



## Reproductive Performance of Breeder Rabbits Fed Diets with Graded Levels of Orange Pulp Meal as Energy Source

O. O. Effiong<sup>1\*</sup>, L. E. Asuquo<sup>2</sup> and B. E. Atiata<sup>1</sup>

<sup>1</sup>Department of Animal Science, University of Calabar, Nigeria.

<sup>2</sup>Akwa Ibom State College of Education, Afaha Nsit, Nigeria.

### Authors' contributions

*This work was carried out in collaboration between all authors. Author OOE designed the study, wrote the protocol and wrote the first draft of the manuscript. Author OOE reviewed the experimental design and all drafts of the manuscript. Authors OOE and LEA managed the analyses of the study. Author BEA identified the treatment samples and processed them. Authors OOE and LEA performed the statistical analysis. All authors read and approved the final manuscript.*

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### ABSTRACT

The study was designed to assess the reproductive performance of breeder rabbits fed graded levels of orange pulp meal (OPM). The pulps were gathered, sun-dried and milled prior to proximate analysis and feed formulation. Four experimental diets were formulated to supply 18% crude protein and 2600 KcalME/kg of Metabolizable energy. Diet 1 was control, while OPM replaced maize at 20, 40, and 60% for diets 2, 3, and 4, respectively. Forty (40), eight weeks old rabbits (32 does and 8 bucks) of a crossed between American chinchilla and New Zealand white rabbits used for the experiment were weighed and distributed into four groups with ten rabbits (8 does and 2 bucks). Groups were randomly assigned to one of the four dietary treatments in a completely randomized design. Animals were raised under the experimental condition until sexual maturity at five months. At sexual maturity, does and bucks of the same treatment were crossed, does kindled within thirty two (32) days. Four parities were obtained during the experiment. Data

\*Corresponding author: E-mail: [okokoneffiong2010@yahoo.com](mailto:okokoneffiong2010@yahoo.com);

collected were subjected to analysis of variance and significant means separated by Duncan's multiple range test. The rabbits did not vary significantly in their mean daily feed intake but differed in their mean weekly weight gain. Does on treatment diets had significant higher average litter size at birth and average litter size at weaning. Average litter weights at birth and at weaning were statistically similar. The mortality was not due to treatment effect. It was therefore concluded that orange pulp meal could replace 60% of maize in the diets of breeder rabbits without adverse effect on reproductive performance.

*Keywords: Breeder rabbits; litter size; litter weight; orange pulp; energy source.*

## 1. INTRODUCTION

Rabbits are unique animals of small sizes with short generation interval, highly prolific, rapid growth rate, and genetic diversity and have the ability to utilize forages and agricultural by-products as a major diet component [1]. They are raised to provide an alternative meat for man due to the short fall in production from other conventional sources, like poultry, cattle, sheep and goats.

In animal production, feeding plays a vital role in attaining the optimum productivity and quality per quantity of animal products [2]. Concentrates are vital ingredients for growth and production of rabbits, but this is affected adversely due to the high cost of feed/feedstuffs owing to the stiff competition between man and animals (mostly monogastrics) that feed highly from grains and oil seeds [3].

Considering the cost implication and the availability of these feedstuffs, animal nutritionists have sort for alternative feedstuffs to enhance administration of good balanced feed at relatively lower cost to rabbits and incorporating agro-by- products into animal diet is one way of solving the problem of feed shortages and high cost of production in Nigeria [4].

OPM has proven to be a unique energy source in the partial replacement of maize, sorghum and wheat in rabbits ration [5]. It contains high level of energy amounting to 3756.14 KcalME/kg, minerals, and vitamins, with all year round availability, making it a unique product in feeding rabbits. With rabbits undergoing coprophagy and cecotrophy (pseudo-rumination and gut fermentation), where large fibre substances are absorbed into the caecum and acted upon by special bacteria and enzymes into absorbable nutrients like simple sugar, starches and amino acids, utilization of Orange pulp meal is advantageous at pre-partum, partum and post-partum stages of production [5,6]. There is

dearth of information on the utilization of orange pulp meal as energy source in breeders rabbit ration, therefore the study was designed to evaluate the litter traits performance of breeder rabbits fed diets with OPM as an alternative energy source.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The feeding trial was conducted in the Department of Animal Science Teaching and Research Farm, University of Calabar, Nigeria, while the chemical analysis was conducted at the Central Laboratory of the University of Uyo, Nigeria.

### 2.2 Processing of Experimental Material

Sweet orange wastes (mesocarp and endocarp) were obtained from local fruit juice processing industry in Calabar municipality of Cross River State, Nigeria. They were chunked into smaller pieces and sundried to a moisture content of 10-12%. The sun dried samples were milled using a small local grinder and stored prior to chemical analysis and feed formulation.

### 2.3 Proximate Analysis

Proximate analysis of the orange pulp meal and the experimental diets were carried out to determine their proximate composition [7]. The fractions determined were the crude protein, ether extracts, crude fibre, and ash. The Nitrogen Free Extract (NFE) was determined as a difference.

### 2.4 Experimental Diets

Four experimental diets were formulated (Table 1) to supply the crude protein value of 18% and a Metabolizable energy of about 2600 kcalME/kg. Diet 1 was control while orange waste (pulp) meal was used to replace maize at 20%, 40% and 60% levels for diets 2, 3 and 4, respectively.

**Table 1. Composition of experimental diets**

Ingredients	Levels of orange pulp meal			
	0%	20%	40%	60%
Maize	45.50	36.40	27.30	18.20
Orange pulp meal	-	9.10	18.20	27.30
Soybean	15.20	15.20	15.20	15.20
Wheat offal	25.00	25.00	25.00	25.00
Bone meal	3.00	3.00	3.00	3.00
Palm kernel cake	10.00	10.00	10.00	10.00
Salt	0.50	0.50	0.50	0.50
Lysine	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
*Vitamin/mineral premix	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
<b>Determined analysis</b>				
% Crude protein	18.06	18.00	18.00	18.02
ME(Kcal/kg)	2609	2601	2602	2604

\*Grower mineral premix containing the following per kg. Vitamin A, 8,000,000IU; Vitamin D3, 1,600,000IU; Vitamin E, 5,000IU; Vitamin K, 2,000 mg; Thiamine, 1,500 mg; Riboflavin B2 4,000 mg; Pyridoxine B6, 1,500 mg; Anti-oxidant, 125 g; Niacin, 1,500 mg; Vitamin B12, 10 mg; Panthotenic acids, 5,000 mg; Folic acid, 500 mg; Biotin, 20 mg; Choline chloride 200r, manganese, 80 g; Zinc, 50 g; iron, 20 g; 1 ron, 20g; copper, 5 g; Iodine 1.2 g; Selenium, 200 mg; Cobalt, 200 mg

## 2.5 Experimental Procedures

A total of forty (40) rabbits, ten (10) weeks old cross breed New Zealand white x American chinchilla rabbits consisting of eight males and 32 females were purchased from a private farm in Calabar municipality for the experiment. The rabbits were weighed and randomly distributed into four groups of eight females and two males. Groups were randomly distributed to one of the four experimental diets described earlier and fed to sexual maturity at five months. Each treatment was replicated thrice with four females and one male. The animals were housed individually in wooden cages of dimension 120x60x50 cm in a two tier hutch. Concentrates and water were provided in concrete crocks with equal quantity of experimental diets (120 g/animal) offered across the groups.

At sexual maturity, does were weighed and introduced to the bucks with the same treatment for mating. After successful mating, males were returned to their individual cages and the mating dates recorded. Pregnancy diagnosis was done by palpation and weight method. Does were supplied wooden nesting boxes on day 25 of pregnancy.

Data collected include feed intake and weight gain during pregnancy and lactation, litter size and weights, still births. Kindling rate = (number of does kindled / number of does mated) x 100 and kitten mortality at 7 days post partum. Four

## Animals and

parities were obtained and the experiment lasted for 5 months.

The experimental design employed was the completely randomized design, data collections were subjected to the analysis of variance ANOVA procedures [7] and the significant means separated using Duncan Multiple Range Test.

## 3. RESULTS AND DISCUSSION

### 3.1 Proximate Composition of Orange Pulp Meal and Maize

The proximate composition of the orange pulp meal relative to maize is presented to Table 2. Maize contained higher percentage of crude protein (9.05%) and fats (3.94%) relative to orange pulp (5.60% and 1.67%, respectively), while the orange pulp was superior to maize in ash content. Maize and orange pulp were similar in their carbohydrate composition, whereas orange pulp had the higher crude fibre content of 8.6%. Breeder Rabbits have the capacity to effectively digest fibrous food, hence would utilise the high energy of the orange pulp meal.

### 3.2 Mineral Composition of Orange Pulp and Maize

Maize was richer in all the minerals (Table 3) monitored, except for iron where OPM had superior value (220.24 mg/100 g) relative to maize. Prevalence of the third trimester pregnancy anemia has been attributed to low

level of iron in the blood among animals. In this research, OPM was observed to have higher level of iron than maize. The low contents of calcium and phosphorus in the OPM can be cover come by the dietary supplementations of these compounds.

**Table 2. Proximate composition of orange pulp and maize**

Constituents (%DM)	Orange pulp meal	Maize
Crude protein	5.60	9.05
Crude fibre	9.60	2.52
Ash	3.90	1.74
Carbohydrate	80.23	82.75
Crude fat	0.67	3.94

*Means are values of triplicate determination*

**Table 3. Minerals composition of OPM and maize**

Constituents (mg/100 g)	OPM	Maize
Calcium	1.63	48.30
Magnesium	4.90	107.90
Sodium	1.53	59.20
Potassium	1.81	324.80
Iron	200.54	4.80
Phosphorus	14.54	299.60

*Means are values of triplicate determination*

### 3.3 Performance of Breeder Rabbits Fed Graded Levels of OPM

The performances of breeder rabbits fed graded levels of OPM are presented in Table 4.

The mean daily feed intake ranged from 74.21 g in does fed 60% OPM diet to 77.59 g in does on 20% OPM diet. The variation in the mean daily feed intake was not significant among the treatment groups. Non significant differences in feed in take among the treatments groups suggest general acceptability of the feed by rabbits. Animals eat to satisfy the energy requirement [8]; therefore similarities in the feed intake among the treatment groups suggest that the energy intake of the feed were adequate for the rabbits during gestation and lactation periods. The mean daily feed intake observed in the experiment was higher than the range (36.39-48.31 g) reported by [9] for rabbits fed cassava peels. The range (65-80 g) reported by [10] was similar to findings of this research. Most authors reported a range of 70-85 g as the mean daily feed intake for breeder rabbits.

Does placed on treatment diets had the highest ( $P=.05$ ) mean weekly weight gain relative to does

placed on control diet. Similarities in the mean weekly weight gain between rabbits fed 20% OPM diet and those on 40 and 60% OPM diets imply that they were efficient in converting the nutrients in OPM to nutrients to satisfy their requirement during gestation (foetal development) and milk synthesis. Most of the nutrients gained by rabbits on control diet must have been channeled to foetal development and less for weight gain as evidenced in the lower weight gain recorded in this experiment [11]. The result of this experiment agrees with findings of [12,13]. The authors observed a decrease in the mean weight gain of rabbits during pregnancy and lactation.

Variation in the mean litter size at birth was not significant among the treatment groups. However, numerically, rabbits fed 40 and 60% OPM diets recorded the highest litter size at birth relative to does on the control and 20% OPM diets. The result suggests that the OPM diets were suitable and supplied necessary nutrients required by the gestating animals. [11,13,5]. The result of this work agree with the findings of [14] who reported a mean litter size range of 3.75-6.25 for rabbits fed diets supplemented with different levels of rumen digesta. The authors observed increase in litter size with higher levels of the fibrous digesta in the diets. The dietary fibre has positive effect on the gut health, welfare and reproductive performance of rabbit, especially during regnant period [15].

The mean litter weight at birth showed no significant different among treatment groups. However, kittens from does fed the treatment diets recorded higher weight at birth than from does fed control diet. The birth weight range (21-60.5 g) for kittens reported by [16] agree with the report of this study. The result implies that OPM diets supplied necessary nutrients required by the rabbits to produce healthy kittens.

The mean litter size at weaning was statistically similar among treatment groups, although does fed 60% OPM diet numerically had the superior mean litter size at weaning followed by those fed the control diet. Does fed 20% OPM recorded the mean litter size of 3.52 at weaning. Superior performance and survivability of the kittens suggest that the treatment diets at 60% OPM provided sufficient amount of necessary nutrients that enabled the rabbits produce quality milk for the fryers [17]. The better performance could be attributed to factors of good mothering ability, maternal environment and effect of dietary fibre inclusion [18].

**Table 4. Litter traits performance of rabbits fed orange pulp meal**

Parameter	Percentage level of OPM				± SEM
	0%	20%	40%	60%	
Mean daily feed intake of gestating and lactating does (g)	77.14	77.59	75.88	74.21	0.57
Mean weekly weight gain of gestating and lactating does (g)	220.40 <sup>b</sup>	382.82 <sup>a</sup>	355.42 <sup>a</sup>	300.96 <sup>a</sup>	5.99
Mean litter weight at birth (g)	45.56	57.81	53.29	56.73	1.09
Mean litter size at birth	5.38	5.17	6.56	6.51	0.39
Mean litter size at weaning	3.42	3.52	4.33	4.67	0.38
Mean litter weight at weaning (g)	1871.58 <sup>a</sup>	1665.08 <sup>b</sup>	1812.43 <sup>a</sup>	1847.33 <sup>a</sup>	4.48
Average mortality (%)	34.25	31.77	33.46	28.30	0.76

The means of the same row with different superscript are significantly different ( $p < 0.05$ ); SEM: Standard error of mean

The mean litter weight at weaning was significantly ( $P=05$ ) different among the treatment groups. Fryers from does on control diets and those fed 40 and 60% OPM diets recorded similar weight range. The average litter weights from this experiment was in the range (1275 - 2112.7g) reported by [15] for breeder rabbits fed agro industrial by products and mixed forage.

The average mortality ranged from 28.30% in rabbits fed 60% OPM to 34.25% in rabbits on control diet. The variation in average mortality was not significant. Most of the does, especially during the first parity were in experienced and failed to remove their furs to provide heat to the kittens. Most of the kittens died as a result of cold stress rather than the treatment effect.

#### 4. CONCLUSION

It was therefore concluded that orange pulp meal could replace 60% of maize in the diets of breeder rabbits without adverse effect on reproductive performance.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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