The Effect of Replacement of Maize with Kocho on Feed Intake, Growth Performance and Carcass Characteristics of Hubbard Broiler Chickens

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The replacement value of maize with *kocho* on feed intake, growth performance and carcass characteristics of growing Hubbard broiler chicken was evaluated. The four treatment diets contained 0% (T1), 33% (T2), 67% (T3) and 100% (T4) kocho as a replacement for maize in the concentrate mixture. The concentrate mixture was composed of noug (*Guizotia abyssinica*) seed cake, wheat bran, soybean, limestone, vitamin/mineral premix), dicalcium phosphate, lysine, methionine and common salt. Unsexed broiler (180) chickens were allocated to the dietary treatments with three replicates of 15 chickens each in a completely randomized design. Feed and water were provided *ad libitum*. The experiment lasted for 49 days. At the beginning of the experiment, eight unsexed chicks were selected and killed by dislocating the neck and kept in deep freezer (-20^{0}C) until chemical analysis to determine nutrient retention. At the end of the experiment, two chickens (1 male and 1 female) per replicate were randomly selected for measurement of carcass characteristics and nutrient retention. The dry matter intake was similar (P>0.05) among treatments. The crude protein intake of chicks fed on T1 diet were the highest (P<0.05) while the lowest was for T2. The metabolizable energy retention for T1 diet was greater (P<0.05) than those receiving T3 and T4 diets. There was an increasing trend in phosphorus retention with increasing levels of *kocho* in concentrate mixture. There were no significant difference in body weight gain, slaughter weight and edible carcass of chicks across treatments. The dressing percentage for chicks receiving T4 diet was higher than that of T2 diet. In conclusion due to the year round availability and easy access by smallholder farmers in the southern and south-western part of Ethiopia where enset is widely grown, *kocho* could be used as energy source as a substitute for maize.

Keywords: Broiler chicken, *Ensete ventricosum*, Feed intake, *Kocho*, Weight gain.
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INTRODUCTION

Inadequate feed supply and poor quality of the available feedstuffs are one of the major reasons for the poor performance of poultry sector in Ethiopia (Negussie and Alemu, 2005). The productivity of the sector in the tropics has been grossly limited by the scarcity and consequent high prices of the conventional protein and energy sources (Aberra *et al*., 2011). Poultry today has emerged as the fastest growing segment of the agricultural industry. Broiler farming is an important part of commercial poultry enterprise which provides a large part of increasing demand for animal protein, cash income and creates employment opportunities (Mahbub *et al*., 2011).

There are different types of locally available feed resources that are used for livestock feed among which enset (*Ensete ventricosum*) is widely used especially in the southern parts of Ethiopia. Cultivated enset grows in a wider area comprising the central, south and south-western parts of Ethiopia and it is used as a staple food by 7–10 million people and its use is expanding in other parts of the country (Admasu, 2002). In addition to its use as a source of carbohydrate rich human food, all parts of enset is utilized as animal feed. For example, the by-products of enset processing such as *furfurame* is used as poultry feed (Seyoum, 2013). According to Ajebu (2008) enset pseudostem (12 MJME/kg DM) and corm (13 MJME/kg DM) are rich in energy. According to the same author, these fractions are highly digestible. Mohammed et al. (2013) indicated that pseudostem (65% DM) and corm (71% DM) are rich in starch.

The major foods obtained from enset are *kocho*, *bulla* and *amicho*. *Kocho* is the most common one and it is the bulk of the fermented starch obtained from the mixture of the decorticated (scraped) leaf sheaths and grated corm. According to Admasu (2002), *kocho* yield of enset per unit of space and time, in terms of edible dry weight and energy, was much higher than the yields of any other crop cultivated in Ethiopia. It was also indicated that the starch content of *kocho* is similar to that of maize (Gebre-mariam and Schmidt, 1996). Yilma (2001) reported that *kocho* has high carbohydrate (96% DM) content than maize (83% DM). Ajebu *et al.* (2012) observed similar effect on intake, digestibility and growth performance when *kocho* partially replaced maize in sheep feeding. *Kocho* could be produced throughout the year and hence is available year round unlike that of maize which is seasonal. If that is the case, *kocho* could be used as a substitute to maize in poultry ration. However, there is no information which evaluated the replacement value of maize with *kocho* on the performance of broiler chickens. Therefore, the objective of this study was to assess feed intake, growth performance and carcass characteristics of Hubbard chickens fed with different proportion of maize and *kocho* in concentrate mixture.

MATERIALS AND METHODS

Experimental chicks and design

The experiment was carried out at the poultry farm of School of Animal and Range Sciences, Hawassa University, Hawassa, Ethiopia. Three hundred day-old unsexed broiler Hubbard chicks were used for the experiment. The experimental floor was covered with wood shavings of 4-5 cm depth. Experimental house and equipments were cleaned, disinfected with formalin and aerated before the transfer of chicks. The chicks were reared in the brooder for two weeks at the experimental site and during that phase they were provided with the starter ration. After brooding, the chicks were divided into four treatment groups of 45 chicks each and randomly assigned to the four treatment diets in a completely randomized design. Each treatment group was further sub divided in to three replicates of 15 chicks per replication and kept in a 1.50 m x 2.0 m wire mesh partitioned pens.

The chicks were vaccinated against Gumboro and Newcastle diseases using appropriate vaccine as per the recommendation of the manufactures. For coccidiosis prevention amprolium (20-40 g/100 liters of water) was provided for five consecutive days per week from first week to fourth week of age and oxytetracyline - 10% (20 g/100 liters) was given with drinking water whenever necessary. The chicks were administered with commercial anti stress (vitalyte) to prevent stress which could be associated with transportation. It was given in drinking water during the first three days upon arrival. Other poultry management routine procedures were maintained.

Experimental feed preparation and feeding management

Maize, wheat bran, noug seed cake and soybean were purchased from local market. Vitamin-mineral premix, lysine, methionine, dicalcium phosphate and limestone were purchased from Addis Ababa commercial market. Soybean was roasted for 5 minutes to deactivate trypsin inhibitor. The feed ingredients were milled and mixed well manually. The proportion of experimental diet is shown in Table 1. Wet *kocho* was purchased from Tula market and sun dried without squeezing the water part. The fibers of wet *kocho* were separated by hand and mesh. Then the flour of *kocho* was spread over mat to dry till it become safe for storage. All ingredients of the ration were mixed at required proportion for feeding of the chicks. The diet was formulated to be iso-nitrogenous and iso-caloric. Initially it was planned to offer diets which contain 21% CP and 13.2MJ ME/kg DM as recommended by Eekeren et al. (1997) for broiler chicks.

Table 1. Proportion of feed ingredients (% as feed basis)

Feed ingredients	Dietary level of the diet (%)			
	T1	T2	T3	T4
Maize	35	21	14	0
Kocho	0	14	21	35
Noug seed cake	23	29.5	32.25	41.75
Wheat bran	14	10	9	3
Soybean	24.5	22	20.25	16.75
Lime stone	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Dicalcium phosphate	0.5	0.5	0.5	0.5
Vitamin-mineral premix	0.5	0.5	0.5	0.5
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100	100	100	100

The feeds were offered once a day at 8:00 am. Water was provided ad libitum. The duration of feeding trial was 49 days excluding the adaptation period.

Measurement of chicks performance

Chicks were individually weighed at weekly intervals. Feed intake was calculated as the difference between the amount of feed offered to the chicks and the amount refused. Body weight gain was calculated as the difference between the final and initial chicks' weight. Nutrient efficiency ratio was determined from the amount of body weight gain of the chicks per unit of nutrient consumed.

Determination of carcass characteristics

For evaluation of carcass traits 24 chicks, two chicks from each replicate group (one male + one female) that represent the mean body weight were selected randomly at the end of the feeding trial. All chicks were deprived of feed and water over night to empty the gut content. Chicks were slaughtered by severing jugular vein and allowed to bleed completely and then plucked manually and weighed to determine blood and feather weight. Data on pre-slaughter live weight, weight of blood, weight of shank, neck, head, breast meat, drum stick, thigh, digestive tract, wing, gastrointestinal and reproductive organs, the visceral organs including heart, kidney, spleen, lung, and liver weight were recorded. The edible carcass weight was calculated by subtracting the non edible offal (shank, spleen, feather, pancreas, head, respiratory organs, reproductive organs, digestive tracts) from the total live body weight. Edible carcass weight was determined by summation of back, drumsticks, thighs, wings and breast including skin, gizzard and liver. Total edible (TE) offal was calculated by adding gizzard, liver and skin to commercial carcass (back bone, drumsticks, thighs, wings, breast muscle, breast bone and neck). Dressing percentage was calculated from carcass weight as a percentage of slaughter weight. DP = WC/SBW x 100, where DP = Dressing percentage, WC = Carcass weight, SBW = Slaughter body weight.

Determination of nutrient retention

At the beginning of the experiment 8 chicks representing all the treatment groups (two unsexed chicks that representing the average body weight of each treatment group) were selected, weighed and leg banded. Before slaughtering the chicks by cervical dislocation they were starved for 12 h to make empty stomach. After slaughtering, the chicks were placed into plastic bags and frozen (-20^{0}C) for determination of nutrient retention. In the same manner, at the end of the experiment two chicks (one male and one female) from each replicate (6 chicks / treatment), whose body weight was closest to the mean body weight of their respective groups were selected. The chicks were identified by means of a leg band and were starved for 12 h, weighed and killed by cervical dislocation. The frozen whole body was then cut up into small sections by using machetes and minced thoroughly using meat mincer. After uniform mixing of the minced meat samples were taken and dried at 65^{o}C for 100 h and finely milled to pass through 1mm mesh screen. The absolute dry matter of the carcass sample was determined by drying the sample at 105^{0}C overnight.

After determination of each nutrient in the sample, the amount of each nutrient deposited in the whole body were determined by multiplying the obtained values with their respective slaughter weight. The amount of each nutrient retained during the experimental period was calculated by the difference of the initial and final nutrient composition of the chick. The amount of nutrient retained daily was also determined by dividing the nutrients retained by the total experimental duration. The percent of nutrient retained in the whole body were calculated as amount of nutrient in the whole body/ Amount of nutrient consumed × 100. Crude protein intake (PI**)** was determined following the method of Sevier *et al*., (2000) using the formula: PI = Total DM intake × % crude protein in the diet. Protein efficiency ratio (PER), as a measure of nutritive value of dietary protein, was determined according to Wilson (1989): PER = Mean weight gain (g)/ Mean protein intake.

Chemical analysis of the experimental feeds and minced carcass

Experimental feed offered and refusals were weighed and sampled daily for each treatment. Sub samples were dried in a dry oven at 65^{o}C for 48 h and ground to pass through 1mm mesh screen and the dry matter (DM), ether extract (EE), crude fiber (CF) and ash were determined according to the procedures of AOAC (1995) and nitrogen free extract (NFE) was calculated by difference. A micro-Kjeldahl procedure of nitrogen analysis was employed to determine the nitrogen content. The crude protein (CP) was then determined as nitrogen content x 6.25. Calcium was determined by atomic absorption spectrophotometer and phosphorus calorimetrically as described by AOAC (1995). The metabolizable energy (ME) was estimated by the formula: ME (Kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 ash (Wiseman, 1987).

Statistical analysis

The data were subjected to Analysis of Variance, using the Statistical Analysis System (SAS, 2004). A significant level of differences among means was determined by using the Duncan Multiple Range Test. Difference between treatment group were considered statically significant at P<0.05.

The following statistical models were employed to analyze the data: $Y_{ij} = \mu_i + T_j + E_{ij}$, Where, Y_{ij} = the response variable: μ_i = over all mean: T_i = the effect of treatment: E_{ij} = random error.

RESULTS

Chemical composition of the feed ingredients

Chemical composition of *kocho* and maize are presented in Table 2. *Kocho* had low crude protein, low ether extracts and high nitrogen free extract content when compared with maize that had high CP, high EE and low NFE. The highest CP content was for soybean while the lowest was for k*ocho*.

Nutrient intake

The daily nutrient intakes of broiler chicks are presented in Table 4. The DM intake was not significantly different among the treatments. The CP intake of chicks fed on T1diet was the highest (P<0.05) whereas T2 had the lowest intake. The CF intake was highest in T4 and lowest for T1. Chicks fed T3 diets had the highest (P<0.05) ME intake followed by T2 while those fed T4 had the least. The Ca and P intake increased with increasing level of *kocho* in the diet. Similarly, there was a trend of increasing ash intakes with increasing levels of *kocho*.

Table 2. Chemical composition (% dry matter, unless specified) of the feed ingredients

Nutrients	Feed ingredients				
	Maize	Soybean	Noug cake	Wheat bran	*Kocho*
Dry matter (%)	94.7	95.6	94.5	93.7	96.2
Crude protein	8.1	30.8	29.9	17.0	3.8
Crude fiber	2.0	13.1	19.4	5.2	4.1
Ether extract	8.7	16.6	12.1	9.4	5.8
Ash	1.0	1.0	1.0	0.9	1.0
Nitrogen free extract	75.0	34.1	32.2	61.1	81.4
Calcium	0.63	0.68	0.54	0.59	0.62
Phosphorus	0.28	0.22	0.29	0.25	0.31
ME (kcal/kg DM)	4209	3651	2856	3962	3857

ME =metabolizable energy, Kcal= kilo calories, NFE = DM-(CP + CF + EE + Ash). Metabolizable energy (Kcal/Kg DM) = 3951+ 54.40 Crude fat – 88.70 Crude fiber – 40.80 Ash (Wiseman, 1987).

Table 3. Chemical composition (% DM, unless specified) of the treatment diets

Chemical component	Treatments			
	T1	T2	T3	T4
Dry matter (%)	97.7	96.0	95.0	93.4
Crude protein	23.0	18.7	18.0	18.0
Crude fiber	7.2	7.5	7.1	8.5
Ether extract	10.8	13.0	12.4	10.4
NFE	55.7	55.9	56.5	55.5
ME (kcal/kg DM)	3864	3953	3957	3722
Ash	1.0	1.0	1.0	1.1
Calcium	0.64	0.65	0.67	0.69
Phosphorus	0.23	0.21	0.24	0.26

DM = dry matter; NFE = nitrogen free extract; ME = metabolizable energy; Kcal = kilo calories; NFE= DM-(CP + CF + EE + Ash). T1= 0%*kocho:* 100% maize, T2= 33% *kocho* = 67% maize, T3= 67% *kocho*=33% maize, T4= 100% *kocho*: 0% maize in concentrate mixture

Table 4. Daily nutrient intake (g/day) of chicks fed different levels of *kocho* and maize in concentrate mixture

Intake	Treatments				Mean	SEM
	T1	T2	T3	T4		
Dry matter	160^{ab}	155^{b}	167^{ab}	161^{ab}	161	4.45
Crude protein	37.7^{a}	29.0^{c}	32.3^{b}	32.7^{b}	32.9	0.87
Crude fiber	11.5^{c}	12.8^{b}	13.1^{b}	16.2^{a}	13.4	0.29
Ether extract	16.9^{c}	22.6^{b}	23.9^{a}	17.1^{c}	20.1	0.49
Nitrogen free extract	88.0^{b}	87.6^{b}	96.8^{a}	92.1^{ab}	91.1	2.49
Metabolizable energy (kcal)	3761^{c}	3950^{b}	3999^{a}	3348^{d}	3765	5.53
Ash	2.17^{b}	2.20^{b}	2.30^{a}	2.27^{a}	2.26	0.04
Calcium	1.27^{b}	1.20^{b}	1.53^{a}	1.50^{a}	1.35	0.04
Phosphorus	0.60^{b}	0.67^{ab}	0.73^{a}	0.72^{a}	0.68	0.06

$^{abc:}$ Means in the same row with different superscript are significantly different at p< 0.05). Kcal, kilo calories. Treatment descriptions are as given under Table 3.

The dry matter and nutrient efficiency ratio

The DM and nutrient efficiency ratio of chicks fed on different levels of *kocho* and maize based diet are shown in Table 5. The efficiency ratio for DM and NFE were similar (P>0.05) among treatments. The highest (P<0.05) CP efficiency ratio was observed for chicks fed T2 diets while the lowest was for those fed T1 diet. The Ca efficiency ratio for T1 and T2 was higher (P<0.05) than that of T3 and T4. The highest (P<0.05) ME efficiency ratio was for T4.

Table 5. Nutrient efficiency ratio of chicks fed different levels of *kocho* and maize in concentrate mixture

Intake	Treatments				Mean	SEM
	T1	T2	T3	T4		
Dry matter	0.30	0.33	0.33	0.26	0.30	0.03
Crude protein	1.30[d]	1.70[a]	1.60[b]	1.46[c]	1.51	0.05
Ether extract	2.86[a]	2.23[b]	2.13[b]	2.76[a]	2.50	0.12
Nitrogen free extract	0.53	0.56	0.50	0.50	0.52	0.03
Metabolizable energy (kcal)	0.012[b]	0.011[b]	0.011[b]	0.013[a]	0.012	0.0003
Ash	0.10[a]	0.10[a]	0.10[a]	0.08[b]	0.09	0.003
Calcium	1.93[a]	1.83[a]	1.53[b]	1.46[b]	1.69	0.07
Phosphorus	4.0[a]	3.66[b]	3.50[b]	3.13[c]	3.57	0.11

[abc:] Means in the same row with different superscript are significantly different at p< 0.05). Kcal, kilo calories. NFE = DM-(CP + CF + EE + Ash). Treatment descriptions were as given under Table 3. Treatment descriptions are as given under Table 3.

Table 6. Daily nutrient retention (g/day) of chicks fed different levels of *kocho* and maize in concentrate mixture

Intake	Treatments				Mean	SEM
	T1	T2	T3	T4		
Dry matter	39.33[a]	36.61[a]	32.46[b]	32.98[ab]	36.35	4.99
Crude protein	22.60	25.31	23.00	23.16	23.53	3.44
Ether extract	7.26[a]	3.91[b]	3.46[b]	4.10[b]	4.68	1.39
Nitrogen free extract	9.10[a]	7.05[a]	5.91[b]	5.85[b]	6.97	1.79
Metabolizable energy (kcal)	1957[a]	1660[ab]	1465[b]	1537[b]	1655	252
Calcium	0.75	0.69	0.72	0.80	0.74	0.08
Phosphorus	0.29[b]	0.33[ab]	0.36[a]	0.38[a]	0.34	0.04

[abc] :Means in the same row with different superscript are significantly different (P< 0.05). SEM =standard mean error. Treatment descriptions are given under Table 3.

Both Ca and P efficiency ratio declined with increasing dietary level of *kocho*. The amount of Ca and P required per unit of body weight gain increased with increasing levels of *kocho*.

Nutrient retention

The nutrient retention of chicks fed different levels of *kocho* and maize in concentrate mixture is shown in Table 6. The DM retention for T1 and T2 was higher (P<0.05) than that of T3 whereas T4 had an intermediate value. The ME retention for T1 was higher (P<0.05) than that of T3 and T4. There was an increasing trend in P retention with increasing levels of *kocho* in the concentrate mixture

Body weight gain

Initial body weight, final body weight, average daily body weight and total body weight gain of chicks are presented in Table 7. There were no significance differences in body weight gain of chicks among the treatments.

Carcass characteristics

Carcass characteristics of chicks fed with different levels of *kocho* and maize in concentrate mixture is shown in Table 8. The result indicated that the slaughter weight of chicks did not vary across the treatments. There was no significant difference (P>0.05) among treatments in edible carcass weight. The chicks that received ration containing different levels of *kocho* (T2-T4) performed similarly (p>0.05) in terms of wings and thigh weight with the highest value for T1. The highest (P<0.05) total edible offal was obtained from T1 and the lowest for chicks fed T3 diet. The dressing percentage for T4 was higher than that of T2 whereas T1 and T3 had an intermediate value.

Table 7. Body weight change (g) of chicks fed different levels of *kocho* and maize in concentrate mixture

Weight change	Treatments				SEM
	T1	T2	T3	T4	
Initial weight	247	247	251	254	8.57
Final weight	2442	2370	2302	2339	162.2
Total weight gain	2195	2123	2050	2085	158.5
Average daily gain	44.8	43.3	41.1	42.6	3.21

abc: Means in the same row with different superscript are significantly different at p< 0.05, SEM standard mean error. Treatment descriptions are as given under Table 3.

Table 8. Effect of feeding different levels of *kocho* and maize in concentrate mixture carcass characteristics of chicks

Parameters (g)	Treatments				Means	SEM
	T1	T2	T3	T4		
Slaughter weight	2231	2062	1978	2019	2073	197
Commercial carcass:						
Neck	80.4^{a}	69.5^{b}	58.2^{c}	67.7^{b}	69.0	5.5
Wing	102^{a}	82.7^{b}	80.3^{b}	82.1^{b}	86.9	6.39
Drumstick	231^{a}	211^{b}	205^{bc}	187^{c}	208	15.7
Thigh	256^{a}	217^{b}	210^{b}	231^{b}	229	17.6
Breast muscle	396^{a}	339^{b}	268^{c}	337^{b}	335	39.5
Breast bone	196^{a}	172^{b}	181^{ab}	180^{ab}	182	12.4
Back bone	150^{ab}	159^{a}	137^{b}	144^{ab}	148	16.6
Liver	47.5^{b}	53.2^{a}	58.0^{a}	53.2^{a}	53.0	4.37
Gizzard	56.1^{ab}	55.3^{bc}	60.3^{a}	51.4^{b}	55.8	5.22
Skin	149^{a}	111^{abc}	105^{c}	123^{b}	122	12.1
[1]TEO	1665^{a}	1470^{b}	1363^{c}	1450^{b}	1487	71.0
[2]Edible carcass	1649	1501	1475	1527	1538	186
Dressing percentage	73.8^{ab}	72.7^{b}	74.3^{ab}	75.4^{a}	74.1	20.5

abc: Means within the same category with different superscripts across the row are significantly different (P<0.05) , , SEM standard mean error, g gram,, [1]TEO = total edible offal = (calculation included skin, gizzard and liver and edible part of carcass), [2]Edible carcass weight = (slaughter weight – TNEO), Dressing % = (Weight of carcass/slaughter weight)*100. Treatment descriptions are as given under Table 3.

DISCUSSION

Nutrient and metabolizable energy contents of the experimental diets and ingredients

The analyzed CP values for all treatment diets were comparable and within the recommended levels suggested by Scanes *et al*. (2004), 20% and 18.5% CP for grower and finisher broilers, respectively, and is above the minimum CP requirement (16%) for broiler breed suggested by NRC (1994). The ME content of treatment diets were between 3722 to 3957 kcal/kg DM which were higher than the minimum values of ME requirement (2801 kcal/kg DM) recommended by NRC (1994) for broiler chickens.

The decreasing trend of EE with an increase in the proportion of *kocho* in diets may be explained by the increasing contribution of soybean oil due to the use of full fat soybean. This, together with CF and ash values contributed to differences in ME content of diets. The CF content of the diets varied between 7.1 and 8.5%. A crude fiber level above 7% has negative effect by reducing production as well as chicken growth (Varastegani and Dahlan, 2014). However, chickens fed on this diet showed significantly a good appetite, which suggests that the level of CF in *kocho* is still below the upper critical fibre level that can negatively affect feed intake and performance of chicks. The composition of calcium increased with the incorporation of *kocho* in the diets, as might be expected which could be due to high calcium content of *kocho* (Ajebu, 2008). All the treatment diets were in accordance with the recommended levels of calcium (0.8 to 1%) and phosphorus (0.35 to 0.45%) in terms of quantity and proportion (Ca: P ratio) in grower chicken diets under tropical conditions (Smith, 1990). The nutrient contents of *kocho* revealed that it is rich in energy (3857 kcal/kg DM), Ca (0.81%) and P (0.37%). The CP content of *kocho* (3.8%) in the present study was higher than the values (2.7%, 2.6%, 1.78 %; 1.5) reported by Ajebu *et al.* (2012), Yilma (2001), Kalekristos (2010) and Yewelsew et al. (2006), respectively. This difference may be due to the variation of enset varieties from which *kocho* is produced. Ajebu (2008) observed varietal differences in CP content of unprocessed corm and pseudostem from which *kocho* is produced.

The CP content of *kocho* in the present study is lower (38 g/kg DM) compared with maize (81 g/kg DM) which agrees with the result reported by Ajebu et al. (2012). The current study showed that *kocho* could be rich source of energy. Moreover, the high ME content of *kocho* noted in this study is indicative of its potential as a substitute to energy rich feed such as maize in the diet of broilers. The low CP content of *kocho* in the present study clearly suggested that by improving its CP content through mixing with high protein sources (like noug cake and soybeans) in ration formulation, it is possible to increase the efficiency of nutrient utilization. The EE content of *kocho* (5.8%) found in this study was higher than *furfurame* (4.1%), the by-product of *kocho* processing, as reported by Seyoum (2013). The CF content of *kocho* (4.1%) obtained from the present work was lower than the value of CF of *furfurame* (10%) reported by Seyoum (2013). The CP content of the noug cake used in this study (299 g/kg DM) was similar to the value (301 g/kg DM) reported by Ajebu et al. (2012) but it is higher than the value (253 g/kg DM) reported by Abebe (2011). The variation observed in CP content may be due to the difference in efficiency of extraction while extracting oil and other factors such as stage of maturity, time of harvesting, storage, soil type and environmental condition (Adugna, 2008). The CP content of wheat bran recorded in the present study (170 g/kg DM) was slightly lower than the value (180 g/kg DM) reported by Abebe (2011) and but greater than the value (128 g/kg DM) reported by Ajebu et al. (2012).

Nutrient intakes

The present result has shown that DM and nutrient intake was not affected by replacement of *kocho* with maize. The similarity in total DM intake among treatments indicates that feeding *kocho* as a replacement to maize in diet of broiler chicks had no negative effect on intake. The result of the present study agreed with Etalem *et al.* (2013) who observed similar intake and performance in chicken fed cassava root chips as a replacement to corn grain. The similarity among treatments in DM intake indicated the comparable feeding value of *kocho* and maize as an energy source. Similar to the current experiment, Seyoum (2013) has shown that *furfurame*, a by-product of *kocho* processing, has been shown to have similar feeding value with that of maize. As reported by Ochetim (1991), complete replacement of maize with cassava root resulted in reduction of feed intake which is not consistent with the current experiment. However, Hossain et al. (2013) and Ngiki et al (2014) reported increased feed intake with increasing level of cassava root meal in the diet of chicken in maize based diets. There was an increasing trend in the intake of phosphorus with increasing level of *kocho* in the diet. Ajebu et al. (2008) indicated that pseudotem is rich in phosphorus.

Effect of replacement of maize with *kocho* on weight gain of chicks

The similarity in average daily weight gain of the chicks could be due to the similarities in DM intake, DM conversion ratio and DM efficiency ratio. This once again indicates the comparable feeding value of *kocko* and maize as an energy source. Similar to the current experiment, Etalem *et al*. (2013); Hossain et al. (2013) and Ngiki et al. (2014) indicated that the replacement of cassava meal with maize grain at different levels did not influence daily weight gain in broiler chickens. Contrary to the current experiment, Seyoum (2013) observed a decrease in body weight gain with increasing levels of *furfurame*. The reason for decreased weight with increasing level of *furfurame* may be due to its fibrous nature compared with *kocho*. Similarly, loss of body weight was observed when cassava meal totally replaced maize in the diet of poultry (Ochetim, 1991).

The current result implies that due to the year round availability and easy access by smallholder farmers in the southern and south-western part of Ethiopia where enset is widely grown, *kocho* could be used as an energy source as a substitute for maize.

Nutrient retention of chicks

The high CP intake for T1 could be due to the high CP content of this nutrient in that treatment group. Chicks fed T1 diets had higher CP intake than the remaining treatment groups but in the case of CP retention, it was similar among the treatments. The result is not consistent with that of Seyoum (2013) where there was a tendency of decreased CP retention with increasing level of *furfurame*. The decreased protein retention could be due to lower protein efficiency ratio in this treatment. As it has been indicated by Jackson *et al.* (1982), the carcass moisture, protein, fat and ash content of broiler depend upon the protein concentration in a diet. Accordingly, in the present experiment chicks which were fed T3 diet had the lowest DM retention which could be due to lower content of fat, protein and ash as compared to other experimental groups.

The body composition of the chicken is affected by many factors such as strains, sex, age, quantity and quality of the dietary CP and ME, slaughter and sampling methods and environmental conditions. Among the different nutritional components, proteins (amino acids) are fundamental because they are related with synthesis of structural tissues, for instance in growing animals amino acids deposition in the skeletal muscle represent 65% of whole daily protein intake.

Carcass characteristics of chicks

Carcass yield is an indication of the quality and utilization of the ration (Bambgbose and Niba, 1998). The present information indicated that the slaughter weight of chicks in all treatment diets was not affected by the inclusion of *kocho*. However, there was a tendency of decreased slaughter weight with the increasing levels of *kocho*. This is in agreement with the previous finding of Seyoum (2013) for broiler chickens fed *furfurame*.

The weight of chicks fed T1 diet was relatively higher in edible carcass weight, drumstick, thighs, breast muscle, back and wing than the remaining treatment which is consistent with the work of Seyoum (2013) in chicks fed *furfurame* and Ocheiim (1992) in those chicks fed cassava meal as a replacement to maize. High carcass yield suggests more nutrient bioavailability for anabolic processes, perhaps more so, in protein synthesis than other diets (Tegene and Asrat, 2010) since the true muscle development is an accumulation of protein. From this it can be deduced that chicks fed on *kocho* based diets had low carcass yield than T1 diet, which might be due to poor bioavailability of nutrients in *kocho* diet which resulted in poor tissue growth. This indicated that protein and energy deposition depends to a great extent on the quality and quantity (biological value) of dietary protein and energy.

A progressive decrease in weights of edible carcass and the carcass components (drumsticks, thighs, breast, back and wings) were observed with increasing levels of *kocho*. Similarly, a decrease in weight of total edible offal was also noted with increasing level of *kocho* in the treatment diets. Similar results were reported by Seyoum (2013) where broilers were fed *furfurame* as a replacement to maize and Ochetim (1991) in chicks fed increasing levels of maize as a replacement to cassava meal. Thus, the lower weights of these carcass parts of the experimental groups compared to those fed T1 fed diets might be due to less deposition of protein in the former group. A non-significant result on dressing percentage of chickens fed different levels of *furfurame*, a by-product of *kocho* processing, was reported by Seyoum (2013) which is not consistent with the current experiment. The difference might be attributed to the difference in fiber content between *furfurame* (10%) and *kocho* (4.1%) The value of dressing percentage obtained in the current experiment is more or less similar to the value (70%) reported by Scanes *et al*. (2004) and Maigualema and Gernat (2003) for broiler breeds regardless of diets. Seyoum (2013) also reported a dressing percentage of 72.7% where f*urfurame* replaced maize in concentrate mixture which is similar with the current experiment

CONCLUSIONS

The replacement of maize with *kocho* in the diet of growing Hubbard chicks had no negative impact on the performance (live body weight, daily weight gain, slaughter weight, carcass yield), DM intake, and efficiency ratio of the chicks compared to T1, which indicates that *kocho* could partially or totally replace maize in broiler diets as energy feed ingredient. Thus, in areas where maize grain feeding is not common, *kocho* could be used as a source of energy. In fact a source of protein is required since *kocho* is very poor in CP content.

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REFERENCES

Abebe Berecha. 2011. *Feeding effect of Tagasaste (Chamaencytisus palmensis) leaf meal on the growth performance and carcass characteristics of Rhode Island Red chickens.* MSc Thesis, Hawassa University, College of Agriculture, Hawassa, Ethiopia.

Aberra Melesse, Workinesh Tiruneh and Tegene Negesse. 2011. Effect of feeding *Moringa stenopetela* leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. *Trop. Subtrop. Agroeco*. 14: 485-492.

Admasu Tsegaye. 2002. *On indigenous production, genetic diversity and crop ecology of enset (Ensete ventricosum (WelW.) Chessman)*. PhD Thesis. Wageningen University, The Netherlands.

Adugna Tolera. 2008. Feed Resource and Feeding Management. A manual for feed operators and development workers. Ethiopia Sanitary and Phyto-sanitary Standards and Livestock and Meat Marketing Program (SPS-LMM). Addis Ababa Ethiopia, 38pp.

Ajebu Nurfeta and Aman Getiso, 2014. The nutritional value of enset *Kocho* as an alternate concentrate for sheep fed Rhodes grass hay. *Ethiop J. Anim. Prod*. 14 (1): 34-50.

Ajebu Nurfeta, Meseret Tsegaye and Aster Abebe, 2012. Effects of substituting maize with *kocho* on intake, digestibility, nitrogen utilization and body weight gain in sheep fed a basal diet of Rhodes grass hay. *Ethiop J. App. Sci. Technol*. 3(2): 13-24.

Ajebu Nurfeta. 2008. *Evaluation of the Nutritive Value of Enset (Ensete ventricosum) as Livestock Feed in Southern Ethiopia*. PhD Thesis, Norwegian University of Life Sciences, Department of Animal and Aquaculture Science, Norway.

Ajebu Nurfeta, Adugna Tolera, Eik, L.O. and Sundstøl, F. 2008. Yield and mineral content of ten enset (*Ensete ventricosum*) varieties. *Trop. Anim. Health Prod*. 40: 299-309.

Ajebu Nurfeta, Meseret Tsegaye and Aster Abebe. 2012. Effect of substituting maize with kocho on intake, digestibility, nitrogen utilization and weight gain in sheep fed a basal diet of Rhodes grass hay. *Ethiopian J. App. Sci. Technol*. 3(2): 13-24.

AOAC. 1995. Association of Official Analytical Chemists. 16th ed, Washington DC.

Eekeren, N.V., Mass, A., Saatkamp, H.W., Verschuur, M. 1997. Small scale chicken production. Agrodok 4, Agromissa, CTA, 70.

Etalem Tesfaye, Getachew Animut, Mengistu Urge and Tadelle Dessie. 2013. Cassava root chips as an alternative energy feed ingredient in broiler ration. *Int. J. Poul. Sci*. 12 (5): 298-306.

Gebre-mariam, T, and Schmidt, P.C. 1996. Isolation and phycico-chemical properties of enset starch. *Starch*. 48: 208-2014.

Hossain, M.A., Amin, J.R. and Hossain, M.E. 2013. Feasibility of cassava meal in broiler diets by partial replacing energy source (corn) in regard to gross response and carcass traits. *Int. J. Agric. Res. Innov. Tech.* 3(2): 59-65.

Jackson.S.J., Summer, D. and Lesson, S. 1982. Effect of dietary protein and energy on broiler carcass composition and efficiency of nutrients utilization. *Poul. Sci*. 61: 2224-2231.

Kalekristos Yohannes.2010. Influence of baking time and temperature on the quality of *kocho* biscuit enriched with faba bean and wheat, Addis Ababa, Ethiopia.

Mahbub, A.S.M., Baqui , M.A. and Sarker, N.R. 2011. Replacement of maize by different levels of triticale on performances and meat yield characteristics of broiler chickens. *Int. J. Natural Sci*. 1(1): 25-30.

Mohammed Beyan, Gabel, M. and Karlsson, L.M. 2013. Nutritive values of the drought tolerant food and fodder crop enset. *Afri. J. Agri. Res*. 8(20): 2326-2333.

Negussie Dana and Alemu Yami. 2005. Characterization and classification of potential poultry feeds in Ethiopia using cluster analyses, Ethiopian *J. Anim. Prod*. 5 (1):107-123.

NRC.1994. *Nutrient requirements of poultry*. 9th Revised Edition. National Academic Press, Washington, D.C.

Ngiki, Y.U., Igwebuike, J.U. and Morupp, S.M., 2014. Effect of replacing maize with cassava root-leaf meal mixture on the performance of broiler chickens. *Int. J. Sci. Technol*. 3(6): 352-362.

Ochetim, S. 1991. The use of cassava in broiler feeding in the south pacific. *Asian-Australasian J. Anim. Sci.* 4(3): 241-244.

SAS. 2004. SAS user's guide, Version 9.1, (SAS Institute Inc., Cary, NC, USA).

Scanes, C.G., Brant, G. and Ensiminger, M.E. 2004. *Poultry Science*. 4th ed., Pearson Prentice Hall.

Sevier, H., Raae, A.J. and Lied, E. 2000. Growth and protein turn over in-Atlantic Salmon (*Salmo saler* L.): the Effect of dietary protein level and protein siz. *Aquaculture* 185: 10-20.

Seyoum Debebe. 2013. *Effect of feeding different levels of Furfurame on growth performance and carcass traits of Hubbard Chickens.* MSc Thesis. College of Agriculture, Hawassa University, Ethiopia

Smith, A.J. 1990. *Poultry: the Tropical Agriculturalist*. Macmillan Education Ltd. Hong Kong, China.

Tadelle Dessie. 1996. *Studies on village poultry production systems in the central highlands of Ethiopia.* MSc. Thesis, Swedish University of Agricultural Sciences, Uppsala.

Tegene Negesse and Asrat Tera. 2010. Effects of feeding different levels of cooked and sun dried fish offal on carcass traits of growing Rhode Island Red chicks. *Trop. Anim. Health Prod*. 42: 45–54.

Varastegani, A. and Dahlan, I. 2014. Influence of dietary fiber Levels on feed utilization and growth performance in poultry. *J. Anim. Pro. Adv*. 4(6): 422-429.

Wilson, R.P. 1989. Amino acids and protein. In: Halver. J.E. *Fish Nutrition*. 2nd ed., New York, Academic press. pp112-152.

Wiseman, J. 1987. Feeding of non-ruminat animals. In J. Wiseman (Ed): *Meeting Nutritional Requirements from Available Resources*. Butterworth. London.

Yewelsew Abebe, Barbara, S, Margaret, H and Gail, G. 2006. Nutritive value and sensory acceptability of corn and *Kocho* based foods supplemented with legumes for infant feeding in Southern Ethiopia. *Afri. J. Food Sci*. 6: 1-13.

Yilma, T. 2001. Coffee-livestock interactions for sustainable livelihood in the Sidama area of Southern Ethiopia. *J. Agri. Trop. Subtrop*. 102: 119-131.