Inclusion levels of sweet potato root meal in the diet of broilers I. Effect on performance, organ weights, and carcass quality

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ABSTRACT The amount of corn available for animal and poultry feed has been unpredictable in recent years due to the increased use of corn for ethanol production. As a consequence, there has been an increase in the price of feed, chicken, and chicken products. Researchers are exploring alternative feed sources to substitute for corn in poultry ration. This study evaluated the performance and carcass quality of broilers fed diets containing sweet potato root meal (SPRM). After a complete nutrient analysis of the SPRM, diets were formulated where 0, 10, 20, and 30% of corn was substituted with SPRM. The study utilized 360 1-d-old Cornish X Rock male broiler chickens randomly assigned to one of 4 treatments; 0%, 10%, 20%, and 30% SPRM. Body weights and feed intake (FI) were monitored weekly for 7 wk. Birds were slaughtered on d 50 and FI, BW gain, ADG, ADFI, abdominal fat, dressing percentage, and organ weights measured. White (breast) and dark (leg and thigh) meat were evaluated for nutrient content (protein, moisture, fat, and ash). Results showed birds fed 20% SPRM had lower ($P < 0.03$) final BW, BW gain and ADG than those fed the 30% SPRM diet. There were no differences in FI and ADFI among treatments. Feed conversion ratio was lowest ($P < 0.02$) in birds fed 10, 20, and 30% SPRM than the control. There were no differences in dressing percentage among treatments. Abdominal fat was highest ($P < 0.05$) in birds fed 30% SPRM. Organ weights were similar across treatments except for gizzard which weighed highest ($P < 0.05$) in the control. For white meat; moisture, protein, fat, and ash were similar across treatments. For dark meat, moisture ($P < 0.004$) and fat ($P < 0.03$) were highest in the control, while protein and ash were similar among treatments. Birds fed the SPRM diets compared well with those fed the control for both performance and nutrient content of meat.

Key words: alternative ingredient, broiler, sweet potato root meal, performance, carcass quality

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INTRODUCTION

Alternative uses of corn for ethanol production in the United States consume a significant amount of corn resulting in a large impact on corn prices (Kreutzer, 2012). This has had a major impact on the livestock and poultry industries. Corn serves as the major energy ingredient in the diets of most livestock and especially non-ruminants like poultry. In broiler production, corn accounts for approximately 55% of the feed (Mourao et al., 2008). A decrease in the availability of corn and an increase in the price for feed have a direct impact on the broiler industry worldwide (Ayuk, 2004), and in some cases, production output is reduced (Donohue and Cunningham, 2009). An increase in the price of grains and the cost of producing poultry meat and eggs increased significantly resulting in a decreased ability of some of the world's population to purchase and consume chicken meat (Aho, 2007). In order to compensate for this change, alternative feed ingredients must be identified (Agwunobi, 1999). The new ingredients must be able to substitute for corn totally or partially and not have a negative impact on the efficiency of broilers; that is, it must not reduce feed efficiency, dressing percentage, and must produce a product of the same or superior quality (Ojewola et al., 2006). Several studies have evaluated the use of possible alternative feed ingredients; however, more extensive feed trials must be done in order to meet the requirements set forth by the National Research Council.

One possible alternative is sweet potato (*Ipomoea batatas* L. [Lam]). It is a root 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 (Dominguez, 2010). The storage roots of sweet potato are a valuable source of carbohydrates, vitamins, and micro-nutrients especially in the orange and yellow-fleshed cultivars, which contain β-carotene (Woolfe, 1992; Bromfield and Bovell-Benjamin, 2002;

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Byamukama et al., 2003). Research conducted at Tuskegee University by Dr. George Washington Carver in the early 20th Century demonstrated that more than 100 industrial products could be made from the sweet potato (Carver, 1936), but few have been commercialized in the United States. The roots are rich in nitrogen-free extract indicating its potential value, mainly as an energy source with carbohydrates generally making up about 80–90% of the sweet potato root. Sweet potato roots can be graded into marketable and unmarketable (culls) roots. Some studies have indicated that sweet potato can replace corn in the diet of broilers to some extent (White, unpublished data; Ravindran and Sivakanesan, 1996; Agwunobi, 1999; Ayuk and Essien, 2009). For example, Maphosa et al. (2003) fed 0, 20, 50, 75, and 100% sweet potato root meal (SPRM) to broilers and concluded that up to 50% inclusion had no negative effect during the finisher period, however, these diets adversely influenced BW gain, feed intake, and feed conversion during the starter phase. Similarly, Ayuk and Essien (2009) fed diets consisting of 0 to 50% SPRM and found that there was increased BW gain up to 40% inclusion; however, there was a significant reduction at the 50% level of substitution. Although a few studies have been conducted utilizing sweet potato in its different forms as a feed ingredient, very little has been done in the United States. Since there are many varieties of sweet potato grown under different types of environmental, soil, and management conditions, results of these studies are varied, and can be used as a guide to estimate the potential acceptability of the sweet potato meal as a feed ingredient. It is not known what levels of inclusion will produce the same quality product that is now produced by the broiler industry. Also, limited information is available on the impact on meat quality (Agwunobi, 1999). Therefore, much work must be done in evaluating this alternative ingredient in totality. The objectives of this study were to evaluate growth rate, feed intake, dressing percentage, organ weights, and meat quality of broilers fed diets containing different levels of SPRM.

MATERIALS AND METHODS

Harvesting and Processing of Sweet Potatoes

Discarded sweet potatoes roots (culls and cracks) of 4 varieties, TU 155, Georgia Jet, Carver 2000-1, and TU 1892 were harvested. The roots were thoroughly washed and sorted before being shredded by a TROY BILT chipper/shredder. The chopped material was air dried in the green house for 48 h at 24–29°C, and humidity of approximately 20%. Drying was done in the greenhouse, because this took place in the fall when environmental temperatures outside were low. In the greenhouse, it was possible to increase the temperature and also control humidity. If outdoor temperature is ideal, sun drying can be done.

Table 1a. Chemical composition of sweet potato root meal.

Macronutrients	SPRM[1]	Minerals	SPRM[1]
Moisture (%)	5.30	Ca (%)	0.27
Dry Matter (%)	94.70	K (%)	2.04
Nitrogen (%)	1.14	Mg (%)	0.30
Crude protein (%)	7.10	P (%)	0.17
Digestible protein (%)	3.30	Cu (ppm)	9.47
NDF (%)	19.89	Fe (ppm)	136.4
ADF (%)	10.42	Mn (ppm)	86.18
Crude fiber (%)	12.82	Zn (ppm)	16.10
TDN (%)	63.00	Ca/P	1.56
ME (Mc/kg)	2.37		

[1]SPRM: Sweet potato root meal.

Feed analyzed at Auburn University Feed and Forage Analysis Laboratory, Auburn, AL. Procedures of Goering and van Soest (1970). ME values were calculated using a modification of Goering and van Soest (1970) methods using the TDN values.

Table 1b. Amino acid composition of sweet potato root meal.

Amino acids	SPRM[1] (%)
Cysteine	0.08
Methionine	0.10
Lysine	0.43
Alanine	0.38
Arginine	0.23
Aspartic acid	1.46
Glutamic acid	0.71
Glycine	0.28
Isoleucine	0.28
Leucine	0.41
Serine	0.28
Threonine	0.29
Valine	0.40
Histidine	0.13
Phenylalanine	0.35
Tyrosine	0.15
Taurine	0.01
Tryptophan	0.08

[1]SPRM: sweet potato root meal.

SPRM sample analyzed at the Minnesota Valley Testing Lab., Inc.

New Ulm, MN. Procedures of AOAC (2005).

Each variety was ground separately into a meal to pass through a 1-mm screen using a WILEY MILL. Before the rations were formulated, a composite sample was made of each sweet potato variety (5 g each) and chemically analyzed for nutrient composition according to the methods of Goering and van Soest (1970) at the Auburn University Feed and Forage Analysis Laboratory, Auburn, AL (Table 1a), and the Minnesota Valley Testing Lab., Inc, New Ulm, MN, according to the methods of AOAC (1995) (Table 1b). The ME values of the sweet potato root meal were obtained using the analyzed total digestible nutrient (TDN) values.

Experimental Animals and Brooding

The research protocol for this study was approved by the Tuskegee University Animal Care and Use Committee. This research was conducted at the Poultry Unit of the George Washington Carver Agricultural

Experimental Station, Tuskegee University, Tuskegee, Alabama. Three hundred and sixty 1-d-old Cornish X Rock male broiler chickens were utilized in this experiment. On arrival at the Poultry Unit, the chicks were wing-banded, weighed, and randomly placed into 1 of 12 pens. Brooding pens were approximately 3.57 m × 2.90 m. Each pen was fitted with two 250-Watt infrared fluorescent brooding lamps to provide heat for the chicks. Bedding material consisted of wood shaving laid down approximately 3 inches thick to provide comfortable cushioning. Chick feeders and waterers were placed in each pen to provide at least 5.08 cm of feeder space and 1.27 cm of drinker space per bird. The starting environmental temperature in the brooder house was 35°C and was reduced by 5° weekly until it reached environmental temperature. The humidity in the brooder house was approximately 75%.

Experimental Diets

The experiment utilized 4 dietary treatments of sweet potato root meal (SPRM) replacing 0% (control), 10%, 20%, and 30% of the corn in the diets. The BRILL ration formulation computer software was used to balance starter (23% CP), grower (21% CP), and finisher (18% CP) rations for each experimental diet mentioned above. The rations were balanced to be isonitrogenous and isocaloric according to recommendations by NRC (1994). The formulated rations are presented in Tables 2, 3, and 4 for the starter, grower, and finisher periods, respectively.

Experimental Procedure

The study was conducted over a 49-d period utilizing 4 treatments, each replicated 3 times (30 birds per replication = 90 birds per treatment). The birds were randomly assigned to pens in the brooder house and offered 1 of the 4 experimental diets. The starter ration was offered the first 3 wk of the study, the grower ration wk 4 and 5, and the finisher ration the final 2 wk. There was no restriction on feed and water consumption, however, to monitor intake, the feed offered and left over were weighed and recorded weekly. Body weights were recorded weekly for the entire study period. At the end of the 3-wk brooding period, the birds were removed from the brooder house and placed in the grower house in floor pens measuring approximately 4.51 m × 3.6 m containing a three inch layer of bedding material. Each pen was equipped with 2 automatic drinkers and 2 hanging feeders. The birds were maintained in their respective treatment groups.

Slaughtering and Processing of the Birds

After the final weighing on d 49 of the study, feed was withdrawn from the birds in preparation for slaughter and processing on d 50. On the d of slaughter, the fasted BW of each bird was taken and recorded. The

Table 2. Composition of experimental ration for the starter period.

	Diets (%)[1]			
Ingredients	0	10	20	30
Corn, ground yellow (8.7%)	56.19	48.49	42.06	35.74
Soybean meal (49%)	37.07	37.62	37.97	38.35
SPRM	–	5.39	10.52	15.32
Fat	3.80	5.23	6.27	7.35
Dicalcium phosphate	0.19	0.32	0.48	0.49
Limestone	0.26	0.36	0.29	0.25
Salt	0.35	0.35	0.36	0.37
Vitamin premix[2]	0.20	0.30	0.25	0.26
Methionine (99%)	0.14	0.13	0.14	0.14
Coban 90	0.01	0.01	0.01	0.01
Trace mineral	0.10	0.12	0.01	0.08
Defluorinated phosphorus	1.69	1.68	1.65	1.64
Calculated Nutrient Composition				
CP (%)	23.0	23.0	23.0	23.0
Fat (%)	6.29	7.46	8.29	9.16
ME (kcal/kg)	3175	3175	3175	3175
Calcium (%)	1.00	1.00	1.00	1.00
Sodium (%)	0.22	0.22	0.22	0.22
Methionine (%)	0.5	0.50	0.50	0.50
Ca/P (%)	2.22	2.22	2.22	2.22

[1]Diets: 0 = 0% Sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

[2]Supplied per kg of diets: copper, 8 mg; iodine, 0.4 mg; iron, 100 mg; selenium, 0.3 mg; vitamin A (retinyl acetate), 4540 IU; vitamin D_3, 1543 IU; vitamin E, 15.4 IU; choline, 284 mg; niacin, 34 mg; d-pantothenic acid, 5.7 mg; riboflavin, 3.4 mg; menadione, 0.85 mg; vitamin B_{12}, 0.01 mg; biotin, 0.1 mg; folic acid, 0.5 mg; thiamine, 0.6 mg.

Table 3. Composition of experimental ration for the grower period.

	Diets (%)[1]			
Ingredients	0	10	20	30
Corn, ground yellow (8.7%)	61.17	54.25	47.03	39.97
Soybean meal (49%)	32.21	32.47	32.82	33.26
SPRM	–	6.03	11.76	17.13
Fat	3.40	4.40	5.59	6.79
Dicalcium phosphate	1.03	0.39	0.19	0.38
Limestone	0.28	0.70	0.60	0.40
Salt	0.26	0.28	0.19	0.20
Vitamin premix[2]	0.15	0.12	0.12	0.14
Methionine (99%)	0.06	0.06	0.11	0.11
Coban 90	0.01	0.01	0.01	0.01
Trace mineral	0.09	0.07	0.08	0.11
Defluorinated phosphorus	1.39	1.20	1.50	1.50
Calculated Nutrient Composition				
CP (%)	21.0	21.0	21.0	21.0
Fat (%)	6.04	6.82	7.77	8.73
ME (kcal/kg)	3197	3197	3197	3197
Calcium (%)	0.92	0.91	0.94	0.92
Sodium (%)	0.17	0.17	0.15	0.15
Methionine (%)	0.40	0.42	0.44	0.44
Ca/P (%)	2.42	2.54	2.25	2.20

[1]Diets: 0 = 0% sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

[2]Supplied per kg of diets: copper, 8 mg; iodine, 0.4 mg; iron, 100 mg; selenium, 0.3 mg; vitamin A (retinyl acetate), 4540 IU; vitamin D_3, 1543 IU; vitamin E, 15.4 IU; choline, 284 mg; niacin, 34mg; d-pantothenic acid, 5.7 mg; riboflavin, 3.4 mg; menadione, 0.85 mg; vitamin B_{12}, 0.01 mg; biotin, 0.1 mg; folic acid, 0.5 mg; thiamine, 0.6 mg.

Table 4. Composition of experimental ration for the finisher period.

Ingredients	Diets (%)[1]			
	0	10	20	30
Corn, ground yellow, (8.7%)	70.87	62.39	54.35	46.37
Soybean meal (49%)	24.22	24.78	25.10	25.66
SPRM	–	6.93	13.59	19.88
Fat	1.68	2.97	4.23	5.53
Dicalcium phosphate	1.49	0.92	0.90	0.90
Limestone	1.10	1.42	1.20	1.10
Salt	0.33	0.34	0.34	0.35
Vitamin premix[2]	0.16	0.16	0.16	0.16
Methionine (99%)	0.09	0.04	0.08	0.08
Trace mineral	0.09	0.04	0.08	0.08
Calculated Nutrient Composition				
CP (%)	18.0	18.0	18.0	18.0
Fat (%)	4.64	6.00	6.65	7.69
ME (kcal/kg)	3197	3197	3197	3197
Calcium (%)	0.89	1.00	0.82	0.81
Sodium (%)	0.14	0.16	0.14	0.14
Methionine (%)	0.39	0.35	0.37	0.37
Ca/P (%)	2.24	2.84	2.75	2.65

[1]Diets: 0 = 0% sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

[2]Supplied per kg of diets: copper, 8 mg; iodine, 0.4 mg; iron, 100 mg; selenium, 0.3 mg; vitamin A (retinyl acetate), 4540 IU; vitamin D_3, 1543 IU; vitamin E, 15.4 IU; choline, 284 mg; niacin, 34 mg; d-pantothenic acid, 5.7 mg; riboflavin, 3.4 mg; menadione, 0.85 mg; vitamin B_{12}, 0.01 mg; biotin, 0.1 mg; folic acid, 0.5 mg; thiamine, 0.6 mg.

birds were placed in killing cones and their throats cut to facilitate bleeding out. The birds were dipped in a scalder for approximately 30 s in water heated to 62.8°C to loosen the feathers. The feathers were then removed using a batch defeatherer after which the birds were eviscerated. The carcasses were thoroughly washed and excess water drained off. They were then weighed to obtain dressing percentages. The carcasses were placed in an ice bath to chill for approximately 40 min to get to a temperature of 4.4°C before packaging. Non-carcass components (lungs, liver, spleen, kidney, testicles, heart, and feet) were harvested and weighed. The legs, thighs, and breasts were separated, vacuum sealed, and placed in freezer for further analyses.

Nutritional Content of "Dark Meat" and "White Meat" from Broilers Fed Different Levels of SPRM

Fat, moisture, ash, and protein content of the broiler meat were evaluated. Samples from 5 birds in each replication (15 birds/treatment) were ground using a food grinder (Hamilton Beach, Hamilton Beach Brand Inc., Glen Allen, Virginia, 23060). A composite sample of equal parts of leg and thigh were used for dark meat evaluation, while samples from the breast were used for white meat evaluation. Approximately 1.5 g of ground sample was spread evenly on a Smart Trac drying pad and placed in the CEM Smart Trac drying machine (CEM Corporation, 3100 Smith Farm Road, Matthews, NC). The CEM Smart Trac uses microwave and H^1NMR (Hydrogen-1 nuclear magnetic resonance) that analyzes moisture and solids. The samples reached optimal drying temperature in less than 5 min. This instrument was also used to measure the fat content of the samples. The H^1NMR magnet sends pulses through the sample separating hydrogen ions, which are then recorded by a detector. The sample was dried and the amount of moisture was displayed and recorded. Ash content was determined on both white meat and dark meat using the muffle furnace method (AOAC, 1999). Samples from dark (5 g) and white meat (5 g) were weighed in a dried, pre-weighed, white porcelain crucible and placed in a muffle furnace at 550°C for 12 h until residue was light gray or off-white. For protein content, dark and white meat samples were sent to the Minnesota Valley Testing Laboratory, Inc., New Ulm, MN, for analysis (AOAC, 1995).

Statistical Analysis

The experimental design was a completely randomized design (CRD) with 4 treatments and 3 replications. Pens were considered the experimental unit. Data were analyzed using the PROC GLM Procedure of SAS (SAS Institute Inc., Cary, NC) following procedures outlined by St-Pierre (2006). Where the omnibus F-test indicated significant differences among treatments, means were separated using Tukey's test. All percent data were arc sin transformed before analysis. Feed conversion ratio was adjusted for mortality.

RESULTS AND DISCUSSION

Effect of Diets on Performance of broilers fed SPRM

Productivity of broilers can be evaluated by determining BW gain, feed intake (FI), feed efficiency, and dressing percentage, among others. These parameters are mostly influenced by diet, therefore, when a new ration is being evaluated, great emphasis must be placed on these end points. Table 5 shows the initial BW, final BW, total BW gain, and ADG of broilers fed SPRM

Table 5. Initial and final body weights, total weight gain, and average daily gain of broilers fed different levels of sweet potato root meal.

Diets[1]	Initial BW (g)	Final BW(g)	BW Gain (g)	ADG (g)
0	39.9	2,869[a,b]	2,829[a,b]	57.7[a,b]
SEM	0.34	65.4	65.4	1.33
10	39.7	2,812[a,b]	2,773[a,b]	56.6[a,b]
SEM	0.37	67.5	67.5	1.38
20	39.5	2,690[b]	2,651[b]	54.1[b]
SEM	0.44	81.1	81.0	1.65
30	39.6	2,968[a]	2,929[a]	59.8[a]
SEM	0.34	65.3	65.3	1.33

[a,b]Means with the same superscript within columns are not significantly different at the 5% level of *P*.

[1]Diets: 0 = 0% sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

SEM = standard error.

Table 6. Total feed intake, average daily intake, and feed:gain of broilers fed different levels of sweet potato root meal.

Diets[1]	Total feed intake (g)	ADFI (g)	Feed:gain
0	6,631	135	2.13[a]
SEM	587	11.98	0.036
10	6,902	141	1.96[b]
SEM	587	11.98	0.036
20	6.062	124	1.95[b]
SEM	719	14.67	0.045
30	6,072	124	1.91[b]
SEM	587	11.98	0.036

[a,b]Means with the same superscript within columns are not significantly different at the 5% level of P.

[1]Diets: 0 = 0% sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

SEM = standard error.

Table 7. Pre-slaughter weight, carcass weight, dressing percentage, and abdominal fat of broilers fed different levels of sweet potato root meal.

Diets[1]	Pre-slaughter BW (g)	Carcass wt (g)	Dressing (%)	Abdominal fat (%)
0	2,822	2,047	72.57	1.77[a]
SEM	70.8	52.7	0.43	0.28
10	2,791	2,041	73.09	1.84[b]
SEM	73.6	54.8	0.46	0.38
20	2,626	1,910	72.72	1.98[a,b]
SEM	72.7	54.1	0.45	0.08
30	2,909	2,107	72.43	2.11[a]
SEM	70.8	52.6	0.43	0.32

[a,b]Means with the same superscript within columns are not significantly different at the 5% level of P.

[1]Diets: 0 = 0% sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

SEM = standard error.

diets replacing 0, 10, 20, and 30% of the corn in the rations. Due to predation problems during the study that destroyed more than 50% of the birds in one replication in the 20% SPRM diet, that replication was removed and the overall performance data analysis reflects that adjustment. Final BW, BW gain, and ADG were lowest ($P < 0.03$) in birds fed the 20% SPRM, while birds fed the 0, 10, and 30% SPRM did not differ from each other. Total FI and ADFI did not differ among treatments; however, feed conversion ratio was highest ($P < 0.02$) in birds fed the control diet (2.13) compared to 1.96, 1.95, and 1.91 for the 10, 20, and 30% SPRM diets, respectively (Table 6). This feed conversion ratio of more than 10% difference could be of significant importance to producers as it can potentially translate into savings on feed cost. In this study, as the level of SPRM increased, so did the addition of fat. In the current study, there possibly could have been an underestimation of the ME value of the SPRM when it was chemically analyzed (2370 kcal/kg), which led to an increase in the fat added to the ration as SPRM level increased. Other reports have shown higher ME values for sweet potato meal ranging from 2470–2924 kcal/kg (Ladokun et al., 2007), 2962 kcal/kg (Rajaguru and Ravindran, 1985), to 3190 kcal/kg (Woolfe, 1992). There are reports (Mateos et al., 1982) showing that higher supplemental fat in the diet can reduce the transit time of digesta, thereby increasing the digestibility of other nutrients by extending the time of exposure to enzymes and absorptive sites. It can therefore be assumed that the birds on the SPRM diets were able to consume less of the feed to fulfill their nutrient requirements. Results from this study are in contrast to those reported by Ayuk and Essien (2009) who supplemented SPRM up to 50% in the diet of broilers and reported that as the level of SPRM increased from 0% to 50%, BW gains, FI, and ADG decreased. Tewe (1994), in an experiment replacing corn with oven-dried and sun-dried SPRM, found a reduction in BW gain and nutrient utilization of birds fed the SPRM diets. In another study, Gerpacio et al. (1978) replaced 0, 50, 75, and 100% of corn for SPRM in the diet of broiler chicks. These authors reported that the performance of the birds fed the SPRM diets was less satisfactory. They also concluded in their study that feed consumption, BW gain, and feed efficiency were not significantly different than the control; however, at the higher levels of inclusion, these parameters were significantly reduced. These contradicting results could be attributed to the difference in breeds of chickens used, the difference in the varieties of sweet potato, and the different preparation methods of the SPRM.

Pre-slaughter weight, carcass weight, and dressing percentages of broilers fed different levels of SPRM did not differ among treatments (Table 7). Abdominal fat (Table 7) was highest ($P < 0.05$) in birds fed the 30% SPRM. The pre-slaughter weights (2822, 2791, 2626, and 2909 g); and carcass weights (2047, 2041, 1909, and 2107 g) for the 0, 10, 20, and 30% SPRM diets, respectively, in this experiment, were higher than those reported by Agwunobi (1999) after feeding 0, 9, 18, 27, and 36% SPRM in the starter diet and 0, 15, 30, 45% SPRM in the finisher diet of broilers. The author of that study reported the overall pre-slaughter weight for sweet potato-based diet as 1710 g, and the carcass weight as 1460 g. Since the results were not presented for each diet, an accurate comparison could not be made with the current study. According to Agwunobi (1999), there was an increase in wet droppings, and a gradual decrease in live BW gain with increased SPRM in that experiment, which were attributed to nutritional deficiencies in the sweet potato. An observation that was made in the study by the above mentioned author was that the SPRM was supplemented wt/wt for corn in the diet, and was not balanced for nutrient composition after the addition of the SPRM. This could explain the decreased BW in that study.

In the current study, the abdominal fat in birds fed 30% SPRM (2.11%) was higher ($P < 0.05$) than birds fed the 0 and 10% SPRM diets but not different from the 30% diet. Chickens mostly deposit fat in their abdomen and subcutaneously, and according to Leenstra (1986) and Pym (1987), the energy to protein ratio of the feed, and the type and amount of dietary fat, are the

Table 8. Weights of internal organs and other carcass components of broilers fed different levels of sweet potato root meal.

	Diets (%)							
Carcass Parts	0	*SEM*	10	*SEM*	20	*SEM*	30	*SEM*
Neck	2.19	0.10	2.28	0.10	2.25	0.10	2.02	0.10
Heart	0.42	0.08	0.39	0.14	0.41	0.13	0.41	0.14
Liver	1.60	0.05	1.47	0.05	1.44	0.05	1.39	0.05
Gizzard	1.37[a]	0.14	1.12[b]	0.24	1.11[b]	0.23	1.19[b]	0.07
Intestine	3.88	0.59	4.05	0.73	4.32	0.83	4.29	0.45
Lung	0.54	0.15	0.56	0.40	0.54	0.11	0.49	0.27
Spleen	0.08	0.01	0.08	0.01	0.07	0.01	0.08	0.01
Testicle	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01
Feet	3.77	0.06	3.87	0.06	3.80	0.06	3.81	0.06

[a,b]Means with the same superscript within rows are not significantly different at the 5% level of P.

[1]Diets: 0 = 0% Sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

SEM- Standard error.

Table 9. Nutrient content of white meat from broilers fed different levels of sweet potato root meal.

Diets[1]	Moisture (%)	Fat (%)	Protein (%)	Ash (%)
0	74.7	2.16	22.4	1.25
10	74.1	2.56	22.3	1.25
20	73.8	2.77	22.4	1.25
30	73.8	2.38	23.0	1.25
SEM	0.2	0.18	0.31	0.00

[1]Diets: 0 = 0% Sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

SEM- Standard error.

Table 10. Nutrient content of dark meat from broilers fed different levels of sweet potato root meal.

Diets[1]	Moisture (%)	Fat (%)	Protein (%)	Ash (%)
0	74.8[a]	5.48[b]	19.6	1.25
10	73.8[ab]	6.26[ab]	19.2	1.25
20	73.0[b]	6.97[a]	19.3	1.25
30	73.9[ab]	5.92[ab]	18.5	1.25
SEM	0.26	0.30	0.45	0.00

[a,b]Means with the same superscript within columns are not significantly different at the 5% level of P.

[1]Diets: 0 = 0% Sweet potato root meal (SPRM); 10 = 10% SPRM; 20 = 20% SPRM; 30 = 30% SPRM.

SEM- Standard error.

most important factors affecting body fat deposition. Moreover, a low energy-to-protein ratio would cause a reduction in body fat (Tumova and Teimouri, 2010). As mentioned previously, there could have been an underestimation of the ME value of the SPRM, which led to the increased fat addition to ensure that all diets were balanced for energy according to recommendations by NRC (1994). It can be speculated from the results of this study that the underestimation of the ME value of the SPRM led to an increase in the fat added to the 30% SPRM diet, resulting in more fat accumulation in the birds fed that diet.

Effect of Diets on Internal Organs and Other Carcass Components of Broilers Fed SPRM

The weights of the internal organs and other carcass components were calculated as a percentage of the preslaughter weight and are reported in Table 8. There was no significant difference among treatments except for the gizzard which weighed highest ($P < 0.05$) in the control group. To date, no reports have been found in the literature on the effects of feeding SPRM on noncommercial carcass components.

Effect of Diets on Nutrient Content of Meat from Broilers Fed SPRM

Tables 9 and 10 show the nutrient composition (moisture, fat, protein, and ash) of white meat (breast), leg, and thigh (dark meat) muscles from broilers fed different levels of SPRM. There was no difference in nutrient composition of the breast meat among the treatments (Table 9). For dark meat (Table 10), protein and ash did not differ among treatments; however, moisture content was lower ($P < 0.004$) and fat content higher ($P < 0.03$) in the meat of birds fed the 20% SPRM diets. The protein content of white meat was higher than dark meat regardless of treatment, while fat content of dark meat was twice that found in white meat. The results of this study agree with reports that dark meat is generally higher in fat than the white meat. According to Ozdogan and Aksit (2003), the moisture content of broiler meat varies from 70.22 to 71.73% in the thigh, and 71.19 to 71.80% in the breast. The results of the current study show moisture content to be well over the range reported by these authors. Adding SPRM to the diets did not reduce the moisture level in the meat. Ozdogan and Aksit (2003) also reported that the ash content ranges from 0.81 to 0.84% in the thigh, and 0.98 to 1.10% in the breast; fat content ranges from 11.17 to 13.7% in the thigh, and 7.06 to 8.85% in the breast. The results of the current study shows the fat in both thigh and breast to be much lower, and the ash content to be much higher than that reported by Ozdogan and Aksit (2003). This shows that adding SPRM to broiler diets had a positive effect on the fat and ash content of the meat. A comparison of nutrient content of the meat from the current SPRM study could not be made, because the literature did not reveal any previous work showing this information. The results from the current study will provide this kind of information for future reference.

SUMMARY AND CONCLUSION

The results of this study showed that the final BW, BW gain, and ADG were lowest in birds fed the 20% SPRM diet compared with those fed the 30% diet, but did not differ significantly from those fed the 0 and 10% SPRM diets. No differences were observed in total feed intake, ADFI and dressing percentage among treatments. Feeding sweet potato root meal did not significantly impact most of the internal organs and other carcass components measured in this study. Feed conversion ratio was lowest in the birds fed the sweet potato diets, and this can mean a significant difference in feed cost to the producer. With the increasing cost of corn, feeding sweet potato meal could increase the profit margin of the producer. This is because sweet potatoes that would be used as a feed ingredient are generally those that are unsalable and would otherwise be discarded. Based on feed cost, sweet potato root meal could be an effective alternative feed ingredient in the diet of broilers. Recourse to a low priority energy source like SPRM could be a way out of the rising prices of livestock feed due to the use of corn as a biofuel source. If diets can be formulated using this ingredient, farmers would be able to pay less for their feed, hence reducing their overhead cost. However, more work needs to be done to determine the level of inclusion that will allow for the best performance and the most cost effective solution.

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