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Original Research Article

GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF RABBITS FED DIETS CONTAINING WASTE SWEET POTATO TUBER MEAL SUPPLEMENTED WITH *CENTROSEMA PUBENSCENS* LEAF MEAL

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ABSTRACT

The study was carried out to determine the growth performance and carcass characteristics of growing rabbits fed diets containing sweet potato waste meal supplemented with *Centrosema pubenscens* leaf meal with inclusion levels of 0%, 15%, 20% and 25% to replace maize. Dutch cross breed rabbits at 12 weeks of age were used for this experiment and were divided into four treatments, 1 – 4. Parameters determined were initial body weight, final body weight, body weight gain, feed intake, feed conversion ratio (FCR), cost of production, internal organs weight, cut parts weight, dressed weight and dressing percentage. Data collected were analysed using one way analysis of variance. TMT4 had the highest feed intake of 91.66g while TMT 3 had the lowest feed intake of 64.66g. Rabbits on 25% SPWM (TMT 4) supplemented with *centrosema* leaf meal recorded significantly ($P < 0.05$) higher body weight gain while those in 2 and 3 recorded significantly ($P < 0.05$) low body weight gain. Rabbits TMT 4 recorded best feed conversion ratio of 4.45, which was better than control, 2 and 3 respectively. The relative organ weight to live weight obtained were significantly better ($P < 0.05$) with sweet potato waste meal supplemented with *Centrosema pubenscens* leaf meal with TMT 1 and TMT 2 recording the highest percent liver while TMT 4 recorded the lowest kidney percent. Heart, lungs, spleen were not affected by the treatment levels. The result of the carcass showed that the evaluated were significantly ($P < 0.05$) influenced by dietary treatments. The live weights and eviscerated weight were highest in rabbits fed 25% sweet potato waste meal supplemented with *C. pubenscens.* The cost/kg diet showed that the cheapest was diet 4 (₦212.48) while the costliest was the control diet (₦370.88). The result of study showed that sweet potato waste meal supplemented with *Centrosema pubenscens* leaf meal could be used up to 25% in the diets of growing rabbits without affecting performance.

Keywords: Growth performance, carcass characteristics, rabbits, sweet potato waste meal, *centrosema* leaf meal

INTRODUCTION

Rabbits (*Oryctolagus cuniculus*) descended from wild rabbits found in the Mediterranean Countries and was introduced into England in the late Eleventh to early Twelfth Century. The prolific nature of rabbits coupled with its short gestation period and generation interval, makes it the animal of choice for multiplication and a short way of increasing animal protein intake (Uchewa *et al.*, 2014). Domestic rabbits are sources of animal protein, fibre, research models, and they also provide companionship to humans.

Rabbit production presents a promising avenue for food security and income generation in developing countries, particularly due to its low capital requirement, rapid reproduction, and efficient feed conversion. However, feed cost has become a limiting factor to rabbit production, especially when relying on commercial rations. Exploring readily available and cheaper alternative feed sources is crucial for sustainable and profitable rabbit farming (Akinmutimi & Osuagwu, 2008).

The utilization of alternative feed resources for livestock

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production has gained significant attention due to the increasing demand for animal products and rocketing prices of conventional feed ingredients and compounded feeds. In rabbits husbandry, the quest for nutritionally balanced but cost-effective feeding materials has led to the exploration of unconventional feed ingredients for use in least cost feed formulation. The present study hence evaluates the growth performance of rabbits fed sweet potato waste meal supplemented with Centrosema leaf meal in their diets.

METHODOLOGY

EXPERIMENTAL SITE

This research was conducted at the Rabbitry unit of the Teaching and Research farm of Michael Okpara University of Agriculture, Umudike located on latitude 05°29'N and longitude 07°33'E. Umudike is located in the tropical rain-forest zone of Nigeria on an elevation of 122m above sea level and is characterized by annual rainfall of about 2177 mm; monthly ambient temperature ranges of 22-33°C and relative humidity of 50-95 **%** depending on the season (NRCRI, 2021).

EXPERIMENTAL ANIMAL AND MANAGEMENT

A total of sixteen (16) rabbits were purchased from Ohiya, a reputable rabbit farm in Umuahia. The rabbits were 12 weeks of age and of mixed sex. They were weighed at the beginning of the feeding trial to determine their initial body weights and weighed again at weekly intervals to determine their body weight gain. Two weeks to the arrival of the rabbits, the rabbit's hutches were cleaned, disinfected by washing and allowed to dry. On arrival, the rabbits were quarantined in an isolation facility and anti-stress supplements were administered to enhance recover from transportation stress. After one week of isolation, the rabbits were randomly assigned to four (4) treatments of 4 rabbits each with two (2) replicates of two rabbit each and one (1) control. Antibiotics drugs were administered in water at relevant periods as a prophylactic measure. The experiment lasted for 9 weeks.

SWEET POTATO WASTE MEAL, *CENTROSEMA PUBENSCENS* LEAF MEAL AND OTHER FEED INGREDIENTS

The sweet potato waste meal wastes were collected from potato dealers at Orieagu market in Imo State. They were dried under the harmattan sunshine for two weeks, milled to powder and then bagged in an air tight polythene bag until used. *Centrosema pubescens* leaves were harvested from the school environment and wilted under room temperature, graded and bagged for use. Other feed ingredients such as palm kernel meal, maize, wheat offal, premix, salt, methionine, soybean meal, lysine, fish meal; bone meal were procured from a reputable distributor in Umuahia.

PHYTOCHEMICAL DETERMINATION

The test materials fresh and dried sweet potato waste meal *C. pubescens* leaf meal were dried under the harmattan sunshine before they were analyzed for the phytochemicals fatcors such as tannin, oxalate, phytic acid, saponins, alkaloids and flavonoids. Total oxalate and tannin were determined according to Association of Official Analytical Chemist (AOAC, 2005). Phytic acid was determined according to Maga (1982). Saponin was determined according to Brunner (1984). Alkaloids was determined according to Henry (1993), and Allen (1992) method while flavonoids was determined according to spectrophotometric methods of Allen (1979). Other anti-nutrients determined were cyanide, polyphenols, phytate and oxalate in *C. pubescens* leaf meal.

CHEMICAL ANALYSIS OF FEED INGREDIENTS

All the feeding materials sweet potato waste meal, palm kernel cake, wheat offals, soybean meal, fishmeal, *C. pubescens* leaf meal were subjected to proximate analysis according to (AOAC 1995) to determine their nutrient composition. The components that were determined include dry matter (DM), crude protein (CP), Ether extracts (EE) and nitrogen free extract (NFE).

EXPERIMENTAL DIETS

Four experimental diets (diet 1, 2, 3, and 4) were formulated based on maize as the major source of energy. Diet 1 contained maize as main energy source while diets 2, 3 and 4 contained 15%, 20% and 25% of sweet potato waste meal supplemented with Centrosema leaf meal as replacement for maize (Table 1).

DATA COLLECTION

Data was collected and the following parameters were measured:

GROWTH PERFORMANCE PARAMETERS

Body weights of the rabbits were taken at the beginning of the feeding trial and subsequently on weekly intervals.

Feed intake was taken daily as the difference between feed offered and leftover over a 24 hour period. Body weight gain was calculated as:

$$Daily\ weight\ gain = \frac{Body\ weight}{Number\ of\ days\ of\ feeding\ trial}$$

While feed conversion ratio was determined as:

$$Feed\ conversion = \frac{Daily\ feed\ intake}{Daily\ weight\ gain}$$

TABLE I: EXPERIMENTAL DIETS FOR GROWING RABBITS CONTAINING SWEET POTATO WASTE TUBER MEAL

INGREDIENTS	DIET 1 (CTRL)	DIET 2 (15% SPWM)	DIET 3 (20% SPWM)	DIET 4 (25% SPWM)
Maize	40	34.00	32.00	30.00
SPWM	0.00	6.00	8.00	10.00
Soybean meal	5.00	5.00	5.00	5.00
Palm kernel cake	13.00	13.00	13.00	13.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offal	35.00	35.00	35.00	35.00
Bone meal	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.15	0.15	0.15	0.15
C. pubenscens leaf	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**
Proximate composition of the experimental diets				
Crude protein (%)	16.95	16.67	16.57	16.48
Crude fibre (%)	5.27	5.25	5.25	5.20
Ether extract (%)	8.65	8.30	7.92	7.55
Ash (%)	2.28	2.29	2.30	2.25
Phosphorus (%)	1.63	1.60	1.57	1.54
Calcium (%)	1.65	1.64	1.64	1.64
ME Kcal/kg	3132.39	3113.54	3094.65	3079.23

***Premix supplied per type kg diet: Vit. A, 10,000 IU; Vit. D 2,000,000 IU; Vit. E, 2,300 mg; Vit. K3 2,000 mg; Vit. B, 3,000 mg; Vit. B2, 6,000 mg; Niacin, 5,000 mg; Calcium, 800 mg; Panthotenate, 10,000 mg; Vit. B6, 5,000 mg; Vit B12, 250 mg; Folic acid, 100 mg; Biotin, 50 mg; Choline chloride, 40,000 mg; Selenium, 120 mg and Anti oxidant, 12,000 mg**

CARCASS ANALYSIS

At the end of feeding trial, 2 rabbits per treatment was randomly selected, weighed and then starved overnight (24 hours) but water was provided. The body weight of each fasted rabbit was then recorded. The rabbits were then slaughtered by using knife to severe the jugular vein in the throat. Dehaiping was carried out by using the direct flame (singe). Evisceration was carried out by removal of the intestine, lung, liver, gall bladder. The carcass was cleaned from blood and other strain. The carcass was cut into parts, arm, rib, blade, skin, loin, leg and breast. Dressed and weighed individually. Carcass analysis was carried out as described by (Blasco, *et al.*, 1993). Then the carcass was dissected and the internal organs evacuated (to get the eviscerated weight). The carcass was then dissembled into wholesale cuts as described by (Akinmutimi & Anakebe, 2008) and each primal part (thighs, ribs, neck, forelimbs, hind limbs and back and loin) was weighed using a digital scale. The organ weights (lungs, stomach, heart, kidney, liver and intestine) weight of abdominal fat were also taken. The cut-up parts and organs weights were each expressed as a percentage of the dressed weight.

STATISTICAL ANALYSIS

The data collected were subjected to analysis of variance (ANOVA) as described by Steel and Torrie using Statistical Package for the Social Sciences (SPSS, 2013) version 23.0. Significantly different means was separated using Duncan's New Multiple Range Test (Duncan, 1955).

EXPERIMENTAL DESIGN

The experimental design was completely randomized design (CRD). The design model was:

$Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} = observation, μ = overall mean, T_i = effects of treatment, e_{ij} = error means

RESULTS

PHYTOCHEMICAL COMPOSITION OF FRESH AND DRIED SWEET POTATO WASTE MEAL

The Phytochemical compositionin fresh and sun dried sweet potato sweet potato waste meal are shown in (Table II).

TABLE II: PHYTOCHEMICAL COMPOSITION OF FRESH AND DRIED SWEET POTATO WASTE MEAL (SPWM)

Parameters	Fresh SPWM	Dried SPWM
Tannin (mg/g)	1.62	1.60
Saponin (mg/g)	0.05	0.05
Alkaloids (mg/g)	4.86	4.75
Oxalate (mg/g)	0.45	0.45
Phytate (mg/g)	0.07	0.07
Flavonoid (mg/g)	1.06	1.00

TABLE III: PROXIMATE COMPOSITION OF FRESH AND DRIED SWEET POTATO WASTE MEAL (SPWM)

Parameters	Fresh SPWM	Dried SPWM
Dry matter (%)	61.25	88.75
Moisture (%)	38.75	11.25
Ash/Mineral (%)	4.60	6.26
Crude protein (%)	3.28	4.95
Ether extract (%)	0.60	0.82
Crude fibre (%)	1.17	2.64
Nitrogen Free Extract (%)	51.60	74.06
Metabolizable Energy (Kcal/kg)	2068.60	3013.59

TABLE IV: PROXIMATE COMPOSITION OF *CENTROSEMA PUBENSCENS* LEAF MEAL

Parameters	Value
Dry matter (%)	84.26
Moisture (%)	15.74
Ash/Mineral (%)	3.39
Crude protein (%)	23.08
Ether extract (%)	0.35
Crude fibre (%)	25.60
Nitrogen free extract (%)	31.84
Metabolizable energy (Kcal/kg)	3181.88

DISCUSSION

The phytochemical content of fresh and dried sweet potato waste meal was shown in (Table II). The values of tannins (1.62 mg/g), saponin (0.05 mg/g), alkaloid (4.86 mg/g), oxalate (0.45 mg/g), phytate (0.07 mg/g) and flavonoid (1.06 mg/g) recorded in this study fall within the range reported by Akinmutimi (2004), Ameh (2010). Drying of sweet potato waste meal helped to reduce the tannin, alkaloids and flavonoid as stated in (Table II). Drying of sweet potato waste meal was not effective for reducing saponin, oxalate and phytate content.

TABLE V: PERFORMANCE OF THE RABBITS FED SWEET POTATO WASTE MEAL SUPPLEMENTED WITH *CENTROSEMA* LEAF MEAL

Parameters	T_1 Control	T_2 15% SPWM	T_3 20% SPWM	T_4 25% SPWM	SEM
Initial body weight (kg)	0.70	0.60	0.87	0.55	0.07
Final Body weight (kg)	1.55^{b}	1.33^{c}	1.40^{c}	1.70^{a}	0.08
Body weight gain (kg)	0.85^{b}	0.73^{b}	0.94^{ab}	1.15^{a}	0.12
Daily weight gain (g)	15.18^{b}	13.0^{b}	9.46^{c}	20.5^{a}	2.31
Daily feed intake (g)	83.58^{b}	72.00^{c}	64.66^{c}	91.66^{a}	5.99
Feed Conversion Ratio	5.48^{b}	5.52^{b}	6.83^{c}	4.45^{a}	0.48

^{abc} means on the same row with different superscripts are significantly (P < 0.05) different

TABLE VI: RELATIVE WEIGHT OF CUT PARTS OF RABBITS FED DIETS CONTAINING SWEET POTATO WASTE MEAL SUPPLEMENTED WITH *CENTROSEMA PUBENSCENS*LEAF MEAL

Parameters	T_1 Control	T_2 15% SPWM	T_3 20% SPWM	T_4 25% SPWM	SEM
Live weight (kg)	1.65^{a}	1.05^{b}	0.90^{c}	1.62^{a}	0.19
Dead weight (%)	97.00^{a}	95.2^{b}	94.40^{c}	95.70^{b}	0.54
Defurred weight (%)	90.9^{a}	90.50^{a}	88.90^{b}	74.10^{c}	4.02
Fur (%)	1.45^{b}	1.24^{c}	1.56^{b}	1.54^{a}	0.07
Head (%)	9.70^{b}	10.90^{a}	9.67^{b}	9.38^{c}	0.33
Drum Stick (%)	3.20^{b}	8.57^{a}	3.11^{ab}	2.41^{c}	1.42
Thigh (%)	9.6^{b}	3.05^{c}	10.20^{a}	9.32^{ab}	1.68
Hind (Fore) (%)	188^{a}	1.43^{ab}	1.67^{b}	1.40^{c}	46.62
Ribs (%)	9.10^{b}	7.14^{c}	9.80^{a}	8.50^{c}	0.56
Back cut (%)	18.10^{ab}	16.40^{ab}	14.00^{c}	16.20^{ab}	3.71
Shoulder (%)	6.24^{b}	5.90^{ab}	5.80^{c}	7.50^{a}	0.39
Hind (Leg) (%)	1.45^{c}	1.62^{b}	1.80^{a}	1.30^{c}	0.10

^{abc} means on the same row with different superscripts are significantly (P < 0.05) different

TABLE VII: RELATIVE WEIGHTS OF INTERNAL ORGANS OF RABBITS FED DIET CONTAINING GRADED LEVELS OF SWEET POTATO WASTE MEAL SUPPLEMENTED WITH CENTROSEMA LEAF MEAL

Parameters	T_1 Control	T_2 15% SPWM	T_3 20% SPWM	T_4 25% SPWM	SEM
Dressed weight (kg)	1.00^{b}	0.53^{c}	0.80^{ab}	1.20^{a}	0.14
Heart (%)	0.30^{b}	0.60^{a}	0.25^{c}	0.42^{ab}	0.07
Liver (%)	4.00^{ab}	4.70^{a}	2.10^{c}	3.70^{b}	0.54
Spleen (%)	0.10^{b}	0.20^{a}	0.10^{b}	0.10^{b}	0.02
Lung (%)	1.10^{c}	1.32^{ab}	1.50^{a}	1.30^{b}	0.81
Kidney (%)	1.20^{ab}	1.50^{a}	0.90^{b}	0.80^{c}	0.15
Bile (%)	0.10^{b}	0.20^{ab}	0.30^{a}	0.10^{b}	0.04
Abdominal fat (%)	0.20^{c}	0.20^{c}	0.30^{ab}	0.80^{a}	0.14
Large intestine (%)	9.90^{ab}	22.10^{a}	4.10^{b}	1.10^{c}	4.64
Small intestine (%)	20.20^{ab}	21.10^{a}	9.80^{c}	14.50^{b}	2.64

^{abc} means within the same row with different superscripts are significantly (P < 0.05) different.
SEM = Standard Error Mean

TABLE VIII: COST BENEFIT ANALYSIS OF EXPERIMENTAL RABBITS FED *CENTROCEMA PUBENSCENS* AND DIET WITH VARYING LEVELS OF SWEET POTATO WASTE MEAL

Parameters	T1 Control	T2 15% SPWM	T3 20% SPWM	T4 25% SPWM
Cost/kg diet (₦)	370.88	327.68	356.48	212.48
Cost of feed consumed (₦)	8,901	6,335.56	5,703.68	3,187.20
Cost/kg weight gain (₦)	6,622.86	2,925.72	2,970.67	1,070.97
Cost of production (₦)	3,471.44	2,907.74	1,226.26	1,056.15
Revenue (₦/rabbit)	4,250.00	3,650.00	2,650.00	5,750.00
Gross margin	778.56	742.25	1,423.74	4,693.85
Return on investment (%)	22.43	25.53	116.10	444.43

The proximate composition of fresh and dried sweet potato waste meal is presented in (Table III). Values obtained for crude protein, crude fat, moisture content, ash, nitrogen free extract and metabolizable energy fall within the range reported by previous studies by Ameh, (2010), and Anayegbu *et al.* (2021).

Sun drying of the sweet potato waste meal was effective for increasing the dry matter, ash/mineral,

crude protein, ether extract, crude fibre, nitrogen free extract and metabolizable energy (Kcal/Kg) content of the test ingredients (Table III).

The proximate composition of *Centrosema pubenscens* leaf meal is shown in (Table IV). The values obtained for crude protein, crude fibre, moisture content, ash and metabolizable energy fall within the ranges obtained by previous studies Obua *et al*. (2012), Adebayo *et al.* (2019), Bamigboye & Oluwarinde (2017).

The performance of rabbits fed *Centrosema pubescens* leaves and diets containing varying levels of sweet potato waste meal are shown in (Table V).

The daily feed intake of the rabbit was 83.58g, 72.00g, 64.66g and 91.66g for T1 (control), T2, T3 and T4 respectively. Significant differences (P < 0.05) existed among the various groups. Increasing the dietary level of sweet potato waste meal from 15% to 25% significantly (P < 0.05) increase the body weight gain though the rabbits from treatment 4 had consumed significantly (P < 0.05) more feed than those in the control, T2 and T3. Daily feed intake differ among the treatments, however T4 had the highest daily feed intake of 91.66g and T3 had lowest feed intake of (64.66g), this may be as a result of palatability of the experimental diet at 25% inclusion.

Table V shows that the body weight gain was 0.85g, 0.73g, 0.53g and 1.15g for T1 (Control), T2, T3, and T4 respectively. Significant differences (P < 0.05) existed

among the various TMT groups in their body weight gain. The rabbits in T4 (25%) was recorded significantly ($P < 0.05$) higher body weight gain compared to those on the control diet, T2 and T3. The rabbits in T3 recorded significantly ($P < 0.05$) low body weight gain than those in T1, T2 and T4.

Recorded values for feed conversion ratio were 5.48, 5.52, 6.83, 4.45 for the control (T1), T2, T3, and T4 respectively. Significant difference ($P < 0.05$) existed among the various treatments. Rabbits in T4 recorded the best feed conversion ratio of 4.45, which was significantly ($P < 0.05$) better than the control, T2 and T3. The better feed conversion ratio of the rabbits in T4 may be attributed to the higher weight gain of the rabbits in this group.

The results of the effect of the graded levels of sweet potato waste meal on the carcass characteristics of the experimental rabbits are shown in (Table VI). The results showed that carcass characteristics were significantly ($P < 0.05$) influenced by dietary treatments. The Live weight was highest in rabbits fed the diet containing 25% SPWM. This result was not unexpected since the average daily weight gain of rabbits in this treatment was comparatively higher than those in other dietary groups.

The cut parts (fore limbs, hind limbs, thigh and head) varied ($P < 0.05$) across treatments. There were significant differences ($P < 0.05$) in the relative head and thigh weights of the rabbits, however, the highest weights of head (10.9%) and thigh (10.20%) were recorded for rabbits in (T2 and T3) respectively. The highest weights fore limb (1.88%), and back cut (18.10%) were recorded on T1 (control).

The values obtained for visceral organs (internal organs) in (Table VII) varied ($P < 0.05$) with dietary levels of sweet potato waste meal. T1 (Control) and T2 had the highest relative liver weights which were significantly ($P < 0.05$) higher than those of other groups. Rabbits in T4 recorded the lowest kidney percentage (0.8%).

The cost/kg diet were ₦370.88, ₦327.68, ₦356.48, ₦212.48 for the control diet, diet 2, diet 3 and diet 4 respectively. The cheapest diet was diet 4, while the costliest was the control diet. In term of the cost of production, the cost of production ₦/growing rabbit was lowest for those on diet 4 (25% SPTM) (₦1,056.15) while those on diet 1 (control) (₦3,471.44) was the costliest.

CONCLUSION

The result of the study showed that sweet potato waste meal supplemented with *Centrosema pubenscens* leaf meal could be used up to 25% in the diet of rabbits without affecting body weight gain, feed intake and feed conversion ratio. Based on the result of the study it is therefore recommended that dried sweet potato waste meal supplemented with *Centrosema pubenscens* leaf meal could be used up to 25% in the diet of rabbits for optimum performance.

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