The Effect of Grain Type on Growth Performance and Economics Production of Rabbits

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Abstract: *A study was carried out to investigate the effects of grain type on growth performance production economics of weaner rabbits in 84days feeding trial. Fifteen weaner rabbits of mixed breeds (Chinchilla, Flemish giant, Dutch, California brown and Newzea land) and average initial weight of 684.33g were randomly allotted to three dietary treatments according to live weight in a complete randomized design (CRD). Diet 1 contained white maize, diet 2 contained white sorghum and diet 3 contained red sorghum. Maize and sorghum served as the main energy sources in the diets. Each treatment consists of five (5) rabbits, replicated five times with one rabbit per replicate. Weighed amounts of feed were served every morning while fresh, cool and clean drinking water was provided ad-libitum daily throughout the experimental feeding period. Routine management practices were strictly carried out. Results indicated that, there were no significant difference (P>0.05) between feed intake, weight gain, feed conversion ratio, cost kg^{-1} diet, feed cost per unit weight gain and total feed cost. This suggests that, inclusion of white maize, white sorghum and red sorghum in diets of weaner rabbits has no adverse effect on growth performance production economics.*
Keywords: *grain types (maize, sorghum), growth performance, economics of production, rabbits*

I.   Introduction

Rabbit is an ideal animal in meeting the protein need of developing countries like Nigeria because, according to (1), rabbits are prolific and have relatively low incidence of epidemic diseases compared to other farm animals. The use of their meat to meet the high protein demand of humans is increasingly becoming important in both the developed developing countries (2, 18). Rabbit meat is known to contain high quality and quantity protein, less fat with high proportion of polyunsaturated linoleic and linolenic fatty acids (23). In spite of these advantages, rabbit production has not received the desired attention in the tropics because, productivity is usually 50% or less of what is typical in the temperate countries (9, 24). Feed cost is estimated to represent over 70% of the total cost of producing livestock intensively (13, 27).

Maize, a conventional feedstuff, has remained the chief energy source in compounding rations for rabbits and the other non-ruminant animals. It accounts for over 40% rabbit diets (7). It is slightly higher in energy content compared to sorghum (30).

Sorghum on the other hand contains more crude protein than maize (18). Sorghum is somewhat cheaper than maize, and is one of the most abundant cereal grain in the drier areas of Africa, Asia and Australia (16).

A lot of research work has been done in Nigeria in an effort to replace maize with sorghum, household and industrial by-products in rabbit diets in order to reduce cost and over-dependence on maize, (3, 10, 13, 15, 18, 20, 25, 29 and 36). However, there is dearth of information on the utilization of white and red varieties of sorghum in rabbit diets in Nigeria.

This study was therefore aimed at investigating the effects of grain type (white maize, white sorghum and red sorghum) as energy sources on economics production of rabbits.

II.   Materials and Methods

Experimental Site and Location

The experiment was carried out at the Rabbit Unit of the Livestock Teaching and Research Farm, College of Animal Science, Federal University of Agriculture, Makurdi, Benue State, Nigeria. Makurdi is located between latitude $17^{o}14'$ North and longitude 8° 31' East of the equator. It has a tropical climate with distinctive wet and dry season. The mean temperature varies from 15.6^{o}C in December/January to 38°C in February/March with annual mean temperature value of 27.5^{o}C (35). Rainfall range between 353mm to

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378.9mm but sometimes rises to 1000mm. The relative humidity is about 47% to 85% and between 00mm to 100mm above sea level (34)

Experimental Animals

Fifteen weaner rabbits of mixed sex (seven male, eight female), strain (Dutch, Chinchilla, Flemish giant, California brown and Newzea land) and age (4-7 weeks) were obtained from a local farm in Makurdi town. The initial live weights of the rabbits ranged from 450 to 860g. They were randomly allotted to three dietary treatments according to live weights with five rabbits per treatment in a complete randomized design (CRD). Each treatment was replicated five times with one rabbit per replicate. The animals were individually housed in cages (60x60x45cm). The cages had been well cleaned and disinfected with saponated creso (Izal) and allowed to dry for seven (7) days before the rabbits were introduced therein. The rabbits were conditioned for three weeks to facilitate adaptation before the experiment commenced. During this period they were fed commercial ration (grower's mash) and water *ad-libitum.*

Medication

The rabbits were treated against external and internal parasites by subcutaneous injection of ivomectin (kepromec[®]) at 0.2ml per rabbit prior to commencement of the experiment. A broad spectrum antibiotic Neomycin[®](water soluble powder) and protective, absorbent anti-diarrhoea; diaroak[®] (dry suspension) were used in drinking water against bacterial infection.

Experimental Feed Ingredients

The diets were compounded using the following ingredients: white maize, white sorghum, red sorghum, full fat soya beans, Rice husk, brewer's dry grains, common salt (iodized salt), bone ash and vitamin-mineral premix. Maize, red sorghum, white sorghum and full-fat soyabeans were procured from Makurdi modern market while rice husk was also packed from rice mill of the same market. Brewers dry grains was source from Benue brewery limited (BBL) while bone ash, salt and premix were source from an open market in North Bank.

Experimental Procedure

Fullfat soyabean was processed after sorting. The pan (open pan) was pre-heated on fire made from wood with alluvial sand. The sand was heated to a temperature of about 80^0C (19). The soyabeans was poured in the pan and continuously agitated to prevent charring of the beans. It was considered toasted when a characteristic aroma of toasted beans was perceived and the seed coat easily peels off when pressed in between the fingers and also tasted crispy (19). The toasted beans was allowed to cool after which, it was separated from the sand by sieving. Maize, white sorghum, red sorghum and toasted soyabeans were semi-coarsely crushed with a 4mm size sieve from Makurdi Modern Market

Chemical Analysis

The milled samples of test ingredients were analyzed for proximate chemical composition using the procedure of AOAC (6). The samples were analyzed for dry matter, crude protein, ether extract, crude fibre, nitrogen free extract, and ash. The metabolisable energy (ME) values of the test ingredients were determine using the formular of (31). The proximate chemical composition of test ingredients is presented in table 1

Experimental Diets and Feeding

Three dietary treatments were formulated such that, diet one (T1) contain white maize as the major energy source. The proportion of white maize in diet one was replaced with white and red sorghum in diet two (T2) and three (T3) respectively. 50.4kg of feed was compounded for each dietary treatment throughout the experimental feeding period which lasted for 84 days. Weighed feeds(100g) was served to the experimental animals every morning with fresh, cool and clean drinking water *ad-libitum* throughout the experimental feeding period Ingredients and nutrient composition of each dietary treatment is shown in Table 2

III. Data Collection and Analysis

Feed Intake

Feed intake was determined by subtracting the leftover and waste feed from feed given to each experimental animal (rabbit) at the end of seven day period. Average daily feed intake was also determined by dividing the value of the feed intake by seven (7).

Weight Gain

Weight measurement was sequentially carried out on weekly basis with the use of a weighing scale. Average daily weight gain was also determined by dividing the value of the weight gain by seven (7).

Feed Conversion Ratio

Feed conversion ratio (FCR) was calculated as the quantity of feed consumed by the experimental animals (rabbits) per unit weight gain of the rabbits. It is expressed mathematically as follow;

$$FCR = \frac{Average/total\ feed\ intake}{Average/total\ weight\ gain}$$

Cost Benefit Analysis
Feed cost was calculated based on the prevailing cost of ingredients per kg as at the time, the experiment was conducted. Thus, feed ingredients per kg cost is presented in Table 3
Feed cost kg^{-1} diet was calculated by multiplying the proportion of each ingredients in the diets with it cost per unit weight as of the time, the experiment was conducted and the summation of all cost per unit weight of each experimental diet.
Feed cost per unit weight gain of the experimental treatment (diet) is computed as feed cost per unit weight of the experimental treatment multiply by feed conversion ratio (FCR) of the experimental animals.
From feed cost per kg diets, the quantity of feed consumed for the whole experimental period per treatment multiply by feed cost kg^{-1} diet gave total feed cost
Statistical Analysis
Data collected were subjected to one way analysis of variance (ANOVA) as outlined by (37). Where ANOVA indicate significance difference between treatment effects, mean were separated using Duncan new multiple range test (33).

IV.   Results and Discussion
Proximate Composition of the Test Ingredients and Experimental diets.
        The proximate chemical composition of test ingredients (maize and sorghum varieties) is presented in table 1. Energy values were similar with the value obtained by (18) but slightly higher than the value of (26) and (1). The crude protein (CP) of white maize, white sorghum and red sorghum were also similar but higher in white sorghum than maize and red sorghum. Crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) were also found to be similar among the grain type but ash content was higher in maize than red and white sorghum.
        The calculated proximate composition of the experimental diets is presented in table 2. The crude protein (CP) and crude fibre (CF) values of all the experimental diets were similar. The values agreed with 18-20% CP and 9-12% CF recommended requirement for growing rabbits reared in tropical countries (5 and 28). However, (32) recommended up to 20% CP for weaner and grower rabbits which is slightly above the value of all the experimental diets. The crude fibre value is within the range of 10-15% in accordance to that, stated by (11). Also, (8) recommend a crude fibre level of 10-12% for growing rabbits. The metabolisable energy (ME) were also similar in all treatment group but slightly higher than the ME of 2500 - 2700 kcal/kg requirements of growing rabbits (28). The nitrogen free extract (NFE), ether extract (EE) dry matter (DM) and total ash were also found to be similar among the experimental treatments.
Growth Performance and Economics Production of Rabbits.
Growth performance and economics production of rabbits fed grain type is presented in table 4.
Growth Performance of Rabbits.
        Mean feed intake ranged from 4.70kg in T_1 to 5.63kg in T_3. Feed intake was highest for rabbits fed diet 3 (red sorghum) with mean intake of 5.63kg, followed by diet 2 (white sorghum) with mean intake of 5.57kg and diet 1 (white maize) had the lowest intake level of 4.70kg. Rabbits fed sorghum ate more feed than those fed maize. However, mean feed intake were statistically similar (P>0.05). This result indicates that, the level of protein did not significantly affect feed intake. However, there is no significant (P>0.05) interaction effect between protein level and grain type. This work compared favorably with the results obtained by (2, 12, 18, and 22) who fed similar diets to rabbit.
        Mean weight gain (kg) of rabbits fed the experimental diets is shown in Table 4. The mean weight gain ranged from 1.10kg in T_1 to 1.38kg in T_2. It was highest in T_2 (1.38) followed by T_3(1.15) and lowest in T_1(1.10). The cumulative weight gain within the period of study (84days) did not show significant difference (P>0.05). This result is supported with the work of (1) who reported higher weight in rabbits fed diets containing malted and unmalted sorghum as replacement for maize.
        Feed conversion ratio (FCR) during the whole study period differed no significantly (P>0.05). The values ranged from 4.03 in T_1 to 5.02 in T_3. The highest value was observed in T_3 (5.02) indicating low feed conversion ratio, while the lowest value was obtained in T_2 (4.03) which indicate high feed conversion ratio. The superior value of 4.03 obtained in T_2 was better than those of T_1 (4.37) and T_3 (5.02) indicating that, the diet

(white sorghum) was more utilized than maize and red sorghum based diets. This finding is supported with the work of (1) who obtained best feed efficiency in rabbits fed malted sorghum based diet. 18.92% CP level gave better FCE (P>0.05) compared with the 18.59 and 18.48% CP. It was also noted that, the slight increase in protein, improved FCE. Rabbits taking diet based on maize and white sorghum showed superior values in feed intake and FCE compared with rabbits consuming diet based on red sorghum.

Economics Production of Rabbits

The economic production of rabbit fed grain type is presented in table 4.Cost kg^{-1} diet decreased non significantly (P>0.05) as presented in Table 4 from #68.16kg^{-1} to #66.38kg^{+1} . It was slightly higher in T_1(#68.16kg^{-1}, maize based diet) than T_2 and T_3(#66.38kg^{-1}, sorghum based diet). This was attributed to cost of ingredients as of the time the experiment was conducted. This finding is supported with the work of (18) who reported that, the more the quantity of sorghum in the diet, the less expensive the diet becomes. Results obtained by (1) also report lower cost of feed kg^{-1} in malted and unmalted sorghum diets than maize based diet.

Mean total feed cost ranged from #320.35 in T_1 to #373.72 in T_3. It was highest in T_3 (#373.72), followed by T_2 (#369.74) and T_1 (#320.35). Though, there was no significant difference (p>0.05) between the treatments, total feed cost was observed to be higher in sorghum based diets than maize. This was thought to be because rabbits fed sorghum ate more feed than those fed maize. This may be attributed to the slightly lower levels (10.92 vs 10.73) of fiber in sorghum based diets than maize (11.03) based diet.(18) also reported higher total feed cost in sorghum based diets than maize, when two sorghum varieties were fed as replacement for maize at graded levels.

Mean total feed cost kg^{-1} body weight gain also decreased non significantly (P>0.05) from #333.23kg^{-1} in T_3 to #267.51kg^{-1} in T_2. It was lowest in T_2 (#267.51kg^{-1}), followed by T_1 (#297.86kg^{-1}) and T_3 (#333.23kg^{-1}) respectively. This is due to higher feed efficiency in T_2 and T_1 (white sorghum and white maize) than T_3 (red sorghum). This finding is similar with the work of (22) who reported a higher feed utilization efficiency in white sorghum, followed by maize, and a poorer feed utilization efficiency in brown sorghum.

Regardless of the type of grain used in the diet, however, white sorghum was relatively preferred to maize, which in turn was more preferred to red sorghum. This finding is similar to the finding of (22) who fed rabbits with diet containing maize, white sorghum and brown sorghum. It could also be observed that, comparable gains were obtained between diet 3 and 1. The lowest feed cost kg^{-1} live weight gain was recorded in diet 2 while the highest feed cost kg^{-1} live weight gain occur in diet 3 but if we are projecting that, rabbits should reach market weight quickly, diet 2 will be preferred. This result is supported with the work of (2) who fed rabbits with diets containing malted and unmalted sorghum as replacement for maize.

V.   Summary, Conclusion and Recommendation
Results of this study indicate that, 40% of white maize, white and red sorghum varieties are sources of energy and their inclusion in diet of rabbits have no adverse economic effects. Sorghum (red or white) is similar to maize in all variables considered in the present study, and can therefore substitute maize in diets of rabbits. The use of sorghum as energy feed ingredient also resulted to reduced feed cost kg^{-1} diet. These advantages warrant its recommendation as feed source in rabbit diets.

Considering weight gain, feed intake, cost per unit weight gain, feed conversion ratio, total feed cost and cost per kg diet, 40% grain type inclusion in diets is recommended as good energy source for feeding rabbits.

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Table 1: Proximate chemical composition of the test ingredients

Parameter	White maize	White sorghum	Red sorghum
Crude protein (%)	10.65	11.47	10.37
Crude fibre (%)	2.80	2.75	2.06
Ether extract (%)	4.35	2.75	2.40
Total ash (%)	1.27	2.75	1.75
Dry matter (%)	94.18	94.44	93.94
Nitrogen free extract (%)	75.11	76.42	77.36
ME (kcal/kg)	3416.29	3362.25	3326.29

Metabolizable Energy (ME) = calculated according to the formula of (31)
$(ME= 37\times\%CP+81.8\times\%EE+35.6\times\%NFE.$
Sources: (14, 18 and 21)

Table2: Ingredients composition of the experimental diets (%).

	Dietary Treatments		
Ingredients	T1(white maize)	T2 (white sorghum)	T3 (red sorghum)
White maize	40	-	-
White Sorghum	-	40	-
Red sorghum	-	-	40
Full fat soya bean	25	25	25
Rice husk	20	20	20
Brewers dry grains	12	12	12
Bone ash	2.5	2.5	2.5
Salt	0.5	0.5	0.5
Premix*	+	+	+
Coccidiostat[a]	+	+	+
Total	100.00	100.00	100.00
Calculated nutrient composition of the experimental diets			
Dry matter (%)	90.87	90.98	90.78
Crude Protein (%)	18.59	18.92	18.48
Ether extract (%)	9.24	8.60	8.46
Crude fibre (%)	11.03	10.92	10.73
Total ash(%)	5.83	5.83	6.02
NFE (%)	46.18	46.71	47.09
ME (kcal/kg)	3078.87	3057.29	3042.89

*(Bio-Mix[®] grower) manufacture by Bio-organic nutrient system, Nigeria Limited supplied the following per kg: Vitamin A=3,200,000iu,Vitamin D3= 600,000iµ, Chlorine Chloride= 70, 000mg,Manganese=16,000mg, Zinc=12,400mg, Iron=8,400mg, Niacin= 6,000mg, Vitamin E=2800mg, Pantothenic acid= 2200mg, Copper=1200mg, Vitamin B_2=100mg, Vitamin B1=800mg, Vitamin k3=600mg, Antioxidant= 500mg Iodine=400mg, Folic acid =200mg, Biotin H_2=100mg Cobalt=80mg, Selenium=80mg, Vitamin B_{12} =4mg.
[a] Administered in water at 0.5g/l per rabbit (weekly) to prevent intestinal coccidiosis.
ME = Metabolizable Energy, NFE = Nitrogen free extract

Table3: Feed ingredients kg^{-1} cost

Ingredients	Cost kg^{-1} (#/kg)
Maize	104.44
White sorghum	100.00
Red sorghum	100.00
Soybean	74.45
Rice husk	5.00
BDG	20.00
Bone ash	100.00
Vitamin mineral premix	600.00
Salt	100.00

Table 4: Effect of grain-type on economics production of rabbits

Parameters	Dietary Treatment				
	T_1	T_2	T_3	SEM	LS
Number of rabbits	5	5	5		
Mean total weight gain (kg)	1.10	1.38	1.15	1.38	NS
Mean total feed intake (kg)	4.70	5.57	5.63	2.32	NS
Feed conversion ratio (FCR)	4.37	4.03	5.02	1.46	NS
Mean total cost kg^{-1} diet (#/kg)	68.16	66.38	66.38	0.00	NS
Mean total feed cost (#)	320.35	369.74	373.72	1.71	NS
Mean total cost kg^{-1} gain (#)	297.86	267.51	333.23	1.55	NS

SEM = Standard error of mean, NS = No significant difference and SL=Significant level