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GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF GROWING RABBITS FED TWO VARIETIES OF SORGHUM AS REPLACEMENT FOR MAIZE AS ENERGY SOURCE IN TROPICAL ENVIRONMENT

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ABSTRACT
Twenty-five (25) mixed sex cross breeds (New Zealand White x Dutch) of rabbits aged 5 to 7 weeks old with average initial live weight of 569.4 g to 581 g were used in this study to evaluate the effect of replacing maize with two varieties of sorghum ("Chakalere" and "Jigare") on the performance and nutrient digestibility of growing rabbits. The rabbits were assigned to five (5) experimental diets designated as treatment 1 (100% maize and 0% sorghum), 2 (50% maize and 50% "Chakalere" sorghum), 3 (100% "Chakalere" sorghum), 4 (50% maize and 50% Jigare" sorghum) and 5 (100% "Jigare" sorghum) which were replicated five (5) times with one (1) rabbit per replicate in a randomized complete block design (RCBD). "Chakalere" is the low-tannin sorghum while "Jigare" is the high tannin sorghum. The rabbits were fed with the experimental diets and clean drinking water *ad libitum* for experimental period of eight weeks (56 days). The final live weight were not significantly different ($p>0.05$) in all the treatment groups. The mean daily feed intake and daily weight gain were statistically different ($p<0.05$) and higher in treatments 3, 4 and 5 than the other treatments. Feed conversion ratio (FCR) were significantly better ($p<0.05$) in treatments 4 and 5 than the other treatments. Digestibility of nutrients showed significant difference ($p<0.05$) in all the treatments. Dry matter, crude protein, crude fibre and ether extract digestibility were superior in treatment 5 (100% Jigare) than the other treatments while treatments 1 and 3 had better ash digestibility. Results obtained from this study indicates that "Chakalere" and "Jigare" sorghum varieties can be used to replace 100% of maize in the diet of growing rabbits without adverse effect on performance and nutrient digestibility.

KEYWORDS: Maize, Sorghum, Rabbit, Performance and Nutrient Digestibility

INTRODUCTION

There is global awareness on the shortage of animal protein supply in the tropics (Adekunle and Ajani, 1999). The production of ruminants such as cattle, sheep and goats have not been able to bridge the gap because of their long production intervals, feed shortage, poor genetic make – up and disease incidence among other factors. Ayinde and Aromolaran (1998) reported that there has been continuous rise in the cost of production of cattle, sheep, goats and poultry and implored researchers to explore the potentiality of alternative feeds for livestock feeding. Now, there has been rising awareness on the virtues of rabbit production in developing countries as a means of alleviating world's animal protein shortage. Taiwo *et al.* (2005) attributed this to several advantages of rabbit over other livestock in the tropics and advocated its increased production in Nigeria. However, Ayinde and Aromolaran (1998) showed that feed accounted for 65.75% of the total cost of rabbit production and recommended research into alternative and cheaper feeds for rabbits in Nigeria. Rabbits are highly prolific and have short generation intervals (Cheeke, 1999). Rabbit meat has high biological value and contains with crude protein (21%), fat (10%), low cholesterol, low sodium (0.25mg/g) and higher proportion of linoleic and linolenic fatty acids (Cheeke, 1999). Rabbit grow rapidly and their growth rate is comparable to that of broiler chicken (Rao, 1999). Despite these attributes of rabbits, their production has not received the desired attention in the tropics. Productivity is usually 50% or less of what is typical in the temperate countries (Cheeke, 1992). However, the adoption of proper nutritional strategies will greatly enhance the productivity of rabbits. Maize grain has remained the major energy source in rabbit feeds in Nigeria. Maize, which usually accounted for over 40% of the total diets of rabbits is expensive (Adegbola and Okonkwo, 2002; Bamgbose *et al.,* 2004). An alternative is to search for cheaper and readily available sources of energy. Several research works have been carried out in Nigeria with the aim of replacing maize with other products and hence lower production cost. These include sorghum waste (Igwebuike *et al.,* 1995), cassava peel meal (Adegbola and Okonkwo, 2002), bread waste meal (Dairo and Ojewale, 2004) and mango kernel meal (Diarra *et al.,* 2008). Another important energy source is sorghum grain. Howver, there is limited information on the use of sorghum grain in rabbit diets in the tropics. The objectives of this work were therefore to assess the growth performance and nutrient digestibility of rabbits fed two sorghum varieties ("Chakalere" and "Jigare") as replacement for maize. The "Chakalere" and the "Jigare" are high and low – tannin sorghum varieties respectively.

MATERIALS AND METHODS

The experiment was carried out at the University of Maiduguri, Teaching and Research Livestock Farm, Department of Animal Science, University of Maiduguri, Borno State, Nigeria. Maiduguri is located at 11.5°N and 30.05°E and on elevation of 364 m above sea level within the North-east Nigeria (Ugherughe and Ekedolum, 1986). The hottest period occurs from March to June when the ambient temperature reaches 40°C and above by the month of April and May (Ugherughe and Ekedolum, 1986). The relative humidity ranges from 30 to 50%. It is about 42% in August and a minimum of 10% in February to March (Encarta, 2007). It has shorter period of rainfall (500 to 600mm) from June to September followed by longer period of dry season (8 to 9 months) (Encarta, 2007). Twenty-five (25) mixed sex and cross breeds (New Zealand white x Dutch) of rabbits aged 5 to 7 weeks old with average initial weight of 569.4 g they were obtained from University of Maiduguri Teaching and Research Livestock Farm and from small-scale producers within Maiduguri. The rabbits were all weighed individually and assigned to five (5) experimental diets designated as Treatments 1 (100% maize and 0% sorghum), 2 (50% maize and 50% "Chakalere" sorghum), 3 (100% "Chakalere" Sorghum), 4 (50% maize and 50% "Jigare" sorghum) and 5 (100% "Jigare" sorghum). Each treatment was replicated five (5) times with one (1) rabbit per replicate. The experimental diets and clean drinking water were provided *ad libitum*. The experiment lasted for eight (8) weeks (56 days) in a randomized complete block design (RCBD). The ingredient composition of the experimental diets is presented in Table 1 and proximate composition of the experimental diets in Table 2.

TABLE 1: Composition of the experimental diets

Ingredients (%)	T1 100% maize + 0% sorghum	T2 50% maize + 50% Chakalere	T3 0% Maize + 100% Chakalere	T4 50% maize + 50% Jigare	T5 0% Maize + 100% Jigare
Maize	34.00	17.00	0.00	17.00	0.00
Sorghum ("Chakalere")	0.00	17.00	34.00	0.00	0.00
Sorghum ("Jigare")	0.00	0.00	0.00	17.00	34.00
Wheat offal	17.00	17.00	17.00	17.00	17.00
Groundnut cake	16.45	16.45	16.45	16.45	16.45
Fish meal	3.00	3.00	3.00	3.00	3.00
Groundnut haulms	27.00	27.00	27.00	27.00	27.00
Limestone	2.00	2.00	2.00	2.00	2.00
Common salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Premix*	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00

Premix (grow fast) Manufactured by Animal Care Service Consults Nigeria Ltd., Lagos, supplying the following per kg of premix; vitamin A = 32,000,000 IU, vitamin B_3 = 640,000 IU, vitamin E = 2,000 IU, vitamin K = 800 mg, thiamine (B_1) = 600 mg, riboflavin (B_2) = 1600 mg, pyridoxine (B_6) = 600 mg, vitamin B_{12} = 4 mg, pantothenic acid = 2000 mg, folic acid = 200 mg, biotin = 8 mg, choline = 80 mg, antioxidant = 50 g, managanese = 32 g, zinc = 20 g, iron = 8 g, copper = 2 g, iodine = 0.48 mg, selenium = 80 mg and cobalt = 80 mg.*

Data collected during this study were feed intake, daily weight gain, feed conversion ratio and nutrient digestibility. Data obtained from the study were subjected to Analysis of variance (ANOVA) using the randomized complete block design as described by Steel and Torrie (1980). Where there are significant ($p<0.05$) differences, means were separated using Duncan's Multiple Range test. (Duncan,1955). The proximate analysis of the diets and faecal samples were determined according to AOAC (1990) methods.

RESULTS AND DISCUSSION

The proximate composition of the experimental diets fed to the rabbits is shown in Table 2. The crude protein (CP) content of the diets (19.77 to 20.11%) was higher than the 18% recommended by Omole (1977) for growing rabbits reared in tropical countries. However, the quality of dietary protein is very important in rabbit nutrition since voluntary feed intake has been found to increase with improvement in the quality of protein in the diet (Kennedy and Hersberger, 1974; Spreadbury, 1974). The crude fibre (CF) level of the experimental diets were (9.27 to 10.98%) which is close to the recommended levels of 10% reported by Spreadbury and Davidson (1988). Champe and Maurice (1983) recommended a level of crude fibre in excess of 9% for normal growth of rabbits and for prevention of enteritis. The metabolizable energy (ME) level of the diets were 2563.97, 2618.19, 2643.72, 2635.93 and 2572.27 kcal/kg for diet 1 (100% maize and 0% sorghum), 2 (50% maize and 50% "Chakalere" sorghum), 3 (100% "Chakalere" sorghum), 4 (50% maize and 50% "Jigare" sorghum) and 5 (100% "Jigare" sorghum) respectively. The energy levels of the experimental diets were within the range 2500 to 2700kcal/kg ME levels reported by (Aduku 2004) for growing rabbits in tropical environments.

TABLE 2: Proximate composition of the experimental diets fed to the rabbits

Nutrients (%)	Levels of maize replaced by sorghum				
	1 (100% maize + 0% sorghum)	2 (50% maize + 50% Chakalere)	3 (100% Chakalere)	4 (50% maize + 50% Jigare)	5 (100% Jigare)
Dry matter (DM)	93.30	97.90	98.30	98.10	97.50
Crude protein (CP)	19.77	19.94	20.11	19.94	20.11
Crude fibre (CF)	9.27	9.89	10.57	10.02	10.98
Ether extract (EE)	3.64	3.40	3.31	3.79	3.31
Ash	5.00	3.00	2.00	3.00	4.00
NFE	62.32	64.39	65.31	64.00	63.31
ME (kcal/kg)	2564	2619	2644	2636	2573
Tannin	-	0.26	0.54	1.27	2.53

ME = Calculated according to formula of Pauzenga (1985) (ME = 37 x % CP + 81 x % EE + 35.5 x % NFE), Chakalere = Low – tannin sorghum, Jigare = High – tannin sorghum
ME = Metabolizable energy, NFE = Nitrogen – free extract

The growth performance and nutrient digestibility of rabbits fed maize and sorghum varieties as energy source is presented in Table 3. The final live weight (1166.00 g to 1470.70 g) obtained in this study were not significantly different ($p>0.05$) but were lower than the values (1805.00 g to 2040.00 g) obtained by Abubakar *et al. (*2006) when dietary maize was replaced by malted or unmalted sorghum on the performance of rabbits. The breeds, initial weights, diets and duration of the experiment are among the factors that were responsible for the differences in final live weight of the rabbits.

The mean feed intake were significantly different ($p<0.05$) among treatment groups. The values (58.67g to 63.30g / rabbit / day) obtained in this study were higher than the values (41.20g) reported by Adeniji and Ehiemere (2003) who fed rabbits with sorghum offal at 33, 66 and 100% level of inclusion. Results obtained from this study were also higher than the values (50.57g to 60.67 g/rabbit/day) reported by Abubabar *et al*. (2006) when maize was replaced by malted and unmalted sorghum diet on the performance of weaner rabbits. This variation may be attributed to higher fibre levels of the diets. The feed conversion ratio (FCR) were significantly different ($p<0.05$) among treatment groups. Rabbits fed diets 4 (50% maize and 50% "Jigare") and 5 (100% "Jigare") were similar and superior to rabbits fed diets 1 (100% maize and 0% sorghum), 2 (50% maize and 50% "Chakalere" sorghum) and 3 (100% "Chakalere" sorghum). This indicates that "Jigare-based diet have better feed conversion compared to the other diets that contained maize and "Chakalere" sorghum.

TABLE 3: Growth Performance and nutrient digestibility of rabbits fed two varieties of sorghum

Parameters	T1	T2	T3	T4	T5	SEM
	100% maize + 0% sorghum	50% maize + 50% Chakalere	100% Chakalere	50% maize + 50% Jigare	100% Jigare	
Number of rabbits	5	5	5	5	5	
Initial weight (g)	568.80	581.60	563.20	566.00	567.40	61.98^{NS}
Final weight (g)	1166.00	1196.70	1311.30	1399.00	1410.70	91.57^{NS}
Mean daily feed intake (g)	58.95^{b}	58.67^{b}	66.25^{a}	68.30^{a}	66.01^{a}	1.98^{*}
Daily weight gain (g)	8.86^{b}	9.89^{b}	14.52^{a}	15.54^{a}	14.81^{a}	1.84^{*}
Feed conversion ratio	7.96^{ab}	8.29^{a}	5.22^{abc}	4.62^{c}	4.93^{c}	1.17^{*}
Mortality (Number)	0.00	2.00	0.00	1.00	0.00	-
Nutrient digestibility						
Nutrients (%)						
Dry matter (DM)	66.47^{a}	74.41^{c}	75.67^{a}	78.27^{c}	79.48^{b}	1.64^{*}
Crude protein (CP)	69.28^{c}	73.78^{bc}	80.57^{ab}	81.67^{a}	84.47^{a}	2.41^{*}
Crude fibre (CF)	30.37^{d}	37.88^{c}	39.94^{bc}	42.27^{ab}	42.88^{a}	0.75^{*}
Ether extract (EE)	57.97^{b}	58.89^{b}	70.57^{a}	73.97^{a}	74.81^{a}	2.21^{*}
Ash	60.88^{a}	58.47^{b}	60.88^{a}	59.78^{ab}	59.41^{ab}	0.53^{*}

SEM = Standard Error of Means
* = Significant difference ($p<0.05$)
NS = Not significant ($p>0.05$)
abcd = Means in the same row bearing different superscripts differ significantly ($p<0.05$)

The mean daily weight gain were significantly different ($p<0.05$) among the treatment groups. Diet 3 (100% "Chakalere" sorghum), 4 (50% maize and 50% "Jigare") and 5 (100% "Jigare) were similar and superior to diets 1 (100% maize and 0% sorghum), 2 (50% maize and 50% "Chakalere" sorghum). This may be attributed to the better feed intake and FCR in diets 3 (100% "Chakalere" sorghum), 4 (50% maize and 50% "Jigare") and 5 (100%

"Jigare) than diets 1 (100% maize and 0% sorghum) and 2 (50% maize and 50% "Chakalere" sorghum). The mean daily weight gain obtained in this study (8.86 g to 15.54 g) were lower than the (22.37 g to 25.72 g) obtained by Abubakar *et al.* (2006) for rabbits fed diets containing maize, malted and unmalted sorghum but close to the values (10g to 20g/day) reported by Cheeke (1987) for rabbits reared in tropical countries. However, other studies in semi-arid environment gave mean daily weight gain of rabbits between 5.20 g and 10.00 g / rabbit/day (Igwebuike *et al.,* 1995; Igwebuike *et al.,* 1998). Aduku and Olukosi (1990) reported mean daily weight gain of 15 g to 20 g as common range in the tropics. The variation of weight gains from this study may be due to the depressive effect of high ambient temperature (34^{o}C) on feed intake and weight gain during this study.

The values (4.93 to 7.96) of FCR obtained in this study were poorer than the values (3.6 to 6.00) reported by Mufwa *et al*. (2010) who fed young rabbit with graded levels of brewers' dried grain and 3.5 by Rastogi (1989) for young rabbits reared in cages and fed pelleted diets. This observation may be attributed to enhanced feed intake and better utilization of pelleted diets. The FCR obtained in this study were comparable to the results obtained by other workers (Omole, 1977; Aduku *et al.,* 1988 and Igwebuike *et al.,* 1995) for growing rabbits in Nigeria.

Data on nutrient digestibility of rabbits fed the two varieties of sorghum and maize are shown in Table 3. Dry matter digestibility were significantly different ($P<0.05$) among all the treatments. The values (66.47 to 79.48%) obtained in this experiments were similar to the values (67.00 to 76.81%) reported by Jegede *et al*. (2008) when rabbits were fed diets containing malted sorghum sprout and slightly higher than the values (64.88 to 68.55%) reported by Murin *et al.* (2002) who replaced maize with sorghum in the diets of growing rabbit. Such variation may be attributed to the varieties of sorghum used. Crude protein (CP) showed significant difference ($P<0.05$) among the treatment groups. Diets 3 (100% "Chakalere" sorghum), 4 (50% maize and 50% "Jigare") and 5 (100% "Jigare") were similar and superior to diet 1 (100% maize and 0% sorghum) and 2 (50% maize and 50% "Chakalere" sorghum). This may be linked to better feed conversion ratio in diets 3, 4 and 5 over diets 1 and 2. The results obtained from this study (69.28 to 84.47%) were higher than the result (64.88 to 65.35%) recorded by Murin *et al*. (2002) when rabbits were fed diets containing graded levels of sorghum. Crude fibre (CF) digestibility were significantly different ($P<0.05$) in all the treatment. Diets 4 (50% maize and 50% "Jigare") and 5 (100% "Jigare") were similar and better than diets 1 (100% maize and 0% sorghum), 2 (50% maize and 50% "Chakalere" sorghum) and 3 (100% "Chakalere" sorghum). The result of CF (30.37 to 42.88%) obtained from this study were within the range (37.44 to 42.89%) for rabbits fed graded levels of sorghum waste reported by Igwebuike *et al.* (1998) but lower than the result (56.13 to 68.15%) reported by Jegede *et al.* (2008) for growing rabbits fed diets containing malted sorghum sprout but higher than the result (25.48 to 26.19%) recorded by Murin *et al*. (2002) when maize was replaced with sorghum in the diets of growing rabbits. Further sprouting of the sorghum before feeding might have improved the digestibility of the fibre in the diets.

Ether extract (EE) digestibility showed significant difference ($P<0.05$) among the treatment groups. Diets 3, 4 and 5 were better than diets 1 and 2. This could be attributed to high dry matter intake and feed conversion ratio in diets 3, 4 and 5 as opposed to diets 1 and 2. The result of EE (57.97 to 74.81%) recorded in this study were close to the range (65.63 to 85.41%) reported by Adama *et al.* (2007) for broiler chicks fed diets containing varying levels of sorghum brewers' dried grains and slightly higher than the result (63.51 to 73.01%) reported by Igwebuike *et al.* (1998) who fed graded levels of sorghum waste to growing rabbits but lower than the values (78.81 to 80.19%) recorded by Murin *et al.* (2002). Such variations may be attributed to the sorghum varietals differences used in this experiment. So many varieties of sorghum are available in the Northern part of Nigeria and their feeding values are yet to be exhaustively evaluated.

Ash digestibility was different among treatment groups. The values (58.47 to 60.88%) recorded in this study were higher than the values (11.70 to 35.60%) reported by Uko *et al.* (1999) when rabbits were fed cereal by – products as energy source and lower than the values (64.70 to 84.48%) reported by Murin *et al.* (2002) who replaced maize with sorghum in growing rabbit diets. This variation may be due to higher dry matter digestibility reported by Murin *et al.* (2002) in their study.

CONCLUSION

This study has shown that sorghum varieties ("Chakalere" and "Jigare") can replace maize (100%) in the diet of growing rabbits without adverse effect on performance and nutrient digestibility. It is therefore, recommended that rabbit farmers in tropical environments can use "Chakalere" and "Jigare" sorghum as energy source in the diets of growing rabbits to enhance productivity and lower production cost.

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