.0^{c}	24.465	0.001
Total body weight gain (g/bird)	1026.0^{a}	1068.7^{a}	836.0^{b}	771.0^{c}	23.426	0.001
Daily body weight gain (g/bird)	42.8^{a}	44.5^{a}	34.8^{b}	32.1^{c}	0.977	0.001
Mean mortality	0	0	0.33	0.33	0.408	0.596
Entire experimental period (1-48 days)						
Initial body weight (g/bird)	45.9	45.8	45.4	45.4	0.274	0.165
Final body weight (g/bird)	1672.0^{a}	1710.0^{a}	1387.0^{b}	1225.0^{c}	24.465	0.001
Total body weight gain (g/bird)	1626.2^{a}	1664.6^{a}	1341.1^{b}	1179.6^{c}	24.424	0.001
Daily body weight gain (g/bird)	33.9^{a}	34.7^{a}	27.9^{b}	24.6^{c}	0.508	0.001
Mean mortality	0.33	0.33	1	1	0.408	0.12

Note: ^{abc}Means within the same row with different superscript letters are significantly different (P<0.05), T1=Diet containing 0%BMSK+100% Maize, T2=Diet containing 40% BMSK+60% Maize, T3=Diet containing 60% BMSK+40% Maize, T4=Diet containing 80% BMSK+20% Maize, BMSK=Boiled Mango Seed Kernel, SEM=Standard Error of the mean

Feed and nutrient conversion ratio

The feed and nutrient conversion ratios of broilers are presented in Table 6. The poorest (P<0.001) FCR was recorded in T4 followed by T3 and the best (P<0.001) FCR was observed in T1 and T2; however, there was no variation (P ≥ 0.05) between T1 and T2 in starter phase, finisher phase and the entire experimental period. This result indicates that feed utilization efficiency of birds in T4 was lower compared with birds in T1, T2 and T3 across all experimental periods. The poorest ($P<0.05$) protein conversion ratio was observed in T4 than other three treatment groups across all experimental periods. However, no significant variation ($P \geq 0.05$) were observed among T1, T2 and T3 in starter phase, and it was improved ($P<0.05$) in T1 and T2 in finisher phase and the entire experimental period. The poorest ($P<0.05$) ME conversion ratio was observed in T4 compared with other three treatments and no significant variation ($P \geq 0.05$) were observed among T1, T2 and T3 in starter phase and the entire experimental period. There was no significant variation ($P \geq 0.05$) among all treatments in case of ME conversion ratio in finisher phase. Calcium conversion ratio of birds in T4 was the poorest ($P<0.001$) compared with T1, T2 and T3 in starter phase. However, there were no variations ($P \geq 0.05$) among T1, T2 and T3 in starter phase and all treatment groups in finisher phase and the entire experimental period.

The reason of low feed and nutrient utilization efficiency in T3 and T4 might be due to higher anti-nutritional factors (tannins, phytates, cyanide, antitrypsin, oxalate and saponins) in higher MSK inclusion diets [11]. The current result disagrees with the report of Kumar et al. [27], who described FCR improved as MSK levels increased in broiler ration. However, the result is in agreement with the finding of Diarra et al. [22], who reported non-significant difference in control diet and 40% BMSK substitution of maize diet, but FCR was decreased at 60% substitution of maize as noted by the same author. Generally the current result indicated, substitution of maize with BMSK at about 40% in broiler ration did not affect feed and nutrient conversion ratio.

Table 6: Effect of replacing maize with BMSK on feed and nutrient conversion ratio.

	Experimental diets					
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**P**
Starter phase (1-24 days)						
Feed conversion ratio (g DMI/g gain)	1.80^{c}	1.80^{c}	1.92^{b}	2.22^{a}	0.018	0.001
Protein conversion ratio (g CPI/g gain)	0.41^{b}	0.42^{b}	0.44^{b}	0.51^{a}	0.006	0.003
Energy conversion ratio(kcal MEI/g gain)	5.78^{b}	5.82^{b}	6.2^{b}	7.05^{a}	0.088	0.036
Crude fiber conversion ratio (g CFI/g gain)	0.16^{c}	0.16^{c}	0.18^{b}	0.21^{a}	0.003	0.001
Calcium conversion ratio (g CaI/gain)	0.02^{b}	0.02^{b}	0.02^{b}	0.030^{a}	0	0.001
Finisher phase (25-48 days)						
Feed conversion ratio (g DMI/g gain)	2.40^{c}	2.34^{c}	2.52^{b}	2.61^{a}	0.043	0.001
Protein conversion ratio (g CPI/g gain)	0.49^{c}	0.48^{c}	0.52^{b}	0.55^{a}	0.008	0.004
Energy conversion ratio (kcal MEI/g gain)	8.1	7.85	8.44	8.77	0.152	0.414
Crude fiber conversion ratio (g CFI/g gain)	0.18^{a}	0.18^{a}	0.15^{b}	0.13^{c}	0.003	0.001
Calcium conversion ratio (g CaI/gain)	0.03	0.03	0.03	0.03	0.003	0.441
Entire experimental period (1-48 days)						
Feed conversion ratio (g DMI/g gain)	2.18^{c}	2.15^{c}	2.29^{b}	2.48^{a}	0.027	0.001
Protein conversion ratio(g CPI/g gain)	0.46^{c}	0.46^{c}	0.49^{b}	0.54^{a}	0.006	0.007
Energy conversion ratio(kcal MEI/g gain)	7.24^{b}	7.11^{b}	7.59^{b}	8.16^{a}	0.113	0.029
Crude fiber conversion ratio(g CFI/g gain)	0.17	0.17	0.16	0.16	0.005	0.095
Calcium conversion ratio (g CaI/gain)	0.03	0.03	0.03	0.03	0.001	0.159

Note: [abc]Means within the same row with different superscript letters are significantly different (P<0.05), T1=Diet containing 0%BMSK+100% Maize, T2=Diet containing 40% BMSK+60% Maize, T3=Diet containing 60% BMSK+40% Maize, T4=Diet containing 80% BMSK+20% Maize, BMSK=Boiled Mango Seed Kernel, SEM=Standard Error of the Mean, DMI=Dry Matter Intake, MEI=Metabolisable Energy Intake, CPI=Crude Protein Intake, CFI=Crude Fiber Intake, CaI=Calcium Intake, Kcal=Kilo calorie

Economic efficiency

The economic analysis of the experimental diets of Cobb 500 broilers fed maize and BMSK based diets is presented in Table 7. Feed cost in the current study was evaluated based on the current market cost of the ingredients and was significantly difference (P<0.001) among all treatment groups. When substitution of BMSK increased in the diet of broilers, feed cost per kg was decreased. As a result, the highest (P<0.001) total feed cost and feed cost per kg was observed in T1, and the lowest (P<0.001) total feed cost and feed cost per kg were found in T4 compared to other treatments. The highest and the lowest (P<0.001) feed cost per kg weight gain were obtained in T1 and T2, respectively. The highest and the lowest (P<0.001) net revenue were observed in T2 and T4, respectively. The highest and the lowest (P<0.001) EE was in T2 and T1, respectively. The reduction of feed cost (Birr/kg) with the increasing level of BMSK is the result of the price difference between BMSK and maize at the time of the experiment. Similarly, the highest economic efficiency in T2 is the reason of low feed cost and higher body weight gain in T2.

Table 7: Economic analysis of Cobb 500 broilers fed maize and BMSK based diets.

	Experimental diet					
Parameters	T1	T2	T3	T4	SEM	P
Total feed cost (Birr/bird)	42.83^a	39.86^b	33.01^c	29.94^d	0.201	0.001
Feed cost/kg gain (Birr)	26.34^a	23.95^d	24.62^c	25.38^b	0.182	0.001
Feed cost/kg (Birr)	11.04^a	10.20^b	9.800^c	9.36^d	0.016	0.001
Total revenue (Birr)	146.22^b	149.66^a	120.58^c	106.06^d	0.406	0.001
Net revenue (Birr)	103.38^b	109.80^a	87.57^c	76.11^d	0.463	0.001
Economic efficiency	2.42^d	2.76^a	2.65^b	2.54^c	0.027	0.001
Relative economic efficiency	1	1.14	1.1	1.05	NA	NA

Note: [abcd]Means within the same row with different superscript letters are significantly different (P<0.05), T1=Diet containing 0%BMSK+100% Maize, T2=Diet containing 40% BMSK+60% Maize, T3=Diet containing 60% BMSK+40% Maize, T4=Diet containing 80% BMSK+20% Maize, BMSK=Boiled Mango Seed Kernel, SEM=Standard Error of the Mean, NA=Non Analysed.

Conclusion

Mango seed kernel has potentially an attractive alternative nutritional attribute that are useful when considering its inclusion in poultry diets. Based on this study it can be concluded that, feed intake, body weight change and feed conversion ratio of chickens fed on control and 40% mango seed kernel diets were similar. The performances of broilers were depressed when substitution level of mango seed kernel increased to 60% and 80% during the whole experimental period. The cost of MSK is cheaper than the cost of maize, its utilization as poultry feed will be beneficial to the poultry industry to minimize production expenses associated with high conventional feed costs. In addition, feeding of mango seed-kernel waste for broiler is so important on solving the problem of competition between poultry and humans for cereal grains. Similarly, utilization of mango seed kernel waste for poultry ration will reduce the disposal problems of such wastes.

REFERENCES

1. Dessie TW, Esatu LV, Waaij F, Zegeye S, Gizaw O, Mwai, et al. Village chicken production in the Central and Western highlands of Ethiopia: Characteristics and strategies for improvement. International livestock research institute, Nairobi, Kenya. 2013.
2. Martinez WS. Vertical coordination in the pork and broiler industries: implications for pork and chicken products. Agricultural Economic Report No 777, U.S. Department of Agriculture, Washington D.C. 1999.
3. Parthasarathy R, Kadrivel R, Kathaperumal V. Azolla as a partial replacement for fishmeal in boiler rations. Ind Vet J. 2002;79:144-146.
4. Mourao JL, Pinheiro VM, Prates JM, Bessa RJ, Ferreira LM, Fontes CM. Effect of dietary dehydrated pasture and citrus pulp on the performance and meat quality of broiler chickens. J poul sci. 2008;87:733-743.

5. Afolayan SB, Dafwang I, Tegbe TS, Sekoni A. Response of Broiler Chickens Fed on Maize-based Diets Substituted with Graded Levels of Sweet Potato Meal. Asian J Poul Sci. 2012;6:15-22.
6. Diarra S and Usman BA. Growth performance and some blood variables of broiler chickens fed raw or boiled mango kernel meal. Int j poul sci. 2008;7:315-318.
7. FAO (Food and agriculture organization of the United Nations). Top producers of mangoes, mango stems and guavas. 2015.
8. Berardini N, Knodler M, Schieber A, Carle R. Utilization of mango peels as a source of pectin and polyphenolics. Innovative Food Sci Emerg Tech 2005;6:442-452.
9. Fowomola MA. Some nutrients and anti-nutrient contents of mango (Mangifera indica) seed. African J Food Sci. 2010;4:472-476.
10. Diarra S, Saleh B, Kwari ID, Igwebuike JU. Evaluation of boiled mango kernel meal as energy source by broiler chickens in the semi-arid zone of Nigeria. Int J Sci Nature. 2011;2:270-274.
11. Dakare MA, Danladi A, Abel S, Sunday EA. Effects of processing techniques on the nutritional and anti-nutritional contents of mango (Mangifera indica) seed. 2012.
12. NRC (National Research Council). Nutrient requirements of poultry 9th revised edition. National academy press, Washington, D. C., USA. 1994.
13. Waheed A and Eltaieb I. Inclusion of some wastes in rabbit diet. Alazhar University. 2005.
14. AOAC (Association of Official Analytical Chemists). International official method of analysis, 17th edn. Association of official agricultural chemists, Maryland, USA. 2000.
15. Wiseman J. Feeding of non-ruminant livestock. Butterworth and C. Ltd. 1987;370.
16. SAS (Statistical Analysis Systems) institute. SAS/STAT user's guide. Version 9.4 (computer program). SAS Institute Inc., Cary, NC, USA. Google Scholar. 2014.
17. Nzikou JM, Kimbonguila A, Matos L, Loumouamou B, Ndangui CB, Abena AA, et al. Extraction and characteristics of mango seed kernel oil. Res J Environ Earth Sci. 2010;2:31-35.
18. Jadhav NV and Siddiqui MF. Handbook of poultry production and management, 2nd edn. Jaypee brothers' medical publishers, New Delhi, India. 2010;38.
19. Kansci G, koubala BB, Mbome IL. Biochemical and physicochemical properties of four mango varieties and some quality characteristics of their jams. J Food Process Preserv. 2008;32:644-655.
20. Arogba SS. Nigerian Mango kernel (Mangifera indica) Physio-chemical analysis and effect of prolonged dry heating. In 13th NIFEST Annual Conference. University of Ibadan, Ibadan, Nigeria. 2000.
21. Jansman AJ, Huisman J, Vander A. Faba beans with different tannin contents; Ileal and fecal digestibility in piglets and growth in chickens. Recent advances in research of anti-nutritional factors in legume seeds. Washington, Netherlands. 1989;176-180.
22. Diarra S, Usman BA, Igwebuike JU. Replacement value of boiled mango kernel meal for maize in broiler finisher diets. J Agric Biol Sci. 2010;5:47-52.
23. Amao EA and Siyanbola MF. Carcass and physiological response of broilers fed dry heat treated mango (Mangifera indica) kernel based diets. Int J Livest Prod. 2013;4:30-34
24. Moore LM. Mango (Mangifera indica) Plant guide. USDA, national resource conservation services. National plant data team. 2004.
25. Joseph JK and Abolaji J. Effects of replacing maize with graded levels of cooked Nigerian mango-seed kernels (Mangifera indica) on the performance, carcass yield and meat quality of broiler chickens. Bio Resource Tech. 1997;61:99-102.
26. Abdulahi I. Nutritive value of differently processed mango seed kernel (local variety (kanbiri) and mixed samples) meal in broiler diets. 2012.
27. Kumar D, Moni C, Singh P. Effects of feeding MSK on performance, carcass characteristics and cost of feeding in broiler starter. Indian J of Poul Sci. 2010;45:46-49.