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Linear Body Measurements and Carcass Characteristics of Rabbits Fed Orange (*Citrus sinensis*) Waste Meal as Alternative Fibre Source in Diet

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Abstract

A study was conducted to assess the effect of orange waste meal as an alternative fibre source on linear body measurements of rabbits. Twenty-four (24) weaned rabbits of cross breed and mixed sexes were used for the study. Experimental animals which weighed between 676.67 to 686.67 g were allotted to four dietary treatments in a completely randomized design. Results of the study showed that head length (HL), body length (BL), heart girth (HG), length of hind limb (LHL) and length of fore limb (LFL) differed ($p < 0.05$) significantly across the dietary treatments. Conversely, ear length (EL) and tail length (TL) did not differ ($p > 0.05$) statistically between the treatment groups. At the end of the experimental period of ten weeks, rabbits fed diet T4 (endocarp + mesocarp) recorded higher ($p < 0.05$) live weight values among the treatment groups. Research results revealed that carcass weight, dressing percentage, primal cuts and internal organ weights were not ($p > 0.05$) influenced by dietary treatments. Therefore, rabbits can effectively utilize orange waste meal as an alternative fibre source without adverse effects on linear body measurements and carcass characteristics.

Keywords: Linear body measurements; Fibre source; Sweet orange waste; Carcass characteristics; Weaner rabbits.

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INTRODUCTION

The major challenge of the livestock industry in developing countries has been shortage of good quality feed needed to sustain poultry and micro-livestock[9]. Consequent to this, the nutritive potential of some agro-industrial by-products and non-conventional feed resources found in abundance during dry season are assessed and utilized to support animal production. However, the utilization or inclusion of non-conventional feedstuffs in animal feed is limited by a number of factors. These include low protein content[4], high fibre[7], amino acid imbalance and presence of anti-nutritional factor. Agro-industrial by-products such as citrus pulp, citrus meal, citrus seed meal, citrus molasses and citrus peel are generated from fresh citrus after the main product of interest have been removed[9]. These are found in clusters on streets and major roads in Nigeria and constitute environmental problems. Productivity of livestock depends to a large extent on the animals ability to utilize feeds that have no value in human nutrition. Sweet orange fruit peel has been found to be rich in calories and protein content which is comparable to maize[9]. The orange peel as waste and of no significant benefit to man becomes a product of interest in this study. Rabbits have the unique characteristics that make them suitable for rearing. The small body size, short generation interval, rapid growth rate, genetic diversity and high reproductive potentials are characteristics which make rabbits suitable as meat producing micro livestock in developing countries[2]. This study was undertaken to assess the effect of orange waste meal on linear body measurements and carcass characteristics of rabbits.

1. MATERIALS AND METHOD

1.1 Experimental Animals and Housing

This research was conducted at the rabbitry unit of teaching and research farm of the Department of Animal Science, University of Calabar, Cross River State, Nigeria. Twenty-four (24) weaned cross bred rabbits of mixed sexes were used for the study.

Table 1
Gross Composition of Experimental Diets (g)

Composition	**Wheat offal Control** (T_1)	**Mesocarp** (T_2)	**Endocarp** (T_3)	**Mesocarp + Endocarp** (T_4)
Maize	47.8	47.8	47.8	47.8
Soya bean meal	10.7	10.7	10.7	10.7
Wheat offal	30	-	-	-
Mesocarp	-	30	-	-
Endocarp	-	-	30	-
Mesocarp + Endocarp	-	-	-	30
Palm kernel cake	10	10	10	10
*Vitamin premix	0.5	0.5	0.5	0.5
Lysine	0.3	0.3	0.3	0.3
Methionine	0.2	0.2	0.2	0.2
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100

*vitamin premix provide per kg of diet: vit. A 13,340 iu; vit. E 10 iu; vit. K 2.68 mg; calcium panthothenate, 10.68 mg; vit B12, 0.02 mg; folic acid, 0.668 mg; choline chloride, 400 mg; chlorotetracycline, 26.68 mg; manganese, 133.34 mg; iron, 66.68 mg; zinc, 53.34 mg; copper, 3.2 mg; iodine, 1.86 mg; cobalt, 0.268 mg; selenium, 0.10 mg.

Table 2
Proximate Composition of Orange Waste (%)

Composition	**Mesocarp**	**Endocarp**	**Mesocarp+ Endocarp**
Crude protein	6.56	5.25	5.1
Crude fibre	10.7	15.5	12.06
Ether extract	0.75	0.75	1.25
Ash	3	1	2.33
NFE	74.99	73.99	75.49
Dry matter	96	96.49	96.25

Table 3
Effect of Dietary Treatment on Linear Body Measurement (cm)

Parameters	T_1	T_2	T_3	T_4	±SEM	**Significance level**
Head length	10.61a	10.74b	9.73c	11.70a	0.39	*
Body length	25.89c	27.34b	25.46d	28.92a	0.58	*
Heart girth	19.60cd	22.66ab	22.10b	19.21d	0.61	*
Hind limb	22.13bc	22.70b	21.34	23.95	0.49	*
Fore limb	13.34c	13.62bc	14.73b	16.61a	0.57	*
Ear length	8.45	9.52	8.43	9.54	0.37	NS
Tail length	6.56	8.14	7.94	8.48	0.43	NS

Mean within rows with different superscripts are significantly ($p > 0.05$) different. Values are means of five animals. SEM: standard error of means

The animals were between 5 to 7 weeks of age and weighed between 676.67 g to 686.67g. Animals were housed individually within cells in double tier hutches. Each rabbit and its cell were properly identified for adequate record keeping. The hutches were raised 60 cm above the ground with the dimension 105 cm × 85 cm × 60 cm. On arrival anti-stress was administered to the animals for two days to combat transportation stress.

2. EXPERIMENTAL DIETS

Four experimental diets were formulated using wheat offal (control diet$-T_1$) and different fractions of orange to replace wheat offal as fibre source in diets. These fractions were mesocarp (diet$-T_2$), endocarp + mesocarp (diet$-T_2$) and endocarp (diet$-T_4$). Animals were fed twice daily (morning and evening). *Centrosema pubescens* was given to the animals as supplement. Composition of experimental diet is shown in Table 1.

2.1 Data Collection

Linear body measurements were taken in cm using the tailors measuring tape. Head length (HL) was measured at the distance from the nose to the point of the shoulder; body length (BL) − from the shoulder to the pin bone or the end of occygeal vertebra; heart girth (HG) − measured as body circumference just below the fore limbs; ear length (EL) − measured as the distance from point of attachment to the head to the tip of the ear; tail length (TL) − as the distance from the end of the occygeal vertebra to the tip of the tail; fore limb (LFL) − was measured from the tip of the fingers while length of hind limb (LHL) was taken from the hip joint to the tip of the toes.

2.2 Carcass Evaluation

Five rabbits were randomly selected and slaughtered per treatment for carcass evaluation. Prior to slaughter animals were starved for 12 hours, thereafter live weights were taken. The animals were stunned by dislocating the neck before severing the jugular veins to bleed them, after which they were singed and eviscerated. Live and dressed weights of animals were taken using a 10kg mechanical dial platform scale while dressing percentage (%) was calculated using the formula of Fielding[3]:

$$\text{Dressing percentage (\%)} = \frac{\text{Dressed carcass weight}}{\text{Live weight}} \times 100\%$$

Weight of primal cuts and internal organs were measured using a digital electronic scale.

2.3 Experimental Design and Statistical Analysis

Animals were assigned to each dietary treatment in a completely randomized design (CRD). All data obtained were subjected to statistical analysis with the general linear model of SAS[6] and significant means were separated using Duncans multiple range test as described by Steel and Torrie[11]. Model for analysis of variance was:

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

Where Y_{ij} = individual observation on the i th treatment;
μ = overall mean of all observations;
T_i = dietary treatment effect ($i = 1-4$);
e_{ij} = random error identically and independently normally distributed, with zero mean and constant variance [iind $(0, \sigma)$].

3. RESULTS AND DISCUSSION

3.1 Nutrient Composition of Orange Waste Meal

Nutrient compositions of the different orange waste meal used in the formulation of experimental diets are presented in Table 2. Results shows that the crude protein values were similar across the groups, while crude fibre were 10.70%, 15.50% and 12.06% for orange mesocarp, endocarp and mesocarp + endocarp, respectively. Nitrogen free extract and dry matter values were similar between the three orange fractions. Ether extract and ash ranged between $0.75-1.25\%$ and $1.00-3.00\%$, respectively among the groups.

3.2 Linear Body Measurements of Rabbits Fed Experimental Diets

Results of experimental diets on linear body measurements of rabbits are presented in Table 3. Data collected and analyzed for this study reveals that head length (HL), body length (BL), heart girth (HG), hind limb length (HLL) and fore limb length (FLL) differed ($p < 0.05$) significantly among the treatment groups while ear and tail lengths showed no statistical difference. Body length values were 25.46 cm (T_3), 25.89 cm (T_1), 27.47 cm (T_2) and 28.92 cm (T_4) with rabbits fed diet T_4 recording the longest length. Head length values followed a similar trend as body length across the treatment groups. However, highest ($p < 0.05$) heart girth (HG) length was observed for rabbits fed dietary treatment T_2 (endocarp). Interestingly, body length (BL); hind limb length (HLL) and fore limb length (FLL) of rabbits fed dietary treatment T_4 differed ($p < 0.05$) significantly among the treatment groups. This observation could be attributed to the use of the orange mesocarp and endocarp combination in the diet, which may have made the feed palatable and more acceptable to the animals. The lengths of the ear and tail were not significantly ($p > 0.05$) influenced by the dietary treatments.

3.3 Carcass Evaluation

Live weight and carcass weight of the experimental animals at the end of 10 weeks did not differ ($p > 0.05$) significantly (Table 4). This is in agreement with the report of Yakubu et al.[12] who gave similar report for carcass weight of rabbits. The average weight of rabbits obtained at the end of the experiment ranged from 1075.00 g to 1460.00 g with the

Table 4
Carcass Evaluation of Rabbits Fed Experimental Diets.

Parameters	T_1	T_2	T_3	T_4	± SEM
Live weight	1075	1403.33	1280	1460	6.08
Carcass weight	942.44	1220.55	1058.11	1111.94	5
Dressing percentage (%)	87.39	87.04	82.66	78.83	0.94
Prime cuts (g)					
Head	135.41	163.48	139.38	155.82	1.69
Trotters	31.51	51.61	29.98	39.92	1.46
Thighs	280.94	338.6	310.59	323.69	2.3
Loin	225.55	317.08	250.27	272.63	5.8
Shoulder	222.23	292.33	279.33	266.53	2.57
Internal organs (g)					
Heart	13.49	14.51	12.99	15.02	0.45
Liver	24.26	33.08	25.77	28.53	0.92
Kidney	9.04	9.56	9.8	9.79	0.27

Values are means of five rabbits. SEM: standard error of means.

highest weight obtained for animals fed diet T_4. These live weight values obtained are however lower than the range of 1575.00 g to 1813.00 g reported by Hon et al.[5] when sweet orange pulp meal was used as dietary substitute for maize in diets of growing rabbit. Average dressing percentage were 87.39%(T_1), 87.04%(T_2), 82.66%(T_3) and 78.83%(T_4), with no significant ($p > 0.05$) difference among the dietary treatment groups. The dressing percentage obtained in this study were however higher ($p > 0.05$) than dressing percentage range of 51.30% to 53.30% reported by Odeyinka et al.[8], when soybean milk residue, cowpea testa and corn starch were used as alternatives for maize and groundnut in diets of rabbits. Results observed in this study may be attributed to differences in strains of rabbits used for individual research. More so, variations in the proximate constituents of the test ingredient, which could in turn, affect the dietary composition of experimental diets.

3.4 Prime Cuts

Primal cuts of rabbits fed dietary treatments are as presented in Table 4. Prime cuts evaluated in this study showed no significant ($p > 0.05$) difference among treatment groups. This result agrees with earlier reports by Orunmuyi et al.[10]. Rabbits on dietary treatment T_2 recorded highest ($p > 0.05$) value for all primal cuts (head, trotters, thighs, loin and shoulder) followed by T_4, T_3 and T_1. In another study by Hon et al.[5], were maize was supplemented with dried sweet orange fruit pulp meal; the loin weight was reported to differ ($p < 0.05$) significantly. Results of this study were at variance to this report.

3.5 Internal Organs

Weights of the heart, liver and kidney recorded did not reveal any significant ($p > 0.05$) difference across the treatments (Table 3). The mean value range for heart, liver and kidney were 12.99 g to 15.02 g, 24.26 g to 33.08 g and 9.04 g to 9.79 g, respectively. Similar results were observed by Amaefule[1] and Hon et al.[5].

CONCLUSION

The utilization of orange waste meal as an alternative fibre source in rabbit has shown no adverse effect on parameters assessed in this study. Similarly results on carcass characteristics compares favorably with results on rabbits performance fed diets containing conventional fibre sources. Therefore, orange waste can be used as an alternative fibre source in rabbit diet thereby eliminating its wastage when considered as waste.

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