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NUTRITIVE VALUE OF COMPOSITE MEAL FROM TWO VARIETIES OF SWEET POTATO (*Ipomoea batatas*) (LAM.) AND ITS EFFECT ON PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWING RABBITS

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ABSTRACT

The nutritive value and potential use of two varieties of sweet potato (*Ipomoea batatas*) (LAM.) composite meal for growing rabbits was studied by comparing seven diets containing an increasing incorporation rate of Composite Sweet Potato Meal (CSPM) in replacement for maize. The composite sweet potato meal contained 65 % of whole root tubers and 35 % of the leaves and vines. The rabbits were randomly allocated into seven treatments. The two varieties of sweet potato i.e CIP440293 (Orange-Flesh) CSPM and TIS87/0087 (White-Flesh) CSPM replaced maize at graded levels 25, 50, 75 % respectively. The seven treatments are: T1−0 % Control, T2−25 % Orange Flesh, T3−50 % Orange Flesh, T4−75 % Orange Flesh, T5−25 % White Flesh Sweet potato, T6−50 % White Flesh Sweet potato and T7−75 % White Flesh Sweet potato. The treatments were performed in four replicates, each in a Completely Randomized Design (CRD) experiment. The diets contained 10.6−12.6 % of crude fibre, 16.4−17.6 % of crude protein and 10,9275−11,6728 $MJ.kg^{-1}$ of metabolizable energy *ad libitum*. Eighty-four rabbit does, at twelve rabbits per treatments, were fed the seven diets from weaning (35 days, mean weight: 570.76 ± 42.09 g) to 98 d of age. The faecal digestibility of the diets was measured between 92 and 97 days of age in 6 rabbits per treatment. CSPM can be considered high-fibre roughage, as it contained 42.45−54.30 % of NDF (38.30−40.35 % of ADF and 13.30−20.40 % ADL) and 9.80−17.45 % of CP. The crude fibre digestibility was reduced with CSPM incorporation. Dietary incorporation of CSPM impaired the rabbit growth (18.08 vs. 14.66 $g.day^{-1}$ during the period 77−98 days without CSPM). However, feed conversion was undermining with the high incorporation rate in feed. The dressing-out percentage of rabbits fed on diets containing the CSPM were comparable to the dressing-out percentage of rabbit fed the control diet. Health status or main slaughter traits were not affected by CSPM incorporation rate. Thus, CSPM had a comparable nutritive value for growing rabbits and it can successfully serve as a high-fibre feedstuff through its potential to supply low digested fibres (cellulose) and lignin. The two composite sweet potato meals could be considered as a high fibre source with a considerable high crude protein for the growing rabbits. The comparable dietary potential of the composites makes it an excellent replacement for maize, which is the conventional feed stuff, especially for hind gut fermenters like rabbits.

Key words: growing rabbit; nutritive value; composite sweet potato leaf-root meal; growth performance; slaughter traits

INTRODUCTION

In Nigeria and other West African countries, stovers and grain by-products are the main fibre sources for rabbit in commercial rabbit production. These by-products from grains are, however, not available all through the year. Therefore, rabbit nutritionists are saddled with the responsible to search for a sustainable alternative to produce balanced pelleted feeds using local raw materials

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available at a lower price and all year round.

Sweet potato (*Ipomoea batatas* [L.] Lam.) is a tropical perennial crop that ranks fifth among the most valuable food crops in the world (Anyaegbunam *et al*., 2016). The Sweet potato plant belongs to the *Convolvulaceae* family, an important root vegetable, which is large, starchy and sweet tasting (Woolfe, 1992). The crop is cultivated in over 100 countries (An, 2004) not only because of its considerably high nutritional content but because its root and leaves contain phytochemicals. The plant is a herbaceous perennial vine, bearing alternate heart-shaped or palmate-lobed leaves and medium-sized sympetalous flowers. The edible tuberous root is long and tapered with a smooth skin. The sweet potato has a short growing period of 90 to120 days and it is widely adapted to the farming systems of tropical and semi-tropical parts of the world (Zhang *et al*., 2015). There occurs varietal difference in flesh colour of sweet potato, which determines its nutritional quality and benefit.

More than 133 million tons of sweet potato roots are produced globally per year. Asia is the world's largest sweet potato producing region, with 125 million tons/year; China with 117 million tons/year accounts for 88 % of world production. African farmers produce only about 7 million tons of sweet potatoes annually, but in contrast to Asia, most of the crop is grown for human consumption (Collins, 1998, CIP, 2007). Sweet potato production in Nigeria rose from 2.51 million metric tonnes in 2006 to 3.4 million metric tonnes in 2007, and later increased to about 4 – 6 million metric tonnes in 2015 (UNECA, 2015., Anyaegbunam *et al*., 2016). Sweet potato root is high in carbohydrates and has played an important role as an energy and phytochemical source in human nutrition and animal feeding. It also contains much higher levels of provitamin A, vitamin C and minerals than wheat or rice (Wang, 1997).

Sweet potato is well adapted to the tropical and subtropical regions. Sweet potato is an excellent source of energy (438 kJ.100 g^{-1} edible portion) and can produce more edible energy per hectare per day than cereals, such as wheat and rice (Abu *et al*., 2000). Among other advantages there are versatility, high yield, hardiness and wide ecological adaptability (Laurie *et al*., 2012). The root is reported to have higher protein content than cassava and yams (Oloo *et al*., 2014). In addition, some varieties of sweet potatoes contain coloured pigments, such as β-carotene, anthocyanin, and phenolic compounds. Sweet potato leaves are recognized to be rich in essential amino acids, such as lysine and tryptophan which are always limited in cereals. Hence, sweet potato can easily replace grain-based diets in livestock nutrition (Mwanri *et al*., 2011; Oloo *et al*., 2014). However, the potential benefits of sweet potato are marginalized and underutilized despite their useful potential, which is well recognized and exploited elsewhere.

Early growing sweet potato vine is of high quality forage for ruminant (Mohammed *et al*., 2018). Wanapat, (2008) reported that sweet potato vine could possibly be used as a complete replacement of roughage for ruminants. Sweet potato leaf and vines are already used as forage in some traditional backyard rabbitries in Nigeria though undocumented and could be a potential source of fibre and protein as the crude protein (CP) content reached 20 % (Sun *et al*., 2014). The present study aimed to determine the nutritive value of the composite sweet potato meal of two varieties as replacement maize for growing rabbit.

MATERIAL AND METHODS

Experimental site

The experiment was carried out at the Rabbitry Unit, Teaching and Research Farm University of Ibadan, Nigeria from September to December in 2017. Chemical analyses were carried out in the Agricultural Biochemistry and Nutrition Laboratory, Department of Animal Science, University of Ibadan.

Feeds, chemical analyses, animals and experimental design

Two varieties of sweet potato plants CIP 440293 (Orange flesh) and TIS 87/0087 (White flesh) were harvested from the National Roots Crops Research Institute, Umudike, Abia State, Nigeria. The whole root tubers were chipped and sun-dried for 3 – 5 days while the leaves and vines were dried in a similar manner. The composite sweet potato meal was prepared and contained 65 % of whole root tubers and 35 % of the leaves and vines. They were thereafter milled to a fine powder and their

Table 1. Chemical composition (% DM) of sweet potato composite in comparison to maize

Parameters	OFCSP	WFCSP	Maize (Shah *et al*., 2016)	SEM	*P*-Value
Dry matter (%)	92.78[a]	92.40[a]	89.70[b]	0.19	0.4522
Crude protein (%)	17.45[a]	9.90[b]	9.80[b]	3.78	0.0019
Ether extract (%)	2.10[b]	1.50[b]	3.05[a]	0.30	0.1153
Ash (%)	7.80[a]	3.45[b]	2.23[c]	2.18	0.0080
Crude fibre (%)	8.70[a]	3.60[b]	1.95[c]	2.55	0.0050
NDF (%)	54.30[a]	42.45[b]	NA	5.93	0.0054
ADF (%)	40.35	38.30	NA	1.03	0.0875
ADL (%)	20.40[a]	13.30[b]	NA	3.55	0.0132

[a, b,c] Means with different superscripts on the same row are significantly different ($P < 0.05$).
OFCSP – Orange flesh composite sweet potato; WFCSP – White flesh composite sweet potato; NDF – Neutral detergent fibre; ADF – Acid detergent fibre; ADL – Acid detergent lignin; NA – Not available (Olaleru and Abu, 2019).

chemical composition was determined (Table 1).

The composite sweet potato meal was included into rabbit diets at graded levels. The diets were designated as T1-control (0 %), 25, 50, and 75 % of orange flesh sweet potato composite meal were T2, T3 and T4, respectively and 25, 50, and 75 % of white flesh sweet potato composite meal were T5, T6 and T7 respectively. The other ingredients were: soybeans, maize offal, maize, rice offal, premix, bone meal and salt. The diets were formulated and pelletized to support optimal rabbit growth (de Blas and Mateos, 2010; Table 2).

The pelletized diets were analysed for chemical composition. AOAC (1990) procedures were used to determine crude protein, crude fibre and acid detergent fibre in diets. Neutral detergent fibre and acid detergent lignin level were determined as described by Maertens (2002) and Robertson and Van Soest (1981), respectively. The recommendations and guidelines for applied nutrition and experiments in rabbits were followed in management of the rabbits (Fernández-Carmona *et al*., 2005).

Eighty-four 35-day old crossbreed (Chinchilla × New Zealand White) weaned doe rabbits weighing 570.76 ± 42.09 g were allotted to seven dietary treatments (12 rabbits/treatment; 4 rabbits/replicate). The rabbits were housed in wire-meshed cages, accommodated in a well-ventilated pen, offered water and experimental diet *ad libitum*. The cages were cleaned and disinfected daily for 63 days of the experiment. The study area lies between longitude of 7°27.05 north and 3°53.74 of the Greenwich Meridian, east at an altitude of 200 m above sea level. Average temperature and relative humidity of the location is between 23 – 42 °C and 60-80 %, respectively (SMUI, 2018).

Experimental procedure

During nine weeks of the experiment, rabbits were fed one of the 7 diets *ad libitum*, with a weekly weight and daily feed consumption recorded. The average daily weight gain (ADWG), average daily feed intake (ADFI) and the feed conversion ratio (FCR) were calculated, respectively, for the experimental period (63 days). At the end of the 9 week experimental period, digestibility trial was conducted. Experimental diets and water were offered *ad libitum* by using fixed containers. A small drawer covered with plastic sheet was underneath the food trough to enable easy collection of any scattered food. The excreta of each rabbit during the collection period were pooled together and then dried at 65 °C for 24 h. The dried excreta for the successive three days were left for few hours to get equilibrium with the atmosphere, then grounded, mixed well and stored in a screw-top glass jars for analysis. Carcass characteristics were determined as described by Blasco *et al*. (1993). Two rabbit were selected from each replicate, weighed, tagged, slaughtered and put to death humanely. The skin, legs, head and intestines were removed and the dressing-out percentage (DP) was then calculated. The weights of major internal organs (liver, heart, lung, kidney and spleen) were determined separately and expressed as the percentage of slaughter weight.

Statistical analyses

A completely randomised design with the following model was adopted in this study:

$X_{ij} = \mu + \alpha_i + \epsilon_{ij}$, where

X_{ij} = any of the response variables; μ = the overall mean; α_i = effect of the *i* treatment (i = diets 1, 2, 3, 4, 5, 6 and 7) and ϵ_{ij} = random error due to experimentation.

All data collected in this study were subjected to analysis of variance using SPSS statistical software package 2011, version 20. The differences between treatment groups were determined by Duncan's multiple range, while statistical significance was assessed at $P < 0.05$.

RESULTS AND DISCUSSION

Composition of composite sweet potato meal and experimental feeds

The chemical composition of composite sweet potato meal showed a commensurate proportion of fibre coupled with an improved protein content compared to maize. The values obtained from this study were close to those found by Tesfaye *et al*. (2011), thou the varieties of sweet potato used by Tesfaye *et al*. (2011) were not specified. The crude protein of the composite sweet potato meal was less than 20 %, which contradicts with the findings of Woolfe (1992), and this may be due to the combination of sweet potato parts used i.e root and vines. The Ether extract content (1.50 – 2.10 %) was in line with the findings of Sanoussi *et al*. (2016; 0.54 to 2.22 %).

Table 2. Ingredient and chemical composition of experimental diets including the levels of the two varieties of CSPM

Ingredient		Levels of orange flesh CSPM			Levels of white flesh CSPM		
	T1 (0 %)	T2 (25 %)	T3 (50 %)	T4 (75 %)	T5 (25 %)	T6 (50 %)	T7 (75 %)
Maize	50.00	37.50	25.00	12.50	37.50	25.00	12.50
*CSPM	-	12.50	25.00	37.50	12.50	25.00	37.50
Soya bean meal	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Palm kernel cake	19.00	19.00	19.00	19.00	19.00	19.00	19.00
Fish meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wheat offal	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Cassava flour	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bone Meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Table Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chemical Composition							
Dry matter (%)	92.46	92.95	93.02	93.19	92.15	92.34	92.54
Crude protein (%)	16.01	16.59	17.59	19.19	16.34	17.72	18.20
Ether extract (%)	3.70	4.35	4.70	5.40	4.30	4.70	4.81
Ash (%)	4.90	5.45	8.80	9.30	7.20	9.25	12.95
Crude fibre (%)	8.85	11.30	12.40	13.05	10.15	11.15	11.35
NDF	46.90	54.50	58.80	60.80	54.85	57.65	60.20
ADF	26.50	32.20	37.10	39.80	32.65	34.70	38.90
ADL	12.30	15.80	17.95	21.80	16.90	17.45	20.10

*CSPM – Composite sweet potato meal; OFSP – Orange flesh sweet potato; WFSP – White sweet potato.

The ash content (3.45 – 7.80 %) of the composite sweet potato meal in this study was in agreement with the value (5.563 ± 0.04) obtained by Teow *et al*. (2013). The crude fibre obtained for the composite sweet potato meal (3.60 – 8.70 %) was lower than was reported for sweet potato root meal (12.82 %) by Beckford and Bartlett (2015). The fibre fractions of the composite sweet potato meal in the current study were above the ranges obtained by Oradho *et al*. (1996). The fibre fractions obtained in this study are comparable with what is obtainable for most of the fibrous feedstuff such as wheat straw or grape pomace (Maertens *et al*., 2002). The fibre fractions obtained in this study meets the minimum dietary requirement of 28 – 46 % NDF and 15 – 23 % ADF required for healthy digestive physiology of rabbits and further reduced the risk of digestive troubles (Gidenne, 2015). As expected, the dietary incorporation of composite sweet potato meal increased the NDF level from 46.90 (control) to 60.80 % (75 % CSPM), while the CP level increased from 16.01 % (control) to 19.19 % (75 % CSPM) (Table 2).

Nutritive value of the composite sweet potato meal

The dry matter digestibility decreased slightly with an increasing level of inclusion of the composite sweet potato meal (Table 3). The slight numerical difference observed in dry matter digestibility could probably explain nutrient accumulation rate in the sweet potato composite, which was comparable to the control. The research findings affirm the report of Davis *et al*. (2014) who reported that the characteristic

Table 3. Effect of composite sweet potato meal dietary incorporation on feed intake and growth of rabbits

Parameters		Levels of orange flesh CSPM			Levels of white flesh CSPM				
	T1 (0 %)	T2 (25 %)	T3 (50 %)	T4 (75 %)	T5 (25 %)	T6 (50 %)	T7 (75 %)	SEM	*P*-Value
Period 35 – 56 days									
Live weight at 35 d (g)	557.25	590.67	551.56	560.89	569.21	563.17	580.11	5.16	0.1291
Live weight at 56 d (g)	875.56^{ab}	891.06^{ab}	814.33^{bc}	729.06^{c}	947.14^{a}	892.44^{ab}	912.17^{ab}	27.41	0.011
Daily intake (g.d^{-1})	33.27^{a}	31.15^{a}	31.96^{a}	30.00^{ab}	31.36^{a}	28.00^{b}	27.77^{b}	0.77	0.012
Weight gain (g.d^{-1})	16.49^{a}	14.33^{a}	12.51^{ab}	8.01^{c}	15.50^{a}	15.68^{a}	15.81^{a}	1.12	0.063
Feed conversion	2.23	2.80	3.52	3.27	2.35	2.91	3.28	0.184	0.011
Period 56 – 77 days									
Live weight at 77 d (g)	1361.50^{ab}	1323.50^{bc}	1169.89^{bc}	1134.17^{c}	1401.69^{a}	1277.22^{bc}	1269.17^{bc}	36.77	0.115
Daily intake (g.d^{-1})	64.83^{a}	53.20^{b}	49.79^{bc}	40.46^{c}	49.21^{bc}	48.34^{bc}	40.92^{c}	3.11	0.004
Weight gain (g.d^{-1})	23.14	20.60	16.93	19.29	21.65	18.32	17.00	0.89	0.268
Feed conversion ratio	2.88	2.93	3.88	4.25	2.60	3.58	3.85	0.23	0.616
Period 77 – 98 days									
Live weight at 98 d (g)	1741.19^{a}	1706.00^{ab}	1531.44^{bc}	1492.28^{c}	1770.19^{a}	1585.28^{abc}	1577.06^{abc}	41.19	0.0422
Daily intake (g.d^{-1})	96.92^{a}	80.81^{ab}	75.174^{bc}	49.70^{c}	63.54^{bc}	78.22^{ab}	63.91^{bc}	5.73	0.021
Weight gain (g.d^{-1})	18.08^{a}	18.22^{a}	17.22^{ab}	17.05^{ab}	17.55^{a}	14.67^{b}	14.66^{b}	0.57	0.036
Feed conversion	5.85	4.79	5.00	5.81	4.10	5.58	5.16	0.23	0.605
Period 35 – 98 days									
Live weight at 35 d (g)	557.25	590.67	551.56	560.89	569.21	563.17	580.11	5.16	0.1291
Live weight at 98 d (g)	1741.19^{a}	1706.00^{ab}	1531.44^{bc}	1492.28^{c}	1770.19^{a}	1585.28^{abc}	1577.06^{abc}	41.19	0.0422
Daily intake (g.d^{-1})	59.23^{a}	50.07^{ab}	43.08^{bc}	40.05^{bc}	48.04^{ab}	37.30^{bc}	33.78^{c}	3.27	0.0066
Weight gain (g.d^{-1})	17.71^{a}	16.56^{ab}	11.67^{bc}	8.53^{c}	16.70^{ab}	10.76^{c}	9.30^{c}	1.46	0.0076
Feed conversion	3.38	3.36	3.68	4.79	2.89	3.51	3.93	0.22	0.4676
Feed-cost/wk/rabbit (₦)	50.05^{a}	40.46^{b}	36.62^{bc}	26.92^{d}	35.64^{bc}	37.15^{bc}	30.63^{cd}	2.79	0.0004
Survivability (%)	91.67^{a}	91.67^{a}	75.00^{b}	58.33^{d}	91.67^{a}	66.67^{c}	58.33^{d}	5.87	0.0001

$^{a, b c}$ values in the same row with different superscript are significantly different ($P < 0.05$); 1US Dollar = 360 Nigeria Naria; OFCSP – Orange flesh composite sweet potato; WFCSP – White flesh composite sweet potato.

of feed ingredients contribute to the variation in dry matter digestibility. However, when the dietary fibre level increases, the diet digestion is reduced because of the lower digestion of fibrous components (Gidenne *et al*., 2010).

Findings of García *et al*. (2002) and Nicodemus *et al*. (2002) indicate that dietary inclusion of fibrous feedstuff at levels of 100 – 150 $g.kg^{-1}$ has little effect on rabbit performance. However, an excessive substitution of lucerne hay with highly lignified sources of fibre, which was the case in this assay, depresses energy digestibility (García *et al*., 1999). CP digestibility was negatively impacted by CSPM incorporation and it could be explained by the fact that proteins can be associated with cell walls, as usually found in roughage, and their availability being limited. The digestibility of fibre fractions was linearly impaired with CSPM dietary inclusion. The NDF and ADF digestibility gradually declined with the increasing levels of inclusion, probably due to harvesting stage of the sweet potato vines, which increased the cellulose content, perhaps with high crystallinity for the cellulose molecule due to their silica content, as reported by Schaller *et al*. (2011). De Blas *et al*. (1989) observed underestimated nutritive value and impaired digestibility when high level of substitution of the basal diet with a high fibrous but low fermentable ingredient like, wheat straw, was applied.

Feed intake, growth and mortality of animals

Throughout the experiment, there was 91.67 % survivability in 0 % CSPM and 25 % CSPM of both varieties, 75 % survivability in 50 % CSPM of orange flesh sweet potato, 66.67 % survivability in 50 % CSPM of white flesh sweet potato and 58 % in survivability in 75 % CSPM of the two varieties. The mortality observed could be attributed to the effect of overloading carbohydrate. The high level of carbohydrate in rabbit diets would promote enteritis causing a proliferation of bacteria (Gidenne *et al*., 1998). No antibiotic treatment was used during the trial. This is an indication that the rabbits were healthy during the period of the experiment. The feed intake, growth, weight gain and feed conversion ratio in this experiment ranged within the values mentioned in the literature, measured for the growing rabbits (Table 3). They did not differ according to the diet for the period between 35 – 56 days and for the period between 56 and 77 days. However, significant increase was detected in feed conversion for the final period (77 – 98 days).

The overall growth rate during the experiment did not exceed 17.71 $g.day^{-1}$, while feed intake varied from 33.78 $g.day^{-1}$ for rabbits fed diet containing 75 % CSPM white flesh sweet potato to 59.23 $g.day^{-1}$ in the rabbits fed 0 % CSPM ($P < 0.05$). The slight but significant reduction in growth rate as composite sweet potato replaced maize may be due to the presence of unidentified inhibitors of digestive, metabolic processes, which could also be attributed to the quality of the starch present in the sweet potato-based diet. The values from this study followed the trends observed by Tewe (2002), who found out in the experiment to replace maize with oven-dried and sun-dried sweet potato meal (SPM), that there was a reduction in body weight gain and nutrient utilization of birds in the SPM-substituted compared to the maize-based control diets.

Consequently, the overall feed conversion ratio was comparable among the dietary treatments.

There is an improvement in performances during the second period of 56 – 77 days compared to the first period of 35 – 56 days with increase in growth rate and increase in feed intake. Though, the feed conversion ratio is almost similar to the period of 35-56 days.

During the 56 – 77 day period, feed intake was higher in the control and steadily decreased with increasing level of the composite meal. This was the consequence of the capacity of the rabbits to control their feed intake according to meet their dietary energy demands. Accordingly, rabbits usually attempt to increase their feed intake to satisfy energetic needs, might still be in deficit because of the high fibre level in the diet (Gidenne and Lebas, 2002).

Thus, there was no improvement in the growth rate but a reasonable increase in feed conversion ratio, as reported by several authors (Maertens, 1992; Lebas and Djago, 2001; Xiccato and Trocino, 2010). Overall, rabbits on the different levels of CSPM achieved a relatively comparable growth performance compared to those in the control.

Slaughter performance

The effect of dietary level of CSPM inclusion or maize substitution on slaughter traits of rabbits is presented in Table 4. Slaughter live weight was significantly affected by CSPM inclusion rate but still reached an average weight of 1338.0 g, which was lower than the local market weight (1400.0 ± 0.05 g), as reported by Kadi *et al*. (2008). The average slaughter live weight obtained at 98 days (1338.0 – 1856.7 g) was comparable to those in the local market, and this may be attributed to the reduction of the anti-nutritional factors of sweet potato composite. This result was consistent with the report of Turner *et al*. (1976), who examined various diets consisting of cooked sweet potato and a protein supplement for poultry feeding, which showed higher dressing out percentage.

The values of dressing out percentage of carcass of rabbits, obtained in this study, were within the range of 56.53 – 66.35 % obtained by Chikaodi *et al*. (2017). The abdominal fat deposit decreased as level of composite sweet potato increased. This could be a result of high energy levels and the quality of the starch content of composite sweet potato in the diets. These results are in agreement with the report of Askov (1997), who noted that the reduction in abdominal fat upon high protein content in the feed is possible in rabbits. Increasing protein content in feed of animals results in enhanced secretion of urea by the kidneys. This process requires energy, which is taken from the energy reserves of the body, thus resulting in less energy for other body functions, such as building up fat deposits (Askov, 1997).

Liver weight was influenced by CSPM incorporation and also by the rate of incorporation with an average values close to the findings of Eiben *et al*. (2010). Papadomichelakis *et al*. (2012) reported that liver weight of rabbits decreased with increasing degradable fibre in the diet. The overall carcass characteristic results in this study were satisfactory and comparable to results provided in the literature (Dalle Zotte *et al*., 2014).

The dry matter digestibility decreased from 0 % CSPM to 75 % CSPM OFSP and 75 % CSPM WFSP respectively, according to the CSPM dietary incorporation (Table 5). When the dietary fibre level increased, the diet digestion is reduced because of the lower digestion of fibrous components (Gidenne *et al*., 2010). The increasing level of fibres in the feed with CSPM incorporation and relatively low NDF digestibility of CSPM could be responsible for a longer retention time of the feed in the digestive tract. The physical adaptation of the rabbit full digestive tract to continual increase diet intake and consequences develop a high cell wall levels (60.08 and 60.20 % NDF in 75 % CSPM OFSP and 75 % CSPM WFSP respectively) has been previously described in the works of Gidenne *et al*. (1991) and Gidenne (1992) that the full digestive tract weight

Table 4. Effect of dietary level of inclusion CSPM for maize substitution on slaughter traits of rabbits

Parameters		Levels of orange flesh CSPM			Levels of white flesh CSPM				
	T1 (0 %)	T2 (25 %)	T3 (50 %)	T4 (75 %)	T5 (25 %)	T6 (50 %)	T7 (75 %)	SEM	*P*-Value
Live weight (g)	1746.0^{ab}	1856.7^{a}	1410.0^{cd}	1600.7^{bc}	1617.3^{abc}	1592.7^{bc}	1338.0^{d}	67.62	0.0039
Bleed weight (g)	1605.3^{ab}	1628.7^{a}	1346.7^{c}	1564.7^{abc}	1538.0^{abc}	1520.0^{bc}	1306.7^{c}	51.19	0.0117
Skinned weight (g)	1487.3^{a}	1523.7^{a}	1212.0^{b}	1391.3^{ab}	1380.7^{ab}	1391.3^{ab}	1180.0^{b}	58.11	0.0137
Dressed weight (g)	890.0^{ab}	998.0^{a}	708.00^{c}	778.33^{bc}	814.33^{bc}	885.67^{ab}	670.0^{c}	43.01	0.0089
Liver (g)	66.00^{a}	42.00^{b}	36.00^{b}	43.33^{b}	37.33^{b}	36.00^{b}	30.67^{b}	4.36	0.005
Full GIT (g)	387.00	402.67	409.67	449.00	408.33	425.00	467.33	10.61	0.445
Dressing %	53.35^{ab}	55.36^{ab}	52.52^{ab}	49.45^{b}	53.07^{ab}	58.56^{a}	51.38^{b}	1.10	0.1175
*Skin (%)	10.72	9.62	10.00	11.15	10.13	9.13	9.63	0.26	0.4282
*Abdominal Fat (%)	0.43^{d}	2.42^{a}	0.49^{cd}	1.01^{bc}	1.11^{b}	0.92^{bcd}	1.02^{b}	0.25	0.0001

$^{a, b, c, d}$ values in the same row with different superscript are significantly different ($P < 0.05$); SEM – standard error of means
CSPM – Composite sweet potato meal; GIT – Gastrointestinal tract; *expressed as % of live weight.

Table 5. Nutrient digestibility coefficients (%) of experimental diets in growing rabbits fed composite sweet potato meal

Parameters	Dry matter (%)	Protein (%)	Ether Extract (%)	Ash (%)	Fibre (%)	NDF (%)	ADF (%)	ADL (%)
T1 Control	58.17	82.29[a]	83.39[b]	29.07[f]	13.47[d]	53.09[a]	31.47[a]	13.27[a]
T2 (25 % OFSP)	57.14	75.33[b]	79.07[d]	27.08[g]	14.16[cd]	42.33[b]	25.01[b]	13.24[a]
T3 (50 % OFSP)	56.38	73.11[d]	84.21[ab]	31.20[e]	16.20[b]	39.16[bc]	19.29[c]	13.19[a]
T4 (75 % OFSP)	55.25	72.09[e]	85.07[a]	49.44[b]	19.48[a]	30.12[c]	17.27[c]	10.43[c]
T5 (25 % WFSP)	58.05	77.12[b]	82.32[c]	37.28[d]	13.27[d]	43.19[b]	26.17[b]	13.03[a]
T6 (50 % WFSP)	57.00	75.35[c]	81.39[c]	41.08[c]	14.34[cd]	41.25[b]	17.07[c]	12.22[b]
T7 (75 % WFSP)	56.07	73.20[d]	84.32[ab]	63.41[a]	15.09[c]	39.23[bc]	12.36[cd]	10.21[c]
SEM	0.40	1.30	0.79	4.90	0.81	2.57	2.48	0.51
P-Value	0.8322	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

[a, b, c, d, e, f] values in the same row with different superscript are significantly different ($P < 0.05$), SEM – standard error of means; OFSP – Orange flesh sweet potato; WFSP – White flesh sweet potato meal; NDF – Neutral detergent fibre; ADF – Acid detergent fibre; ADL – Acid detergent lignin.

linearly impairs dressing out percentage. When a high dietary fibre level decreases the growth rate, slaughter yield falls due to increased digestive tract proportions (Hernández and Dalle Zotte 2010).

CONCLUSION

The nutritive value of the composite sweet potato meal for the growing rabbit appears to be comparable to maize. The composite sweet potato meal can, therefore, be considered as an excellent fibre feedstuff to cover the fibre requirements of the growing rabbits in cellulose and lignin. Orange-flesh composite sweet potato had relatively higher nutritive value compared to the white-flesh composite sweet potato. The composite sweet potato meal from the two varieties can replace maize in rabbit's diet enhancing weight gain, nutrient digestibility and slaughter performance. Further research may be required to determine the optimum mixture for the composite sweet potato that would be more suitable for inclusion in growing rabbit diets without impairing their growth or health status.

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