The Effect of Partial Substitution of Maize with *Furfurame* on the Production Performance and Carcass Characteristics of Broilers

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ABSTARCT

The objective of this study was to evaluate the effect of substituting maize with furfurame, a by-product of kocho (Ensete ventricosum) processing, in a concentrate mix on feed intake, growth performance, nutrient retention and carcass parameters of Hubbard chickens. Four treatment diets namely T1, T2, T3 and T4 were formulated containing 0%, 33%, 66%, and 100% of furfurame as a substitute for maize, respectively, in concentrate mixture. After 3 weeks of brooding, 120 unsexed chicks were weighed and randomly allocated to the four dietary treatments with three replicates of 10 chicks per treatment in completely randomized design. The experiment lasted for 56 days. At the end of the experiment, a cockerel and a pullet were randomly selected from each replicate, and slaughtered to assess nutrient retention and carcass traits. The daily dry matter intake of the chicks fed on T3 and T4 diets were higher (P<0.05) than those reared on T1 and T2 diets. The average daily weight gain of chicks fed T1 diet were higher (P<0.05) than chicks fed T3 and T4 diets. Chicks receiving T1 diet had better (P<0.05) feed conversion efficiency while those receiving T4 were the least (P<0.05) efficient. Crude protein retention was the highest (P<0.05) for T1 diet while chicks in T4 retained the least. Chicks fed on T1 diet had the highest (P<0.05) metabolizable energy retention compared to other treatment diets. Chicks fed on T1 diet had higher (p<0.05) slaughter weight, commercial carcass weight and edible offal weight compared to those fed on T4 diet. The dressing percentage of the chickens did not vary across the treatments. Based on intake of nutrients and dressing percentage, it is concluded that furfurame can be used as energy source feedstuff in poultry ration replacing maize up to 33% for stallholder farmers in enset growing areas.

***Key words**: Broilers; carcass traits; Ensete ventricosum; furfurame, growth, nutrient retention*

INTRODUCTION

Chicken are the most important avian species commonly reared among the resource challenged members of the society while they are also reared in large numbers in commercial enterprises. They are sources of income, animal protein, have cultural values, and can be raised under wide range of climates and with limited resources, feed and housing (Kondombo, 2005). According to Tadelle and Ogle (2003), most of the rural families in Ethiopia own chicken. The current total chicken population in Ethiopia is estimated to be 56.53 million (CSA, 2016/17) which are mainly kept under scavenging system.

Despite the large population of chicken, their contribution is far below the expectation which can be attributed to various constraints among which the scarcity and consequently high prices of the conventional feed (protein and energy sources) predominate (Aberra et al., 2012). In the tropics, poultry keeping has always poses a problem for subsistent farmers since poultry competes with humans for the available scarce concentrate feed ingredients (Tadelle and Ogle, 2003). Being monogastric animal the bulk of poultry ration is composed of cereal grains which are generally used for human consumption resulting in high production cost of poultry (Ravindran and Blair, 1991). Conventionally maize is the most common ingredient used in formulation of poultry ration. Unfortunately, the market price of maize is increasing from year to year under Ethiopian condition. This situation warrants investigating into less expensive and locally available energy source that could safely and economically replace maize in poultry ration (Nurfeta et al., 2015). One of such feed is enset (*Ensete ventricosum*) also called false banana which is used for human and animal consumption in southern region of Ethiopia. It is estimated that about 35% of the total population of Ethiopia live in areas where enset is an important staple food (CSA, 2014).

The major food products obtained from the enset plant are *kocho*, *bulla* and *amicho*. There are by-products not used for human consumption generated during the production and processing of enset plant into human foods that could be included into poultry feeding system of the region. One of such by-product is called *furfurame*. *Furfuram*e is a by-product obtained during *kocho* preparation. During preparations of kocho for human consumption, the processors remove the fiber and allied components from the raw *kocho* using a mesh like material. This by-product is traditionally called *furfurame* in the native Sidama language of Ethiopia. Few studies were aimed at determining the chemical composition (Nurfeta et al., 2008a) digestibility, nitrogen utilization and intake of unprocessed enset varieties (Nurfeta et al., 2008b; Nurfeta et al., 2009). However, there is no research work which evaluated the use of *furfurame* as livestock feed. Therefore, this study was planned to assess feed intake, growth performance and carcass traits of Hubbard chickens fed different levels of *furfurame* in concentrate mixture.

MATERIALS AND METHODS

Experimental Feed

The feeding experiment was done at Hawassa University, College of Agriculture, School of Animal and Range Science poultry research farm. *Furfurame* is the by-product of *kocho*. In brief, after fermentation of crashed pseudostem and corm in the pit, the wet mass is taken out of the pit and homogenized through mixing and hand pressure and allowed to dry using nylon. The dried mass is put on a sieve to separate *kocho* and *furfurame* which is the fibrous part. Some *kocho* could be left attached with the fiber part which was separated as a source of feed in this experiment. *Furfurame* was collected from restaurants in Hawassa town who are involved in preparation of traditional Sidama food such as *Chukame* and *Burssame*. It was collected using plastic sacks. The collected *furfurame* were evenly spread on plastic sheets to facilitate drying and separation from the fibers. Then the fiber was separated by hand. The sun dried *furfurame* was then hand ground by mortar and pestle for ease of mixing. Other feed ingredients, maize soybean and nouge cake were purchased from the local market. Vitamin premix and limiting amino acids (methionine and lysine) were also procured from the suppliers. Soybean was roasted before grinding to inactivate the trypsin inhibitor. The different feed ingredients used in the ration were ground and mixed for each treatment.

Experimental Animals

A total of two hundred day-old unsexed Hubbard chicken breed that had an average body weight of 34.6 g were purchased from Debre Zeit Poultry Multiplication and Distribution Centre, Ethiopia. After 18 days of brooding, the chicks were adapted to the experimental diet for 7 days. The chicks were leg tagged and weighed individually to determine their initial body weight. Thereafter, the chicks were randomly assigned to each of the 12 pens. The 12 pens were randomly assigned to the 4 treatment diets following the completely randomized design with three replications per treatment.

Experimental ration formulation and treatments

The treatment diets (Table 1) were formulated by taking into account the nutrient composition of each ingredients and balancing them with the nutrient requirements of the broilers.

Table 1. Proportions of ingredient feeds used to formulate treatment diets

Ingredients and nutrient content	Treatments			
	T1	T2	T3	T4
Maize	51	33	16	0
Furfurame	0	16	33	50
Soybean	30	30	30	30
Nouge cake	16	18	18	17
Limestone	1.2	1.2	1.2	1.2
Salt	0.5	0.5	0.5	0.5
Methionine	0.75	0.75	0.75	0.75
Lysine	1	1	1	1

T1 = control (100% maize); T2= 66.67 maize + 33.33% of *furfurame*; T3= 33.33% of maize + 66.67% *furfurame*; T4= 0% maize + 100% *furfurame* in the concentrate mixture.

The control treatment (T1) contained maize as the major source of energy. *Furfurame* was included in treatment 2, 3 and 4 to replace 33.33%, 66.67%, and 100% of maize, respectively. The experimental diets were formulated using win feed software to contain 21% CP and 13.2 MJ/kg DM metabolizable energy capable of meeting the recommended (Eekeren et al., 1997) nutrient requirements of broilers by. Adequate amounts of vitamin premixes along with lysine and methionine were added to the diets based on the recommendation of NRC (1994). The diets were formulated to be iso-nitrogenous and iso-caloric.

Management of chickens

The chicks were vaccinated against Gumburo, Lasota, HB1 and fowl pox on day 7, 21, 28, and 60 as per the recommended vaccination schedule. Chicks were reared in deep litter housing with sawdust at a depth of 5 cm. Each wire mesh partitioning pens had an area of 1.25 m*1.25 m. The pens were cleaned and fumigated using standard protocols prior to transferring the chicks.

Feed intake and body weight determination

During the experimental period, chickens were feed *ad-libitum* (with at least 20% refusal at the end of the day). The feed was provided twice a day at 8:00 am and 14:00 pm. The duration of the feeding trial was 56 days. The refusal was collected the next morning prior to offering the feed. Body weights of chicks were assessed weekly on an individual basis. Body weight gain was calculated as the difference between the final and initial body weight. The daily feed intake was measured as the difference between feed offered and feed refused. Samples of offered and refusals were collected throughout the experimental period for further chemical analysis.

Carcass evaluation

At the beginning of the experiment, 8 chicks representing the 4 treatment groups were randomly selected and killed by dislocation of neck after starving for 12 hours. Similarly, at the end of the feeding trial, two chickens (one rooster and one pullet) which are similar to the average body weight of the treatment were randomly selected from each pen. A total of 24 chicks were, therefore, selected for assessment of carcass traits. The chicks were starved overnight and weighed immediately prior to slaughtering. Chicks were slaughtered by severing the jugular veins and carotid arteries. After slaughtering, the chicks were allowed to bleed completely, defeathered manually and weighed to assess the blood and feather weight. Pre-slaughter live weight, eviscerated weight, weight of shank and claws, skin, neck, head, breast, drumsticks, thighs, gastro-intestinal and reproductive organs, the visceral organs which included heart, kidney, spleen, lung and liver were assessed. The carcass weight was calculated by subtracting the non-edible offal (blood, shank, spleen, feather, pancreas, head, respiratory and reproductive organs and digestive tracts) from the slaughter body weight. Dressing percentage was obtained by dividing carcass weight by slaughter weight and multiplied by 100.

Determination of nutrient retention

The nutrient retention was assessed according to the methods suggested by Nurfeta et al. (2015). The absolute dry matter of the carcass was determined by drying the carcass overnight at 105^0C. The amount of each nutrient deposited in the tissue was obtained by multiplying the nutrient being obtained during carcass analysis by the slaughter weight. The percent of nutrients retained by the chicks and the crude protein intake were assessed according to the methods suggested by Sevier et al. (2000).

Chemical analysis

The feed samples were analyzed for dry matter (DM), ash, ether extract (EE) and crude fiber (CF) according to AOAC (1995). Total nitrogen content of the feed was determined by micro-kjeldahl method and the crude protein (CP) was then calculated as nitrogen (N)* 6.25. Calcium was determined by atomic absorption spectrophotometer methods as described by AOAC (1995). All the samples were analyzed in duplicates. The metabolizable energy (ME) of the feed was estimated according to the equation proposed by Wiseman (1987): ME (kcal/kg DM) =3951+54.4EE-88.7CF-40.8ash.

Statistical analysis

The data were analyzed using one way ANOVA using SAS software (SAS, 2002) The means were compared according to Duncan's Multiple range test and the values were considered significant at $P<0.05$.

RESULTS

Chemical composition

The results of chemical composition of feed ingredients used in formulation of the ration are shown in Table 2. *Furfurame* had comparable metabolizable energy content with maize. There was a slight decrease in CP content with increasing levels of *furfurame* while metabolozable energy content of the treatment diets were comparable (Table 3).

Table 2. Chemical composition (% DM, unless specified) of feed ingredients

Nutrients	Feed ingredients			
	Furfurame	Maize	Soybean	Noug cake
Dry matter (%)	92	93	94	95
Ash	5.3	18	9	13
Crude protein	3.2	9.4	31	26
Crude fiber	10	3.4	13	19
Ether extract	4.1	7.3	12	8.5
Calcium	0.5	0.8	1.7	0.8
ME (MJ/kg DM)	13	14	13	9.2

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

Nutrients	Treatments			
	T1	T2	T3	T4
Dry matter (%)	91.5	92.6	93.4	94
Ash	13.8	11.9	10.1	9.3
Crude protein	17.7	17.2	16.2	15.2
Crude fiber	8.7	9.6	11.2	12.4
Ether extract	8.7	9.6	11.2	12.4
Calcium	11	10	10	9.4
ME (MJ/kg DM)	12.9	12.8	12.4	12.1

T1 = control (100% maize); T2= 66.67 maize + 33.33% of *furfurame*; T3= 33.33% of maize + 66.67% *furfurame*; T4= 0% maize + 100% *furfurame* in the concentrate mixture.

Daily DM and nutrient intake

The mean DM and nutrient intake of chicks are presented in Table 4. The chicks fed T3 and T4 diet had higher ($p<0.05$) daily DM intake compared with those fed T1 and T2 diet. The DM intake of chicks fed T1 and T2 diet were comparable ($p>0.05$).

Chicks fed T4 diet had the highest ($p<0.05$) daily OM and CF intake while those fed T1 diet had the lowest ($p<0.05$) intake of OM and CF. There were an increasing trend in daily OM and CF intake with increasing level of *furfurame* in the diet. There were no significant differences in the daily CP and ME intake among treatment diets. Chicks fed T3 and T4 diets had significantly lower Ca intake compared to chicks fed T1 diet. The EE intake of the chicks fed T1 diet was higher ($P<0.05$) than that of T4.

Table 4. Average daily DM and nutrient intake of chicks fed different levels of *furfurame* (g/chick/day or MJ/kg feed) in the diet.

Treatment	DM	OM	CF	CP	EE	ME (MJ)	Ca
T1	137^{b}	105^{d}	12^{d}	28	12.93^{a}	1.8	1.1^{a}
T2	143^{b}	115^{c}	14^{c}	27	12.85^{ab}	1.8	0.83^{ab}
T3	152^{a}	126^{b}	17^{b}	26	12.42^{ab}	1.9	0.75^{b}
T4	158^{a}	134^{a}	20^{a}	25	12.1^{b}	1.9	0.73^{b}
SEM	3.0	2.1	0.32	0.57	0.27	0.04	0.13

^{abc}: Means in the same column with different superscript are significantly different ($p<0.05$).DM: dry natter, OM; organic matter; CP: crude protein, EE: ether extract, ME: Metabolizable energy, SEM: standard error mean,T1 = control (100% maize); T2= 66.67 maize + 33.33% of *furfurame*; T3= 33.33% of maize + 66.67% *furfurame*; T4= 0% maize + 100% *furfurame* in the concentrate mixture.

Mean daily DM and nutrient conversion efficiency ratio

The daily nutrient conversion efficiency of chicks is shown in Table 5. The chicks fed T1, T2 and T3 diets had higher (P<0.05) daily protein and EE efficiency ratio compared to T4 diet. The ME efficiency ratio of the chicks fed T1 and T2 diet was higher (p<0.05) than those chicks fed T4 diet. Chicks fed the control diet had the highest (p<0.05) daily efficiency ratio while those chicks fed T4 diet had the lowest daily OM, CF and NFE efficiency ratio.

Table 5. Mean daily nutrient conversion efficiency ratio

.Nutrients	Treatments			
	T1	T2	T3	T4
Dry matter	0.3±0.01^{a}	0.3±0.01^{b}	0.3±0.01^{c}	0.2±0.01^{d}
Ash	0.85±0.05^{b}	0.7±0.07^{ab}	0.6±0.05^{ab}	0.4±0.07^{a}
Crude protein	1.8±0.04^{a}	1.7±0.05^{a}	1.6±0.04^{a}	1.5±0.05^{b}
Crude protein	3.9±0.05^{a}	3.1±0.07^{b}	2.4±0.05^{c}	1.8±0.07^{d}
Ether extract	3.7±0.05^{a}	3.4±0.07^{a}	3.3±0.05^{a}	3.0±0.07^{b}
NFE	60±0.81^{a}	54±1.1^{b}	54±0.8^{c}	50±1.1^{d}
Calcium	1.5±0.5^{c}	2±0.7^{ab}	3.5±0.5^{a}	4±0.7^{b}
ME (kcal)	26±0.37^{a}	23±0.52^{a}	21±0.37^{b}	18±0.52^{c}
DMCER	0.34^{a}	0.31^{b}	0.26^{c}	0.23^{d}

^{abc}: Means in the same column with different superscript are significantly (p<0.05) different.
NFE: nitrogen free extract, ME: Metabolizable energy, SEM: standard error mean, T_1: 0% *furfurame* and 100% maize, T_2: 33.33% *furfurame* and 66.66% maize, T_3: 66.66% *furfurame* and 33.33% maize and T_4: 100% *furfurame* and 0% maize in concentrate mixture

Daily nutrient retention of chicks

The daily nutrient retention of the chicks fed different diet is presented in Table 6. The retained CP of the chicks fed T1 and T2 diets were higher (P<0.05) than that of T4 diet. The retained ME and EE of the chicks fed T1 diet were higher (p<0.05) compared to the other treatments. Chicks fed on T1 diet had the highest (p<0.05) ash retention while those fed T4 diet had the lowest.

Table 6. Daily nutrient retention (g/chick/day or MJ/chick/day) of the chicks fed different levels of *furfurame* in the diet

Treatment	Crude protein	Ether extract	ME (MJ)	Ash
T1	13.3^{a}	4.3^{a}	17.5^{a}	0.4^{a}
T2	12.6^{ab}	2.5^{b}	17^{b}	0.2^{b}
T3	11.7^{b}	2.3^{b}	17^{b}	0.2^{b}
T4	10^{c}	2^{b}	17^{b}	0.1^{c}
SEM	0.5	0.23	0.11	0.01

$^{a\ bc}$: Means in the same column with different superscript are significantly different (p<0.05), ME: Metabolizable energy, SEM: standard error of the mean, T1 = control (100% maize); T2= 66.67 maize + 33.33% of *furfurame*; T3= 33.33% of maize + 66.67% *furfurame*; T4= 0% maize + 100% *furfurame* in the concentrate mixture.

Average daily weight gain

The mean daily weight gain of the experimental chicks is presented in Table 7. The weight gain of chicks fed T1 and T2 diets were higher (P<0.05) than those fed T4 diet.

Table 7. Average daily body weight gain (g) of chicks fed different levels of *furfurame* in the diet

Treatment diets	Initial body weight	Final body weight	Total gain	Average daily gain/ day
T1	429±14	2811±74[a]	2393±72[a]	43±1.3[a]
T2	426±14	2719±76[ab]	2299±74[ab]	41±1.3[ab]
T3	422±14	2554±71[b]	2111±70[b]	38±1.3[b]
T4	423±14	2284±71[c]	1854±70[c]	33±1.3[c]

[abc]Means in the same column with different superscript are significantly different (p<0.05). T1 = control (100% maize); T2= 66.67 maize + 33.33% of *furfurame*; T3= 33.33% of maize + 66.67% *furfurame*; T4= 0% maize + 100% *furfurame* in the concentrate mixture.

Carcass characteristics of chicks

The carcass components of chicks (neck, wing, skin, back, breast, thigh and drumstick) are presented in Table 8. Chicks fed T1 diet had the highest (P<0.05) slaughter weight while the lowest (P<0.05) was forT4. However, there was no significant difference in slaughter weight between chicks fed T2 and T3 diets but chicks fed T4 diet had the lowest slaughter weight.

Table 8. Effect of different levels of *furfurame* on edible carcass parts

Carcass component (g)	Treatments				SEM
	T1	T2	T3	T4	
Slaughter weight	3216[a]	2785[b]	2770[b]	2266[c]	92
Commercial carcass parts:					
Neck	105.7[a]	95[b]	95[b]	83[c]	3.2
Wing	146[a]	128[b]	127[b]	95[c]	4.1
Back	188[a]	167[b]	169[b]	137[c]	4.8
Breast	715[a]	655[b]	655[b]	590[c]	14
Thigh	397[a]	334[b]	332[b]	262[c]	14
Drumstick	369[a]	315[b]	314[b]	248[c]	12
Skin	194[a]	153[b]	151[b]	102[c]	10
Edible offal:					
Gizzard	90[a]	76[b]	75[b]	55[c]	3.9
Liver	107[a]	90[b]	88[b]	67[c]	4.3
TEO weight	198[a]	165[b]	163[b]	121[c]	13
Carcass weight	2114[a]	1847[b]	1842[b]	1553[c]	52
Total edible weight	2311[a]	2013[b]	2005[b]	1674[c]	69
Dressing percentage	71.8	72.2	72.7	72.7	0.3

[a b c] Means within rows with different superscript letters are significantly(p<0.05) different. SEM: standard error of means *TEO: Total Edible Offal-it is the summation of gizzard and liver; Carcass weight: it is the summation of all commercial carcass parts; *Total edible: the summation of carcass parts and edible offal. T1 = control (100% maize); T2= 66.67 maize + 33.33% of *furfurame*; T3= 33.33% of maize + 66.67% *furfurame*; T4= 0% maize + 100% *furfurame* in the concentrate mixture.

The highest (P<0.05) commercial carcass weight of the chicks was obtained for T1 diet whereas the lowest (P<0.05) was obtained from the chicks fed T4 diet. Under Ethiopian context, total edible includes edible offal such as gizzard and liver and commercial carcass parts such as skin, neck, wing, back, breast, thigh and drumstick. Total edible offal was the highest (P<0.05) for those chicks fed T1 diet and the lowest (P<0.05) was for those chicks fed T4 diet. There was no significant difference on dressing percentage among the chicks fed different treatment diets.

DISCUSSION

Nutrient and Energy Contents of the Experimental Diets

There is no information available on the chemical composition of *furfurame*. The CP content of T1, T2 and T3 diets (16.2–17.7%) is comparable with the minimum CP requirement (16%) suggested by NRC (1994) but the CP content of T4 diets (15.2 %) was lower than the minimum NRC requirement which could be due to low CP content of *furfurame*. The ME content of treatment diets (12 to 12.9/ kg DM) is more than the minimum ME requirement (11.72 MJ/kg DM) suggested by NRC (1994) for broiler breeds. The fat content of treatment diets (0.73 to 0.87%) was below the fat requirement (1%) of broiler breeds as suggested by NRC (1994). However, Ca content of the treatment diets (0.94 to 1%) in the current experiment is within the range recommended (0.8 to1%) for broiler breeds by NRC (1994). *Furfurame* had low ash, CP, EE, ME and Ca compared to maize but it had higher CF content. *Furfurame* had lower EE and ME but higher CF and similar CP content compared with *kocho* as reported by Nurfeta et al. (2015). Due to its high ME and EE content (13.2 MJ/kg DM and 36 g/kg DM, respectively) *furfurame* could be considered as good source energy.

Feed Intake, Weight Gain and DM and Nutrient Efficiency Ratio

The increase in DM intake with increasing levels of *furfurame* in the diet could be due to relatively low energy concentration of *furfurame*. This result agrees with that of Plavnik et al. (1997) who reported that poultry increases DM intake for compensating the low content of energy in their diet. On the other hand, the relatively low DM intake for T1 compared to T4 diets could be attributed to the relatively higher energy concentration of T1 diet which is attributable to maize (14.3 MJ/kg DM). Similar findings have been reported by other workers (Nahashon et al., 2005; Veldkamp et al., 2005) who reported that birds consume feed to primarily meet their energy requirement. The present findings also agrees with the findings of Plavnik et al. (1997) and Nahashon et al. (2006) who reported that as dietary energy increases birds satisfy their energy needs by decreasing feed intake. Decrease in feed intake with high energy diets was reported by Veldkamp et al. (2005) who showed that feed intake decreases linearly as dietary energy increases. The inclusion of high level of *furfurame* in the ration may have affected feed consumption and the bioavailability of other nutrients which agrees with Odensi et al. (1996) who suggested that increasing inclusion level of unconventional feed ingredients may alter the bioavailability of nutrients, texture, color, taste and odor of diets.

The higher daily body weight gain observed for T1 diet could be due to relatively better conversion efficiency. A decrease in body weight gain was observed with increasing levels of *furfurame* which is contrary to the result reported by Nurfeta et al. (2015) who observed similarity in ADG in broilers fed different levels of *kocho* as a substitute to maize. The reason for decreased weight gain with increasing level of *furfurame* in the current study may be due to the fibrous nature of *furfurame* compared with *kocho*. It has been reported that high crude fiber content of leaf meals at high level of inclusion resulted in lower weight gain (Ekenyem and Madubuike, 2006) which could be due to the limited absorption of amino acids and peptide and prevention of their absorption in the intestine (Nworgu et al., 2000). Moreover, Onifade and Babatunde (1997) reported that high fiber content in a diet of broiler interferes with nutrient availability at the tissue level and deprives nutrients availability for growth and maintenance. Dry matter conversion efficiency ratio (DMCER) is a measure of how well a flock converts feed intake into weight gain. It is also the ability of the livestock to turn feed mass to body mass. Birds that have high feed efficiency ratio are considered efficient users of feed. The results of the current study showed that birds fed T1 and T2 diet had better feed conversion efficiency compared to T4. In addition to this, the lower growth rate and the higher DM intake resulted in low *DMCER among the chicks that fed on T3 and T4 diet.*

Nutrient Retention

The CP, ME and EE in the current experiment is not consistent with the findings by Nurfeta et al. (2015) who observed better ME and EE retention in chicks supplemented with maize. Several factors are known to affect body composition such as strain, sex, age, quantity and quality of the dietary CP and ME, slaughter and sampling methods and environmental conditions. According to the results of the current study the higher nutrient retention observed for chicks under T1 and T2 diets might be attributed to the improved feed and nutrient conversion efficiency compared with the other treatments. Chicks fed T1 and T2 diets had higher retained CP than the chicks fed T4 diet because they had the highest feed conversion efficiency and protein efficiency ratio although CP intake was similar among treatments. To the contrary chicks fed T3 and T4 diet had higher DM intakes but lower nutrient retention which may be due to high fiber content of these diets which has had a dilution effect of other nutrient.

Carcass Characteristics

Chicks fed T4 diet had the lowest carcass yield which might be attributed to slightly low energy and CP concentration and poor bioavailability of nutrients. The important commercial parts like drumstick, thigh and breast meat weight were low for the chicks fed T4 diets which could be due to the poor nutrient utilization. However, there were similarities in dressing percentage between the treatments which agrees with the result reported by Scanes et al. (2007) on broiler breeds regardless of diet. To the contrary Nurfeta et al. (2015) observed higher dressing percentage in broilers fed on 100% *kocho* compared with that of 100 % maize. Dana (1999) also observed comparable dressing percentage (63%) for RIR hens kept on choice feeding of energy or protein feeds under intensive and semi-intensive management conditions in the central highlands of Ethiopia. From the result of the current study it can be concluded that *furfurame* diets have no any negative effect on the dressing percentage.

CONCLUSIONS

The availability and utilization of unconventional feed ingredients such as *furfurame* in chicken diets may provide opportunity to reduce cost of production. Better intake of nutrients was observed in T4 when *furfurame* totally (100%) replaced maize. Although important parameters like weight gain, commercial carcass parts are low when maize was replaced by *furfurame*, its availability and low cost may provide an opportunity for smallholder farmers in enset growing areas. *Furfurame* could be included in broilers ration up to 33% for stallholder farmers in enset growing areas.

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