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Effect of Replacing Maize (*Zea Mays L.*) with Orange Fleshed Sweet Potato Tuber (*Ipomoea Batatas*) on Performance of Cobb 500 Broiler Chickens

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Abstract

Effect of replacing maize with cooked orange flesh sweet potato tuber on feed intake, body weight gain (BWG), carcass characteristics and feed conversion efficiency (DMCR) of Cobb 500 broiler chicks and profitability of the rations was evaluated in Hawassa University, in 2017. Sexed 150 Cobb 500 broiler chicks were randomly assigned to 5 treatments (T1…T5) each with 3 replications in a completely randomized design. T1 contained 0% partially cooked sweet potato tuber meal (PCSPTM), T2 4% CSPT, T3 8% PCSPTM, T4 12%CSPT and T516% CSPT during starter phase and 0% , 5%, 10% , 15% and 20% PCSPTM in T1…..T5,respectivelyduring growth phase as percent of concentrate mix. Intake of DM during the starter phase, grower phase and the entire trial period was higher (P<0.05) for T4 and T5 compared with T1, T2 and T3. The highest (P<0.05) (BWG) was recorded in broilers fed T3 during starter phase while the highest BWG was recorded in T4 and T5 during grower phase and the entire experimental period. DMCR of T5 was better (P<0.05) than that of the other treatments during starter phase, but during grower and entire period T2 had the highest (P<0.05) of all treatments. The carcass weight of the chick fed T5 and T4 was significantly higher than that of T1 and T2 but it was similar (P>0.05) with those fed T3. There was no significant difference (P>0.05) in dressing percentage between treatments. The highest total return, net income and marginal rate of return was noted for T5. It can be conclude that PCSPTM can be fed to broiler chickens up to 16% of diet during starter and up to 20% during grower phase with promising growth performance.

Keywords: Broiler; Partial cooked; Performance; Sweet potato

Abbreviations: BWG: Body Weight Gain; PCSPTM: Partially Cooked Sweet Potato Tuber Meal

Introduction

Ethiopia is one of the few African countries with a large population of chicken which covers 60% of the population [1]. Poultry plays an important economic, nutritional and socio-cultural role in the livelihood of rural households in many developing countries, including Ethiopia. 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 [2,3]. The scarcity and prohibitive cost of commercial energy sources like maize and sorghum for poultry rations, has been the main cause of the high cost of poultry products especially in developing countries. This will subsequently lead to inhibition of the cost of production of poultry meat. According to the production data base [4], the total number of chickens for meat production in the world was 59.7 billion in 2012. Maize serves as the major energy ingredient in the diets of most livestock and especially non-ruminants like poultry. A decrease in the availability of maize and an increase in the price for feed have a direct impact on the broiler industry worldwide [5].In order to step down the problem of high and unstable price situation and save the collapse of the poultry industry, there is the need to broaden the energy source base by assessing unconventional feedstuffs [6]. In order to compensate for this change, alternative feed ingredients must be identified [7]. The new ingredients must be able to substitute for maize totally or partially and not have a negative impact on the efficiency of broilers [8].

The other type of feed which could be used for poultry is sweet potato which is capable of thriving and yielding well on poor soils and may be a saving grace for the poultry industry [9]. The rising costs of maize necessitate a research for cheaper and locally available non-conventional energy feed stuffs such as sweet potato (*Ipomoea batatas* LAM). It is for this reason that sweet potato which at present has limited alternative uses, cheap and has a stable price compared to cereal crops, is being considered for evaluation in the feeding of broiler chickens. Non-conventional feedstuffs offer the best alternative for the reduction of feed cost and cost of animal products [9]. Sweet potato is a tuber crop produced in most countries and is consumed mainly as a starch source in the diet of humans but is also rich in other important nutrients [10]. Over 95% of sweet potato is produced in developing countries [11].

The storage tubers of sweet potato are valuable source of carbohydrates, vitamins, and micro-nutrients especially in the orange and yellow-fleshed cultivars, which contain β-carotene. But sweet potato tubers are very low in fiber content.The digestibility of sweet potato carbohydrate fraction is reported to be above 90 % [12]. Some studies have indicated that sweet potato can replace maize in the diet of broilers [13]. Sweet potato tubers contain different anti-nutritional factors which reduce dry matter digestibility and Metabolizable protein and, energy values even when rations contained adequate and high quality proteins [14]. Preheating can destroy or reduce these trypsin inhibitors. Earlier result show that when sweet potato tuber is cooked, between 17% and 31% trypsin inhibit or activity remained and when it was prepared into flour only 5-12% trypsin inhibit or activity was found.

This study was designed to evaluate the effect of replacing maize with cooked orange-fleshed sweet potato tuber meal/ flour on feed intake, body weight gain and carcass characteristics of broiler chicken.

Materials and Methods

Description of study area

The experiment was conducted at College of Agriculture, Hawassa University which is situated 265km south of Addis Ababa at 7 ° 4' N latitude and 38 ° 31'E longitude at an altitude of 1680 meter above sea level. The main rainy season extends from April to September interrupted by some dry spells in May or June with annual precipitation ranging between 1000 and 1200mm. The mean minimum and maximum temperatures in the study area are 13.5 °C and 27.6 °C [15].

Collecting and processing of sweet potato tuber

The orange fleshed sweet potato tuber was collected from Tula Grarekata farm, district of Sidama zone (southern Ethiopia). The tubers were thoroughly washed, sorted, peeled and sliced into equal sized chips using a knife to facilitate uniformity in cooking. Sweet potato tuber was partially cooked in boiled water at 100 °C for forty five minutes to eliminate trypsin inhibit or activity [12]. The chopped sweet potato was air dried on concrete floor for one week to a moisture content of less than 10% to reduce enzymatic and microbial reactions which may lead to spoilage. Finally air dried sweet potato was groundand used in feed preparation.

Preparation of experimental house

The experimental broiler house was divided by wire mesh into 15 equal sized pens. Each pen was separated by 2m x 2m and properly washed and cleaned by using tap water and disinfected by Iosan. Pen floors were covered with saw dust to 5cm depth.

Experimental chicks and their management

Day-old broilers (46+1g) were bought from Alema farm, Debre-Zeyit. The birds received constant illumination and had free access to water and feed. Heat was provided in the daytime by using 150 watt infra-red light bulbs placed in strategic points in the brooder. Moreover, heat from burnt charcoal was used together with bulbs to provide heat during cool nights. During the adaptation period fresh clean drinking water mixed with multivitamins was also given *ad libitum* for the chicks to overcome stress according to the manufacturer's recommendation.

The chicks were vaccinated against Newcastle disease, infectious BD and Lasota disease at 7, 14 and 21 days of age, respectively, according to the manufacturer's guideline. After brooding the chicks were weighed individually to determine initial body weights. They were weighed and transferred to the pens in a separate house. The pens were properly ventilated and electrically heated using two 60 watt light bulbs per pen. The wet litter was changed with dry and clean sawdust whenever necessary. The litter material used was occasionally turned and was totally changed to prevent any contamination during the grower phase. The chicks were offered their respective diets twice a day at 8:00 and 16:00 hours. The refusals were measured every morning using sensitive balance for calculation of feed consumption.

Experiment lay out

At seven days of age (98±2.5g body weight), the chicks were distributed in a completely randomized design (CRD) consisting of 5 dietary treatments replicated 3 times, with 10 birds per replicate. The control diet (Table 1) contain maize as the major energy source with no sweet potato tuber meal and other diets (Table 2-5) contained different levels of PCSPTM to partially replace maize in the control diet.

Experimental Diets and Ingredients

The feed ingredients used in the formulation of the different experimental rations of this study were maize(*Zea mays*), roasted soybean seed (*Glysine max*), wheat bran, noug seed cake (*Guizotia abyssinica*), PCSPTM, premix, limestone and salt (Table 1 & 2).Chicks were fed starter and grower diets for 21 days during each phase. Based on NRC [16] recommendation for optimum production 3200 kcal/kg DM metabolizable energy (ME) is adequate for growing broilers and rations must contain 23% and 20% of crude protein, for broiler starter and grower, respectively.

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Table1: Proportion of feed ingredients (%) of starter diets fed to broiler chickens.

Ingredient (%)	Treatment Diets					
	Week 1	T1	T2	T3	T4	T5
Maize	40	40	36	32	28	24
Sweet potato tuber (dried and ground)	1.5	0	4	8	12	16
Wheat bran	11	12	12	12	12	12
Noug cake	6	6	6	6	6	6
Roasted soybean	40	40	40	40	40	40
Limestone	0.5	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Premix/mineral &vitamin	0.5	1	1	1	1	1
Total	100	100	100	100	100	100
Nutrient composition						
Crude protein (% DM)	23.47	22.37	22.2	22..03	21.86	21.8
Crude fiber (% DM)	6.03	6.2	6.2	6.1	6.2	6.2
Metabolizable energy (kcal/kg DM)	3270	3278	3249	3250	3251	3252

Grower phase (4-6 week): 3-week old broiler chickens acquired from the starter phase were used. The treatments diets consisted of: T1= ration containing 0% PCSPTM+50% Maize; T2=ration containing 5% PCSPTM +45% Maize; T3=ration containing 10% PCSPTM + 40% Maize; T4=ration containing 15% PCSPTM + 35% Maize and T5=ration containing 20% PCSPTM + 30% Maize. Similar data like that of starter phase were collected during the grower phase as well.

Table 2: Proportion of feed ingredients (%) of grower diets fed to broiler chickens.

Ingredient (%)	Treatment				
	T1	T2	T3	T4	T5
Maize	50	45	40	35	30
Sweet potato tuber (dried and ground)	0	5	10	15	20
Wheat bran	12	12	12	12	12
Noug cake	6	6	6	6	6
Roasted soybean	30	30	30	30	30
Limestone	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Premix/mineral & vitamin	1	1	1	1	1
Total	100	100	100	100	100
Nutrient composition					
Crud Protein (%DM)	19.3	19	18.56	18.36	18.14
Crude Fiber (%DM)	5.73	5.72	5.73	5.72	5.73
Metabolizable Energy (kcal/kg DM)	3278	3249	3250	3251	3252

Starter phase (1-3 week)

The experimental diets that were fed after adaptation period were

a. T1=ration containing 0% PCSPTM+40% Maize;

b. T2= ration containing 4% PCSPTM +36% Maize;

c. T3=ration containing 8% PCSPTM + 32% Maize;

d. T4=ration containing 12% PCSPTM + 28% Maize and

e. T5=ration containing 16% PCSPTM + 24% Maize.

Records of feed offered and refused, body weight, and mortality were kept for each replicate in a treatment group.

Grower phase (4-6 week)

3-week old broiler chickens acquired from the starter phase were used. The treatments diets consisted of

a. T1= ration containing 0% PCSPTM+50% Maize;

b. T2=ration containing 5% PCSPTM +45% Maize;

c. T3=ration containing 10% PCSPTM + 40% Maize;

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d. T4=ration containing 15% PCSPTM + 35% Maize and

e. T5=ration containing 20% PCSPTM + 30% Maize. Similar data like that of starter phase were collected during the grower phase as well.

Body Weight and Carcass Measurements

Birds in a replicate were weighed together throughout the experimental period at weekly intervals and average weight of chicks calculated. Feed conversion ratio was calculated by dividing feed intake by weight gain. At the end of the experiment 9 birds per treatment (3 per replicate) were selected to determine carcass characteristics. Feed was withdrawn for 12 hours in preparation for slaughter, and the fast body weight of each bird was taken and recorded. The feathers were removed. After dressing, the weights of dressed carcass, edible and non-edible carcass were determined according to the procedure of Zanu et al. [17]. Thus, the total edible meat was the sum of carcass weight and edible organs. The dressing percentage was determined by dividing total edible meat by slaughter live weight and multiplied by 100.

Chemical Analysis

This was carried out at Hawassa University College of Agriculture Animal Nutrition laboratory and soil laboratory. Samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), Ash, Ca and P using the Weende or proximate analysis method [18]. Kjeldhal procedure [18] of nitrogen analysis was used to determine nitrogen (N) and the crude protein (CP) was calculated as N x 6.25.Mineral (Ca and P) was analyzed by atomic absorption spectrometer [18]. All the laboratory analyses were carried out in duplicate. Metabolizable energy (ME) of the rations was estimated as follows ME (kcal/kg DM) = 3951+54.4 EE - 88.7 CF - 40.8 ash [19].

Partial Budget Analysis

For the determination of the potential profitability of PCSPTM by partial budget analysis, purchasing and selling prices of chick and the total quantity of basal and supplement feed and its purchasing prices were recorded where as veterinary services were common for all treatments.

Statistical Analysis

Data were analyzed for ANOVA using Statistical Analysis System (SAS, 2009 version 9.0) and means were separated using Tukey test at 5% of significance level. The model used was Yij= μ+ti+eij, where; Yij = the response variable; μ= overall mean; ti= treatment effect and eij= random error.

Results

Chemical composition of ingredients and experimental rations

The CP (6.56%), CF (1.97%), EE (1.05%) and P (0.2) contents of partially cooked orange flesh sweet potato tuber was lower than that of maize (8.47, 3.8, 3.02 and 0.25%, respectively) and other ingredients, but its ash (3.91%) and calcium (0.3%) contents were higher than that of maize (2.44 and 0.1%, respectively). The ME content of PCSPTM (3674 kcal ME/kg) was slightly lower than that of maize (3678 kcal ME/kg).

The CF and EE content of starter and grower diets in the present study slightly decreased with increasing level of CSPTM. The calcium content of the diet increased as the level of PCSPTM increased (Table 3).

Table 3: Chemical composition (%DM unless specified) of the starter and grower rations.

Feed composition	Starter phase					Grower phase				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
DM (%)	95.4	95.65	96.23	97.29	96	95.87	95.68	95.61	96.9	95.57
Ash	5.81	4.86	4.44	4.22	4.4	5.14	5.05	5.25	5.02	4.28
Ether extract	4.2	4.04	4.1	3.7	3.4	4.8	4.5	4.03	3.99	3.5
Crude fiber	8.5	8.2	7.96	7.7	7.4	8.3	8.04	7.6	7.54	7.52
Crude protein	23.1	23.31	23.48	23.37	23	20.38	20.4	20.24	20.8	20.25
Calcium	0.9	0.98	1.2	1.3	1.7	1	1.1	1.44	1.3	1.34
Phosphorus	0.32	0.25	0.4	0.33	0.3	0.41	0.36	0.39	0.35	0.29
ME (kcal/kg)	3188	3245	3287	3297	3298.2	3266	3277	3282	3294	3300

Dry matter and nutrient intake

The dry matter (DM) and nutrient intake during the starter and grower phases are presented in (Table 4). Total DM intake during the starter, grower and entire experimental period were higher (P<0.05) for groups fed T4 and T5 diets than those fed with the other treatments, the difference being more pronounced during the last three weeks of the grower phase (Figure 1). The average daily CP intake during the starter phase in T1 and T2 was higher (P<0.05) than in T5 but it was similar (P>0.05) with T3 and T4. During the grower phase, the CP intake for T1 and T2 was greater than that of T3, with similar (P>0.05) intake with T4 and T5. The mean daily ME intakes during starter and grower phase did not differ (P>0.05) significantly among the five dietary treatments.

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Table 4: Effect of replacing cooked orange fleshed sweet potato tuber meal with maize meal on dry matter and nutrient intakes of broilers during starter and grower phases.

Intake	Treatment Diets						
	T1	T2	T3	T4	T5	SEM	SL
Starter phase							
Total dry matter (g/bird)	851^{b}	853^{b}	857^{b}	902^{a}	908^{a}	3.06	*
Dry matter (g/bird/day)	41^{b}	41^{b}	41^{b}	43^{a}	43^{a}	0.15	*
ME(kcal/bird/day)	223	223	223	223	223	0.1	Ns
Crude protein(g/bird/day)	10.9^{a}	10.7^{ab}	9.9^{ab}	9.3^{ab}	9.1^{b}	0.5	*
Grower phase							
Total DM (g/bird)	1900^{c}	1958^{c}	2052^{b}	2175^{a}	2192^{a}	18.3	*
Dry matter (g/bird/day)	91^{c}	93^{c}	98^{b}	104^{a}	104^{a}	0.87	*
ME (kcal/bird/day)	394	401	394	402	401	10	Ns
Crude protein (g/bird/day)	23.9^{a}	23.7^{a}	20.0^{b}	21.8^{ab}	21.7^{ab}	0.6	*
Entire period							
Dry matter (g/bird)	2751^{c}	2811^{c}	2910^{b}	3076^{a}	3100^{a}	18.1	*
Dry matter (g/bird/day)	66^{c}	67^{c}	69^{b}	73^{a}	74^{a}	0.43	*

abcmeans within the same row bearing different superscripts are significantly different (P<0.05); SEM=significant error of mean; SL= significant level; ns= non- significant; *= significant at 5%.

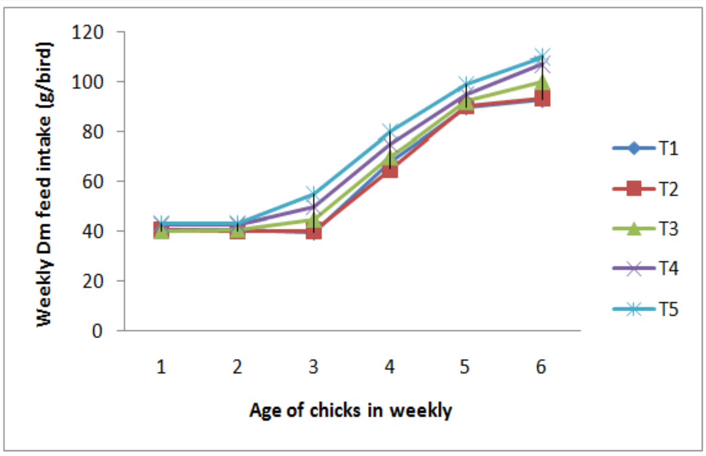

Figure 1: The weekly dry matter intake of chicks during the experimental period.

Body Weight Gain and Dry Matter Conversion Ratio

The initial body weights of chicks were similar. The body weight gain (BWG) for T3 was higher (P<0.05) than that of T4, T5 and T1 but it was similar with T2 during the starter phase (Table 5). During the grower phase the BWG for T5 was greater (P<0.05) than that of T1 and T2. However, for the entire experimental period BWG for T3, T4 and T5 was higher (P<0.05) than that of T1 and T2. Birds fed T5 ration had the highest (P<0.05) dry matter conversion ratio (DMCR) during the starter phase. During the grower phase and the entire experimental period, the groups consuming T2 diets had the highest (P<0.05) DMCR.

Birds continuously increased body weight up to week three in all treatment groups, but T3 gained at faster rate than the remaining treatments between the third and fourth week of the experiment. After week five T3, T4, and T5 had highest body weight than T1 and T2 (Figure 2).

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Table 5: The Effect of substituting cooked orange fleshed sweet potato tuber meal for maize on body weight gain and feed conversion ratio of broiler's during the starter and grower phases.

Body weight	Treatment						
	T1	T2	T3	T4	T5	SEM	SL
Starter phase							
Initial body weight (g)	97.8	99.6	97.6	98.2	99.2	0.38	Ns
Final body weight (g)	512^{b}	600^{ba}	659^{a}	512^{b}	462^{b}	30	*
Total BWG (g/bird)	414^{b}	500^{ba}	561^{a}	414^{b}	362^{b}	30	*
ADG (g/bird)	20^{b}	24^{ab}	27^{a}	20^{b}	17^{b}	1.4	*
Grower phase							
Initial BW (g)	512^{b}	600^{ab}	659^{a}	512^{b}	462^{b}	30	*
Final BW (g)	1147^{b}	1127^{b}	1387^{a}	1417^{a}	1413^{a}	36	*
Total BWG (g/bird)	635^{b}	527^{b}	728^{ab}	906^{ab}	952^{a}	44	*
ADG (g/bird)	30^{b}	25^{b}	35^{ab}	43^{ab}	45^{a}	2.1	*
Entire period							
Total BWG (g/bird)	1049^{b}	1027^{b}	1289^{a}	1319^{a}	1314^{a}	36	*
ADG (g/bird)	25^{b}	25^{b}	31^{a}	31^{a}	31^{a}	0.85	*
DMCR							
Starter	2.1^{c}	1.7^{d}	1.5^{e}	2.2^{b}	2.5^{a}	0.02	*
Grower	3.0^{b}	3.7^{a}	2.8^{b}	2.4^{c}	2.3^{d}	0.04	*
Entire period	2.6^{b}	2.7^{a}	2.26^{d}	2.34^{c}	2.4^{c}	0.02	*

^{abc}dmeans within the same row bearing different superscripts are significantly different (P<0.05); SEM=significant error of mean; SL= significant level, BWG= body weight gain, ADG= average daily gain, g = gram; DMCR= feed conversion ratio

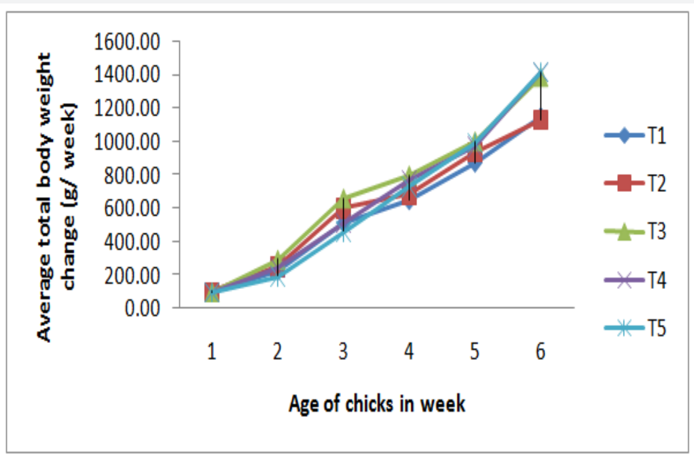

Figure 2: The average body weight change of the broilers fed different treatment diets over the treatment period.

Carcass characteristics

The carcass parameters and edible offal of broilers fed the experimental diets are shown in (Table 6). The slaughter weight and breast muscle for T5, T4 and T3 was higher (P<0.05) than those of T1 and T2 diets. The carcass weight for T5 and T4 was significantly higher than that of T1 and T2 but similar (P>0.05) with that of T3. The lowest (P>0.05) neck weight was for T1. The wing weight for T4 was greater (P<0.05) than T1, T2 and T3. There was no significant deference in the weight of thigh and dressing percentage among treatments. The drumstick weight for T3 was higher (P>0.05) than T1 while the values were similar (P>0.05) with other treatment diets. Skin weight for T5 was higher (P<0.05) than that of T1. The lowest (P<0.05) liver weight was for T1 while the highest (P<0.05) heart weight was for T5.

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Table 6: The effect of substitution of cooked sweet potato tuber for maize on carcass traits and edible offal.

Carcass weight (g)	Treatment						
	1	2	3	4	5	SEM	SL
Slaughter	1147[b]	1127[b]	1387[a]	1417[a]	1413[a]	18	*
Carcass	623[c]	652[bc]	709[ba]	743[a]	764[a]	21	*
Blood	35[b]	40[b]	46[ab]	54[a]	42[ab]	4	*
Neck	28[c]	32[a]	36[a]	38[a]	38[a]	1	*
Wing	27[c]	34[bc]	32[bc]	42[a]	38[ab]	2	*
Breast bone	55[c]	75[b]	75[b]	75[b]	91[a]	4	*
Breast muscle	130[c]	157[b]	186[a]	195[a]	200[a]	9	*
Thigh	123	143	140	143	136	5	Ns
Drumstick	122[b]	127[ab]	135[a]	130[ab]	134[ab]	4	*
Abdominal bone	89[ab]	87[ab]	73[b]	67[b]	117[a]	10	*
Thorax	22[c]	31[b]	31[b]	34[ab]	37[a]	2	*
Dressing percentage	63.9	67.73	60.42	61.8	63.53	2.09	Ns
Edible offal (g)							
Skin	42[b]	70[ab]	66[b]	70[ab]	75[a]	2.81	*
Gizzard	31	31	29	27	25	1.87	Ns
Liver	19[b]	29[a]	27[a]	27[a]	28[a]	1.66	*
Heart	5[b]	6[b]	6[b]	5[b]	7[a]	0.22	*

abcmeans within the same row bearing different superscripts are significantly different ($P < 0.05$); SEM=significant error of mean; SL= significant level; CSPT= cooked sweet potato.

Partial budget analysis

Feed cost in the present study was evaluated based on the current market price of the ingredients. The results indicated that the total return, net return and marginal rate of return was highest for T5 diet (Table 7). The control treatment had the lowest return as compared to the ration containing PCSPTM. The result showed that, the cost of producing a bird with control diet was significantly higher than the rest of the treatments.

Table 7: Partial budget analysis of broiler chicks fed rations.

Parameters	Treatments				
	T1	T2	T3	T4	T5
Purchase price/bird (Birr)	6	6	6	6	6
Feed consumed during entire period (g/bird)	2751	2811	2909.5	3076	3100
Feed cost(TVC, Birr/ bird)	22.5	22.42	23.04	23.07	22.58
Selling price/bird (Birr)	65.97	67.54	73.65	84.63	95.75
Total income (Birr/bird)	59.97	61.54	67.65	78.63	89.75
Net income (Birr/bird)	37.47	39.12	46.61	55.56	67.17
Change in total variable cost (ΔTVC)	0	-0.08	0.54	0.57	0.08
Change in total income(ΔTI)	0	1.57	7.68	18.66	29.78
Change in net income(ΔNI)	0	1.65	7.14	18.09	29.7
MRR (%/bird)	0	-20.62	13.22	31.73	371.25

Maize; ΔNI = change in net income; ΔTVC = change in total variable cost; Birr = Ethiopian currency; MRR = marginal rate of return; NI = net income; TVC = total variable cost; ΔTI=change total income.

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Discussion

Chemical composition of ingredients and experimental rations

The crude protein value of PCSPTM obtained in this study was higher than the values (3.1%) obtained earlier [9]. The total as value of PCSPTM obtained in this study was lower than the 4% obtained earlier [12], but higher than the 2.93% reported earlier [9].The CF content of PCSPTM in the current study was higher than 0.7% reported [20]. But it was lower than that (9.22%) earlier reported [9]. Ether extract content of PCSPTM was higher than 0.71% [9] but lower than 2.5%earlier reported [12]. The variations in chemical composition could be attributed to differences in varieties, geographical areas and the conditions under which the plant was grown [21]. Generally, the CP, CF and EE content of PCSPTM was lower than those of the other ingredients which indicate that it is energy supplement [12]. The CF and EE content of the experimental diets in the present study slightly decreased with increasing level of PCSPTM since PCSPTM has lower CF than maize. Sweet potato tuber is lower in CF, CP and EE content than maize [12]. The calcium and phosphorus content of the diet increased as the level of PCSPTM increased. This finding is in line with the suggestion that sweet potato tuber is a rich source of most minerals like calcium and micro-minerals [12].

Dry matter and nutrient intake

In the present study, feed intake was improved at higher level of supplementation, on 12% (Table 4) and 16% (Table 5) during starter phase and 15% (Table 4) and 20% (Table 5) during grower and entire phase. This is similar with earlier recommendation of 20% sweet potato inclusion for young birds [22] but slightly higher than 10% suggested as optimum level of utilization of sweet potato for broiler chicken [23]. As suggested earlier [24] low feed intake of broilers may be due to palatability problems associated with the nature of the diets which tend to be less digestible. Birds kept on T1 and T2 diet consumed higher amount of crude protein than the others during starter and grower phase due to high CP content of maize than that of PCSPTM. The CP intake of birds kept on T1 and T2 was higher than that of other treatments (Table 3-5) which could be due to the inverse relation between feed intake and nutrient intake (utilization). The absence of significant differences in ME intake of the birds fed the different treatment diets is due to similarity in ME contents of the treatment diets.

Body weight gain and dry matter conversion ratio

Chickens were fed diets consisting of 0 to 50% CSPT and it was found that there was increased body weight gain at higher level of CSPT [13] which is similar to the result in this study. During starter phase in T2 (4%) and T3 (8%) body weight gain was higher than in the rest of treatment diets. This result slightly agrees with the suggested 10% as optimum level of utilization of sweet potato by broiler chicken [23]. However, no significant differences were observed in earlier study when 0-40% sweet potato levels were used in the diets of broilers [13].

The result for dry matter feed conversion ratio (DMCR) at a substitution level of 16% (Table 5) PCSPTM with maize was higher than other treatments during starter stage. During grower and entire period, the poor feed utilization by T2 (5%) PCSPTM birds may be due to the higher maize content of the diet, which could be attributed to its higher CF content. In contrast, DMCR decreased with increasing level of PCSPTM in the diet during growth and entire trial period. This result is in agreement with the earlier reports that the lower feed consumption and poorer efficiency of feed utilization led to an increase in feed conversion ratio [5,25].

Carcass weight and edible organ parts

In the current study, carcass weight was higher in chickens under T4 (15%) and T5 (20%) which might be due to higher feed intake and body weight gain. A progressive increase in weights of total carcass and separate carcass components (drumsticks, breast and wings) were observed with increase in inclusion levels of PCSPTM. In the present study, progressive improvement in slaughter weight with increasing level of PCSPTM up to 20% was observed. In agreement with this result, high values of slaughter weight with increasing levels of orange flesh tuber meal in the diets of broiler chicks was also reported [22]. Dressing percentage was similar among all chickens kept on different treatments. Similar results of dressing percentage of the test diet containing 0-50% CSPT as a replacement for maize and that of the control group were reported [26] and this might be due to similarity in energy content of maize and sweet potato. In the current experiment gizzard weight was similar among all chickens kept on different treatments. This is in agreement with earlier finding that the organ weights of broilers did not present any significant difference among the treatment groups [27].

Partial budget analysis

According to the result of partial budget analysis of the present study, starter and grower rations containing PCSPTM had low feed cost/bird and returned a higher net profit than those fed the control diet. Results of feed cost agrees with what was obtained earlier [9,13,25], who reported a linear decrease in the feed cost with increase in inclusion of sweet potato in broiler diet. Therefore, from biological point of view as well as partial budget analysis, T5 was found to be recommendable when compared to the others.

Conclusion and Recommendations

Substitution level of orange fleshed sweet potato tuber for maize by 12% and 16% at starter phase and 15% and 20% at grower phase have improved feed intake, body weight gain and carcass characteristics. The utilization CSPT by poultry producers should be encouraged because it is profitable by reducing production cost.Additional studies are necessary in order to determine the role of trypsin inhibitors in sweet potatoes on the bioavailability of nutrients and also the best processing methods to deactivate them.

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