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Research Article

Assessing the partial substitution of roasted soybean seed with sweet potato (*Ipomoea batatas*) leaf meal in feed intake and growth performances of broiler chickens

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The aim of the present study was to evaluate the effect of partial substitution of roasted soybean seed (RSS) with sweet potato leaf meal (SPLM) on growth performances of broiler chickens. Two hundred unsexed Cobb-500 broiler chicks were randomly assigned to five dietary treatments consisting of a control diet (T1) and those containing SPLM at the levels of 30 g/kg (T2), 60 g/kg (T3), 90 g/kg (T4) and 120 g/kg (T5) replacing the RSS of the control diet. Each treatment diet was replicated four times with ten chicks each. The average feed intake of birds was (P<0.05) higher in chickens reared in T1 than those of other treatments. The average individual final body weight was higher (P<0.05) in chickens fed with T1 (1536g) than those of T2 (1412g), T4 (1426g) and T5 (1400g) diets. The average individual daily weight gain was higher (P<0.05) in chickens fed with T1 (31.7g), than those of T2 (28.7g), T4 (28.9g) and T5 (28.5g). The daily gain did not vary between T1 and T3 (30.3g). Chickens fed with T3 and T4 diets had (P<0.05) higher CP retention than those of T1 diet. In conclusion, chickens fed with T1 and T3 diets had better body weight and gain compared to other treatment diets. The feed intake decreased with increasing levels of SPLM suggesting the substitution of roasted soybean with higher levels may not be beneficial for broiler chickens.

Key words: Cobb-500 broiler chicken, growth performance, nutrient intake, partial substitution, roasted soybean seed, sweet potato leaf

INTRODUCTION

Poultry plays an important economic, nutritional and socio-cultural role in the livelihood of rural households in many developing countries, including Ethiopia. Poultry are efficient converters of feed to egg and meat within a short period of time. Many scholars are of the opinion that developing the poultry industry in the developing nations can be the fastest means of bridging the existing gap in protein deficiency (Amos, 2006; Melesse, 2014).
Most experiments on poultry nutrition particularly in the developing countries generally deal with the substitution of one ingredient by another by using conventional feed resources. However, the prices of these conventional feeds are becoming unaffordable to most of smallholders involved in promoting the poultry production sector.

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This problem has been further aggravated by the increasing competition between humans and livestock for these already meager sources of cereal based feed ingredients (Nuhu, 2010). Consequently, the productivity of the poultry sector in the developing countries in general and that of Ethiopia in particular has been grossly limited by both scarcity and high prices of the conventional protein and energy sources. This situation has encouraged researchers to look for unconventional feed sources and incorporation of suitable ones into the diets of the poultry (Nuhu, 2010; Melesse *et al*., 2011, 2012, 2013).

Among the existing unconventional feed resources in the tropics, sweet potato (*Ipomoea batatas*) could be an alternative option. It is an herbaceous creeper plant which resists drought and has short generation interval of about four months which makes it to be planted twice a year (Duyet *et al*., 2003). Studies conducted by Ekenyem and Madubuike (2006) and Adewolu (2008) indicated that the leaf has high protein (26 to 35%) with excellent amino acid profiles. According to FAO (1994), sweet potato leaves contain (on dry matter basis, DM) about 8% starch, 4% sugar, 27% true protein and 10% ash. It has been further reported to be rich in beta carotene amounting to 56 g per 100 g. Recent studies conducted by Melesse et al. (unpublished data) indicates that the leaves contain (on DM basis) 9.93% ash, 24.7% crude protein, 10.1% crude fiber and 4.67% sugar.

The use of leaf meals from some tropical legumes and browse plants like Moringa leaves, in chickens, has been reported by several authors (Melesse *et al*., 2011, 2013; Ayssiwede *et al*., 2011). The sweet potato leaves have been used in some developing countries as a cheap source of protein especially for ruminant feeds. Promising results have been reported by the inclusion of sweet potato leaf in the diets of rabbits (Abonyi et al., 2014), grower broilers (Teguia *et al.*, 1993; Farrell *et al*., 2000; Ayuk and Essien, 2009) and finishing broilers (Teguia *et al.*, 1997;Tamir and Tsega, 2010). Even though sweet potato is cultivated in many parts of Ethiopia for tuber production, its by-products are commonly left on the field during defoliation as well as tuber harvesting. Moreover, information on feeding value of the leaves of sweet potato in the diets of grower chicks in Ethiopia is generally scarce. This study was thus designed to assess the effects of substituting roasted soybean seed with sweet potato leaf meal on nutrient intake and growth performances of Cobb-500 broiler chickens.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at Poultry Research Farm of School of Animal and Range Sciences, Hawassa University which is situated between 7^0 4' N latitudes and 38^0 29' E longitudes at an altitude of 1650 m above sea level. Rainfall is bi-modal and ranges from 700 to 1200 mm annually. The main rainy season extends from April to September interrupted by some dry spells in June and sometimes in May to July. The mean minimum and maximum temperatures in the study area are 13.5 ^oC and 27.6 ^oC (NMA, 2012).

Preparation of experimental diets

The sweet potato *(Ipomea batatas)* leaves were collected from farmers' field at Dale district of Sidama zone (southern Ethiopia), which is situated at an altitude of 1200 m above sea level. After removing branches and twigs, leaves were dried under the shade to prevent the loss of volatile nutrients. During the drying process, regular turning of leaves was carried out to ensure uniform drying which is essential to prevent the possible development of moulds. The air-dried sweet potato leaves were finally transported to the experimental site and ground into coarse powder which thereafter was referred to as air-dried sweet potato leaf meal (SPLM). The ground leaves was packed in bags of 100 kg and stored until used. Samples of SPLM and various ingredients were subjected to proximate analysis before being used in the formulation of experimental diets. The soybean seed was roasted for 5 minutes (to deactivate trypsin inhibitor) and ground prior to inclusion. All ingredients were ground at the feed processing plant of School of Animal and Range Sciences, Hawassa University.

Experimental feed ingredients

The dietary ingredients used in this experiment were maize (*Zea mays*), roasted soybean seed *(Glysine max*), wheat bran, Noug seed cake (*Guizotia abyssinica*), sweet potato leaf meal (SPLM), limestone, methionine, lysine, and salt (Table 1). All ingredients excepting the lime stone and SPLM were purchased from local market at Hawassa city.

Experimental design and duration

The experiment was a completely randomized design (CRD) consisting of five dietary treatments replicated four times (Table 3). Ten unsexed broiler chicks were randomly assigned to each of replicates of the five treatment diets. The control diet (T1) contained roasted soybean seed as the major protein source with no sweet potato leaf meal and other diets containing SPLM at the levels of 30 g/kg (T2), 60 g/kg (T3), 90 g/kg (T4) and 120 g/kg (T5) to partially replace the roasted soybean seed in the control diet. The starter rations for the first and second weeks of brooding periods were prepared with 1.5% and 2% SPLM, respectively to adapt the chicks to the experimental diets. Birds in each replicate were fed

Table 1. Proportion of feed ingredients (% dry matter) of the starter and experimental diets of the broiler chickens

Ingredients (%)	Starter diets		Treatment diets				
	Week1	Week2	T1	T2	T3	T4	T5
Maize (white)	40.2	40.0	48.0	48.0	48.0	48.0	48.0
Soybean seed (roasted)	40.7	40.4	30.0	27.0	24.0	21.0	18.0
Wheat bran	10.0	10.0	11.6	11.6	11.6	11.6	11.6
Noug seed cake	4.40	4.40	6.20	6.20	6.20	6.20	6.20
Sweet potato leaf meal	1.50	2.00	0.00	3.00	6.00	9.00	12.0
Limestone[1)]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Lysine	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Vitamin/mineral premix	0.50	0.50	1.50	1.50	1.50	1.50	1.50
Total	100	100	100	100	100	100	100
Calculated values (%)							
Crude protein	21.6	21.6	18.9	18.6	18.4	18.1	17.9
Crude fiber	4.60	4.60	5.21	5.30	5.42	5.45	5.51
Metabolizable energy (kcal/kg)	3258	3207	3177	3136	3122	3115	3096

[1]) Limestone contains 35% Ca (El-Boushy and Van der Poel, 2000)

as a group and the actual experiment was carried out for six weeks exclusive of the diet adaptation period.

Chickens and their management

Three hundred fifty day-old Cobb-500 broiler chicks were purchased from Alama Poultry Farm, situated at Debre Zeit City, Ethiopia. The chicks were reared in the brooder house for two weeks at the experimental site during which they were provided with starter rations along with small quantities of measured SPLM. At the end of the brooding period, two hundred chicks were weighed individually on a digital sensitive balance and randomly distributed to the replicate pens of each experimental diet. Prior to transferring of chicks to experimental pens, the pens, drinkers and feeders were cleaned, disinfected with formalin and aerated. The chicks were reared in a deep litter housing system whose floor was covered with wood shavings at about 5 cm depth. Sufficient management conditions like floor space, light, temperature, ventilation and relative humidity were provided to each of the groups. The chickens were vaccinated against major poultry viral and bacterial diseases including Marek’s disease, Newcastle disease, infectious bursal disease (Gumboro), fowl typhoid and fowl pox diseases as per the recommended vaccination schedule.

During the experimental period, chickens were fed *ad libitum* on replicate basis and provided with clean and fresh water. Feeds were offered daily in two halves; first half in the morning while the second half was offered in the afternoon. Feed refusal was always measured and recorded while in the event of total usage of feed by any replicate, an adjustment was made in the feed to allow for about 10% refusal subsequently.

Data collection protocols

The amount of feed offered to each replicate was weighed and recorded. Moreover, feed refusals were collected from each replicate and weighed. Feed intake was then computed by difference from feed offered and feed refusal. Body weight of the chicks was taken at the beginning of the experiment and subsequently on a weekly basis, in the morning between 7:00 am and 8: 00 am, prior to offering the feed. Total and daily body weight gain and feed conversion ratio values were then calculated using the measured data. Mortality was recorded throughout the entire experimental period

Whole body analysis for nutrient retention

At the beginning of the experiment, 10 chicks, whose average body weight was similar to the average weight of the experimental chicks in the five treatments, were randomly collected from the reserve group and slaughtered. The carcasses were put into plastic bags and kept in a deep freezer at -20 ^{o}C until they were

Table 2. Nutrient (% DM) and metabolizable energy (kcal kg/DM) contents of sweet potato leaf meal and experimental diets

Nutrients	T1	T2	T3	T4	T5	SPLM
Ash	9.17	9.20	9.80	10.1	10.3	9.93
Crude protein	19.7	19.5	19.3	19.0	18.7	25.2
Ether extract	9.60	9.49	9.38	9.17	9.09	1.08
Crude fiber	8.32	8.47	8.61	8.76	9.01	10.6
Nitrogen free extract	41.6	41.7	41.7	41.1	40.9	47.3
Calcium	0.40	0.41	0.43	0.44	0.45	0.64
Phosphorous	0.15	0.16	0.17	0.18	0.18	0.28
Metabolizable energy	3372	3346	3298	3266	3226	2664

SPLM = sweet potato leaf meal; DM = dry matter

processed for whole body chemical analysis. At the end of the experiment, one male and one female chicken were also randomly collected from each of the four replicates and each weighing close to the average weight of their respective group and sex. They were then slaughtered and the carcasses were weighed and transferred to labeled plastic bags and put in a deep freezer.

The whole body of each chicken was chopped and minced using a commercial mixer while still frozen and then put again back to the deep freezer. After thawing, representative samples were taken from each of the homogenized samples for proximate analysis. The amount of each nutrients retained during the experimental period was then calculated by difference between initial and final concentration of nutrients in the whole body. The amount of each nutrient retained daily was also estimated by dividing the total amount of nutrient retained by the duration of the experimental period (42 days).

Chemical analysis of feeds

Samples of sweet potato leaf meal, feeds offered, feed refusals and chickens' whole body were analyzed for dry matter (DM), ash, ether extract (EE) and crude fiber (CF) by proximate analysis procedures (AOAC, 1995). Total nitrogen content of the feed was determined using micro-Kjeldahl method and the crude protein (CP) was then calculated as nitrogen × 6.25. Calcium and phosphorus were determined by atomic absorption spectrophotometer as described by AOAC (1995). All samples were analyzed in duplicates at Animal Nutrition Laboratory of School of Animal and Range Sciences, Hawassa University. The metabolizable energy (ME) of diets and sweet potato leaf was estimated according to the equation proposed by Wiseman (1987). Nitrogen free extract (NFE) was calculated by difference of organic matter and the sum of CF, EE and CP.

Statistical analysis

Data on feed intake, body weight and weight gain, feed conversion ratio and nutrient retention were subjected to the General Linear Model (GLM) procedures of SAS ver. 9.3 (SAS, 2010). Means were separated using Duncan's multiple range tests. Treatment differences were considered significant at the $P<0.05$ level unless noted otherwise.

The following statistical models summarize the statistics employed to analyze the data.

$Y_{ijk} = \mu + A_i + D_j + A_i*D_j + e_{ijk}$, where:

Y_{ijk} = the observed k variable in the i^{th} treatment and j^{th} sex

μ = overall mean of the observed variable

A_i = effect due to i^{th} treatment levels (i = 30, 60, 90, 120 g/kg)

D_j = effect due to j^{th} sex of chickens (j = male and female)

A_i*D_j = the interaction effects between i^{th} treatment and j^{th} sex

E_{ijk} = random residual error

RESULTS

Nutrient contents of the sweet potato leaf and the diets

As shown in Table 2, the ash and CP contents of sweet potato leaf meal (on DM basis) were 9.93 and 25.2%, respectively. The SPLM contains 10.6% of CF and 1.08% EE. The calculated respective values of ME and NFE in the SPLM were 2664 kcal kg/DM and 47.3%. Moreover, SPLM contains reasonable amounts of calcium and phosphorous.

The CP contents of all experimental diets were similar although it was slightly higher in the control diet (Table 2). The ash and CF contents of the diets increased with increased levels of SPLM. The contents of calcium and phosphorous were also comparable across all treatments diets. The contents of ME and EE were similar among treatment diets.

Intake of nutrients

The effects of various levels of SPLM on the average daily nutrient and energy intakes of growing broiler

Table 3. Nutrient (g/chick/day) and energy (kcal/chick/day) intakes of broiler chickens fed diets containing various levels of sweet potato leaf meal

Nutrients	T1	T2	T3	T4	T5	SEM	P
Dry matter	52.8^{b}	52.9^{b}	55.1^{a}	55.0^{a}	52.9^{b}	2.49	**
Crude protein	8.40	7.90	7.43	7.27	7.17	0.39	NS
Ether extract	3.20	3.30	3.30	3.20	3.30	0.08	NS
Crude fiber	2.50^{c}	2.70^{c}	3.00^{b}	3.10^{b}	3.40^{a}	0.38	***
Calcium	0.18^{c}	0.20^{c}	0.22^{b}	0.24^{a}	0.25^{a}	0.02	*
Phosphorous	0.11	0.123	0.124	0.13	0.12	0.01	NS
Metabolizable energy	135	134	136	135	134	3.19	NS

^{a,b,c} Row means with different superscript letters are significantly different (p<005)
*P<0.05; **P<0.01; ***P<0.001; NS = non significant; SEM = standard error of the mean

Table 4. Average values of initial and final body weights, weight gains, feed intake and conversion ratio in broiler chickens fed diets with different levels of sweet potato leaves meal

Parameters (g/chick)	T1	T2	T3	T4	T5	SEM	P
Initial weight	204	205	205	210	205	4.16	NS
Final weight	1536^{a}	1412^{bc}	1479^{ab}	1426^{bc}	1400^{c}	22.9	**
Total weight gain	1332^{a}	1208^{bc}	1274^{ab}	1216^{bc}	1195^{c}	21.3	**
Daily gain	31.7^{a}	28.7^{c}	30.3^{ab}	28.9^{bc}	28.5^{c}	0.54	**
Daily feed intake	106^{a}	105^{b}	105^{b}	104^{c}	104^{c}	1.67	**
FCR (g feed : g gain)	3.34	3.65	3.47	3.60	3.65	0.21	NS
Mortality (%)	7.50	7.50	10.0	7.50	10.0	1.62	NS

^{a,b,c} Row means with different superscript letters are significantly different (p<0.05)
**P<0.01; FCR = feed conversion ratio; NS = non significant; SEM = standard error of the mean

chickens during experimental period are presented in Table 3. The results indicated that the DM intake was (P<0.01) higher in chickens fed with T3 and T4 diets. The intake of CF increased with increasing levels of SPLM being higher (P<0.001) in T3, T4 and T5 than in T1 and T2. The calcium intake varied (P<0.05) across treatments with higher values being observed in chickens fed with T4 and T5 diets. No significant differences were found in intakes of CP, EE, ME and phosphorous across all the treatment diets.

Growth performances and feed consumption

The findings in Table 4 indicated that the individual initial body weight of chicks did not vary (P>0.05) among treatment diets. The findings also indicated that the individual final body weight and the total body weight gain differed between the treatments with the chickens reared in T1 diet having (P<0.01) higher values than those reared in T2, T4 and T5 diets. Chickens fed with T3 had also (P<0.01) higher final and total weight gain values than those reared in T5. No significant differences (P>0.05) were noted in final body weight and total weight gain between chickens fed with T1 and T3 diets. The chickens fed with T2, T3 and T4 diets had intermediate values for final body weight and total gain with no significant difference (P>0.05) between them. Moreover, chickens fed with T2, T4 and T5 diets did not differ in these parameters.

The average individual daily weight gain was (P<0.01) higher in chickens fed with T1 than those of T2, T4 and T5 (Table 4). Chickens reared in T3 had also (P<0.01) higher daily weight gain than those fed with T2 and T5 diets. No significance difference was noted in individual daily weight gain between chickens reared in T1 and T3 as well as among those kept in T2, T4 and T5 diets.

As presented in Table 4, the average feed consumption of individual birds varied across the treatments and was (P<0.05) higher in chickens fed with T1 than those reared in other treatment diets. Chickens receiving T2 and T3 diets had (P <0.05) higher feed consumption values than those fed with T4 and T5 diets. However, the values pertaining to the feed conversion ratio and mortality rates did not vary (P>0.05) across the treatment diets.

As shown in Table 5, the interaction effect of sex by treatment was not significant to the investigated body weight and gain parameters. However, there was a significant effect of sex on initial (P<0.0001) and final body (P<0.05) weights. Accordingly, male chickens were significantly heavier than female birds.

Table 5. Effect of sex and treatment by sex interactions on the body weights and weight gains of broiler chickens fed with sweet potato leaf meal

Parameters (g/chick)	Male	Female	SEM	Trt	Sex	Trt * sex
Initial weight	215[a]	195[b]	2.41	NS	0.0001	NS
Final weight	1471[a]	1429[b]	15.1	0.0001	0.0507	NS
Total weight gain	1256	1234	13.7	0.0001	NS	NS
Daily gain	29.9	29.4	0.357	0.0001	NS	NS

Trt = treatment diets; NS = non significant

Table 6. The daily nutrient retention in broiler chickens fed with different levels of sweet potato leaf meal (g/chick/day)

Nutrients	T1	T2	T3	T4	T5	SEM	P
Dry matter	5.20[ab]	4.96[b]	5.20[ab]	5.45[a]	5.15[ab]	0.27	*
Organic matter	5.20[ab]	5.46[ab]	4.62[b]	5.76[a]	5.36[ab]	0.27	*
Crude protein	2.85[b]	3.03[ab]	3.20[a]	3.13[a]	2.92[ab]	0.01	*
Ether extract	0.90	1.11	1.01	1.14	0.90	0.36	NS

[a,b,c] Row means with different superscript letters are significantly different (P<0.05)
*P<0.05; NS = Non significant; SEM = Standard error of the mean

Utilization of nutrients

As indicated in Table 6, the chickens fed with T4 diet had (P<0.05) higher DM retention than those of T2 which did not differ with other treatments. No significant differences were noted in DM retention among chickens fed with T1, T3, T4 and T5 diets. The organic matter retention was significantly higher in chickens fed with T4 than those of T3. Chickens fed with T3 and T4 had (P<0.05) high CP retention values as compared with those receiving the T1 diet. The retention value for EE was not significant between the treatment diets.

DISCUSSION

Chemical composition of the sweet potato leaf and treatment diets

Sweet potato leaf

The CP and estimated ME contents of dried leaves of sweet potato in this study can be considered as good sources of poultry feed. Teguia *et al.* (1997) reported similar results regarding the CP content of SPLM. The calculated ME in SPLM in the present study was higher to that of Duyet *et al.* (2003) who reported 2223 kcal ME /kg DM in fresh leaves of sweet potato. Studies by Tsega and Tamir (2009) also indicated that the CP and ME values of SPLM were 25% and 2672 kcal/kg, respectively which are comparable to the present findings. The high ash content observed in leaves of sweet potato might be due to the high potassium and iron concentration (Melesse et al., unpublished data). The CF content of SPLM was assessed to be quite low when compared to other roughages and is comparable to the leaves of Moringa species (Melesse *et al.,* 2009, 2012).

Treatment diets

The nutrient compositions of all the treatment diets used in this experiment were almost comparable. The CP contents of all experimental diets were similar although it was slightly higher in the control diet which is justifiable due to high levels of roasted soybean seed in the diet and are within the recommended levels for grower and finisher broilers as suggested by Scanes *et al*. (2004). The decreasing trend of ether extract (EE) with an increased level of SPLM in diets may be explained by the replacement of roasted soybean seed with SPLM as the lipid contents in soybean are higher than that of SPLM. All the treatment diets contain the recommended levels of (Ca: P) ratio for grower chicken diets under tropical conditions (Smith, 1990).

The CF content of the diets increased with increasing levels of SPLM being slightly higher in T5 than the rest of the diets which influenced the dietary intake of chickens and these observations are in accordance with those of Tamir and Tsega (2010). The ash content linearly increased with the level of SPLM in the diets as might be expected due to high mineral content of the sweet potato leaf meal.

Nutrient intakes

The results pertaining to reduced feed intake in chickens fed with higher levels of sweet potato leaf (T4 and T5) diets are in good agreement with the observations of Tsega and Tamir (2009) who reported that the supplementation of dried leaves of sweet potato beyond 10% in the diet of finisher broilers resulted in reduced DM intake than those kept in the control diet. Ayssiwede *et al.*

(2011) also reported that at higher levels of *Moringa oleifera* leaf meal inclusion (16% and 24%), there was a decrease in feed intake in Tanzanian local chickens. Similar observations pertaining to inclusions of different types of leaf meals on reduced feed intake have also been reported by Nworgu and Fasogbon (2007) for inclusion of 2-6% *Centrosome pubescens* leaf meal for growing pullets and Odunsi (2003) for inclusion of 10 and 15% *Lablab purpureus* leaf meal for layers hens. The lower feed intake at higher inclusion levels can be further explained by the combined effects of increasing crude fiber and decreasing ME concentration of diets with increasing levels of SPLM as suggested by Vieira *et al*. (1992), Olugbemi *et al*. (2010), and Melesse *et al.* (2013). This is because the feed consumption of the birds is dependent on the energy content of the feed which they have to fulfill to meet their daily requirements (Vieira *et al*., 1992).

Contrary to the present findings, Kakengi *et al*. (2007) observed higher feed intake in pullets reared on higher levels (10-20%) of *Moringa oleifera* leaf meal. Similarly, Mmereole (2009) reported that diets containing 20% of enzyme treated sweet potato leaf resulted in improved body weight, weight gain and other performance traits in broiler chickens. The studies by Olugbemi *et al*. (2010) indicated that there was improvement in feed intake when broilers were fed up to 5-10% of *Moringa oleifera* leaf meal.

Growth performance parameters

In the present study, non significant interactions between sex of the chickens and the treatment diets were observed indicating that the inclusion of sweet potato leaf had similar effect on both sexes and are in good agreement with the findings of López *et al.* (2011) for broiler chickens and Melesse *et al.* (2013) for dual purpose Koekoek chickens. On the other hand, the observed higher values for initial and final body weights in male birds than females might be attributed to the presence of sex hormones (androgen) that enhanced muscle development (Scanes, 2003). The main factor on sex differences in body weight and muscularity may be predetermined during embryonic development when the number of myofibers is established (Mitchell and Burke, 1995). Findings of Henry and Burke (1998) also suggested that the muscles of male embryos have more but smaller myofibers than females, which may be responsible for the sex difference in embryo weight and provide the framework for the greater post-hatching muscle growth.

The partial substitution of roasted soybean seed up to 9% level of sweet potato leaf appeared to have no detrimental effect on the body weight and weight gain of broiler chickens; and these findings are consistent with those of Olugbemi *et al*. (2010), Ayssiwede *et al*. (2011), Melesse *et al.* (2013) who reported enhanced growth of chickens fed with *Moringa* leaf meal. Similarly, Tsega and Tamir (2009) and Tamir and Tsega (2010) reported that the supplementation of dried leaves of sweet potato upto 10% in finisher broiler diet resulted in improved weight gain than the non-supplemented group. Another study conducted by Abonyi *et al.* (2014) indicated that rabbits fed with 50% of sweet potato leaves by replacing 50% of pelletized concentrate feed resulted in increased values for final body weight, total weight gain, daily weight gain and feed conversion ratio. Surprisingly, rabbits fed with 25% of sweet potato leaves by replacing 75% of the pelletized concentrate feed were inferior in these parameters as compared with those reared in 50% level of inclusion indicating inconsistent response of animals to increasing levels of sweet potato leaf in the rabbits' diet. Similar inconsistent trends were also observed in the present findings in which chickens fed with the control diet (T1) and 6% of SPLM (T3) had better growth performances than those reared in other treatment diets.

On the other hand, chickens reared in treatment diets with higher levels of sweet potato leaf showed reduced final body weight and weight gain values and the findings are consistent with those of Tsega and Tamir (2009) and Tamir and Tsega (2010) who reported that the supplementation of dried leaves of sweet potato at the levels of 15 and 20% of the diet resulted in significant lower weight gain than the non-supplemented group. Ayuk (2004) and Ayuk and Essien (2009) investigated the effect of substituting maize with various levels of sweet potato tuber meal on the growth performances of broilers and reported curvilinear decline in growth rate (from 27.9 to 23.3 g/day) as the maize was replaced by sweet potato root meal. Similarly, Ekenyem and Madubuike (2006) have reported a depressed growth performances in broilers fed with higher levels (15%) of *Ipomoea asarifolia* leaf meal. The observed reduced body weight and gain values with increasing levels of SPLM may suggest that higher levels of inclusions of SPLM in the broiler diets might not be suitable for broiler chickens. This might be attributed to the effects of nutrient imbalance and poor metabolism in monogastric animals fed high levels of unconventional feed ingredients. Moreover, depressed growth performances might be associated with lower feed intake at higher levels of sweet potato leaf meal substitution and possibly, due to deficiencies of essential amino acids in the leaf meal.

In the present study, the feed conversion ratio did not vary among treatment diets and is consistent with the findings of Farrell *el al.* (2000) who reported a non-significant difference in dry matter conversion efficiency in broilers fed with different levels of dried sweet potato vine meals. The findings are also similar to those of Teguia *et al.* (1993, 1997) who reported that no detrimental effect was observed in feed conversion ratio even at higher (20%) levels of sweet potato leaf by substituting maize in broiler diets. Similarly, better feed conversion ratio values were reported by Olugbemi *et al.* (2010) in broiler chickens reared at higher levels of Moringa leaf meal.

The feed conversion ratio did not show a uniformed pattern with increased levels of sweet potato leaf. Accordingly, it was numerically highest in chickens fed with T2, T4 and T5 diets but lowest in those reared in T1 and T3. Chickens with highest feed conversion ratio may suggest that the feed is less efficiently converted to animal products.

Nutrient retention and utilization

The higher (P<0.05) retention values in DM, OM and CP in chickens receiving T4 are in close agreement with the observations of Frankic *et al*. (2009) who reported that herbs such as sweet potato leaves stimulate the secretion of pancreatic enzymes, important factors in nutrient digestion and retention. However, the results were by large inconsistent in chickens receiving T2, T3 and T5 treatment diets vis-à-vis those reared on T1 diets. The inclusion of non-conventional feeds versus conventional feed (T1) indicated that the levels of retention was more or less similar with those of Wolde *et al*. (2011) who observed that among the RIR chickens receiving lowest dietary crude protein resulted in significantly lower protein retention as compared to those receiving high crude protein supplemented diets.

CONCLUSIONS

The effect of the partial substitution of roasted soybean seed with sweet potato leaf meal on performance of Cobb-500 broiler chickens showed inconsistent response patterns to treatment diets. Accordingly, chickens fed with T1 and T3 diets appeared to have better performances in body weight and gain compared to those of other treatment diets. The feed consumption was better in those chickens fed with the control diet and consistently decreased with increasing levels of sweet potato leaf which suggests that higher levels may not be beneficial for broiler chickens. It would be however worthwhile to note that the dry matter intake and crude protein retention of broiler chickens has been improved with increased levels of sweet potato leaf. We thus recommend further studies to assess the effect of sweet potato leaf meal on serum biochemical and meat quality parameters of broiler chickens.

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