Evaluation of Sorghum (*Sorghum bicolor*) as Replacent for Maize in the Diet of Growing Rabbits (*Oryctolagus cuniculus*)

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ABSTRACT : Thirty six young New Zealand white rabbits were used in a randomised complete block (RCB) design with a 3×2 factorial treatment experiment to study the suitability of sorghum as substitute for maize in the diet of growing rabbits in Kenya. Six different diets were formulated to contain 35% of one of the three different types of grain (maize, white sorghum or brown sorghum) and one of the two different levels of crude protein (CP) 16 or 18.5% and fed to growing rabbits for a period of six weeks. The tannin content of the grains was 0.05, 0.52 and 5.6% chatechin equivalents for maize, white and brown sorghum respectively. Weaning weight at 35 days of age was used as the blocking criterion at the beginning of the experiment. Results of feed intake, weight gain, feed conversion efficiency, feed digestibility, as well as the blood parameters, indicated that white sorghum was not significantly different from maize. Animals fed on diets containing brown sorghum had a lower average daily gain (ADG) and a poorer feed conversion efficiency (FCE) ($p<0.01$) in comparison with those fed on diets containing maize or white sorghum. The 18.5% CP level gave a better FCE ($p<0.05$) compared with the 16% CP level. However, increasing the level of CP did not improve the utilisation of any of the grains. It was concluded that white sorghum could effectively substitute maize in the diet of growing rabbits. On the other hand, the use of brown sorghum in the diets of growing rabbits may compromise their growth rate. This may be due to the high concentration of tannins in the brown sorghum. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 4 : 565-569)***

Key Words : Rabbits, Sorghum, Tannins, Digestibility, Growth

INTRODUCTION

In Kenya, the production of maize and wheat is not sufficient for both human consumption and animal feeds (Republic of Kenya, 1997). The scope of expanding their production is narrow because of the scarcity of high potential land. The use of drought-tolerant crops such as sorghum is, therefore, advisable.

Sorghum is well adapted to the medium and low potential areas (Dogget, 1988). In Kenya, these regions comprise about 75% of the total landmass (Republic of Kenya, 1997). The country, therefore, has a wide scope of expanding the production of this crop, some of which can then be used as animal feeds.

In the medium and low potential regions, rabbit production can benefit substantially if sorghum is utilised in their diets, as this would reduce the uncertainties that arise from the heavy dependence on maize and wheat as the sole grains. Unfortunately, some sorghum cultivars are high in condensed tannins (CAB international, 1987), which make the crop less useful to certain animals (El Maki et al., 1999). Jacob et al. (1996) indicated that egg production and feed efficiency were lower for the hens receiving sorghum based diets with high levels of tannins compared to those receiving maize based diets. This study was designed to evaluate the suitability of sorghum in the diets of growing rabbits.

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MATERIALS AND METHODS

Experimental animals and diets

Thirty six growing (6-12 weeks of age) New Zealand White rabbits were used in a randomised complete block design (RCBD) experiment, with a 3×2 factorial treatment, that was conducted in a demonstration farm belonging to Egerton University, Kenya. After parturition the kindlings were left to suckle for 5 weeks and then sorted out into six groups (blocks) of six animals each, based on liveweight. Six diets (table 1) were formulated to contain 35% of one of the three grain types (maize, white sorghum, or brown sorghum) and one of the two crude protein levels (16% or 18.5%). The rabbits were fed *ad libitum* for six weeks. The layout of the experiment is as shown in table 2.

The tannin contents of the grains was determined using the Vannilin Catechin test (Gupta et al., 1992).

Housing and management

Each of the diets was administered *ad libitum* to six rabbits individually caged (one from every block). Water was also provided *ad libitum*. At the beginning of the experiment, the body weight of the animals did not differ significantly (table 2). The experimental animals were housed individually in hanging wire cages (75×30×45 cm) suspended 1 meter above the floor.

Table 1. Ingredients (%) used in compounding the experimental diets

Ingredient	Diets					
	1	2	3	4	5	6
Maize	35.70	35.28	-	-	-	-
White sorghum	-	-	34.51	35.91	-	-
Brown sorghum	-	-	-	-	35.29	35.28
SBM[1]	8.72	8.59	8.43	8.78	8.59	8.59
Fish meal	11.05	14.61	10.14	14.93	10.31	14.61
Lucerne	10.49	12.55	10.14	12.83	10.31	12.55
Maize cobs	30.45	26.51	33.31	25.01	32.01	26.51
Corn oil	1.06	-	1.02	-	1.03	-
Molasses	2.11	2.06	2.04	2.12	2.06	2.06
M&V premix[2]	0.12	0.12	0.11	0.12	0.12	0.12
NaCl	0.29	0.28	0.28	0.29	0.29	0.29
Calculated tannin content (% CE)	0.018	0.018	0.179	0.178	0.1976	0.1976
Total	100.00	100.00	100.00	100.00	100.00	100.00

[1] SBM=Soy bean meal.
[2] M and V premix=mineral and vitamin premix.

Table 2. Experimental layout showing weight (g) of rabbits at the beginning of the experiment

Grain type		Maize		White sorghum		Brown sorghum		Block Mean
Dietary protein(%)		16.0	18.5	16.0	18.5	16.0	18.5	
Diet		1	2	3	4	5	6	
Block	1	550	525	550	550	550	575	550.0
	2	525	525	525	500	500	500	512.5
	3	500	475	450	450	500	450	470.8
	4	425	450	400	425	450	425	429.2
	5	375	375	375	375	375	375	375.0
	6	250	325	250	350	300	275	291.7
Treatment mean		437.5	445.8	425.0	441.7	445.8	433.3	

Measurement and computations

Animals were weighed individually at the start of the experiment and thereafter on a weekly basis during the experimental period. Weighing was done using a pan-scale of a 5 kg capacity and graduations of 25 g. The total weight gain and average daily gain was computed as the difference between the final and the initial weight. The amount of feed offered as well as the amount of feed leftovers was weighed and recorded for each animal on a weekly basis. The average feed intake was calculated as the total amount of feed consumed divided by the number of days in the experimental period. Feed conversion efficiency was computed as the amount of feed consumed divided by the amount of weight gained during the experimental period. The proximate composition of the various experimental diets was determined using the Weende method as described by AOAC (1995). Faeces were collected from individual animals on a daily basis for five consecutive days during the last week of the experiment, dried in an oven at 60°C and stored in sealed polythene bags. Later on, these were analysed for the different nutrients using the same method used for the diets. At the end of the feeding trial, blood was collected from the ear veins into individually marked vials using 3 drops of EDTA as an anticoagulant. Analysis of the various variables (erythrocytes, leucocytes, haemoglobin, and packed cell volume (PCV)) were done within 24 h of blood extraction. Erythrocytes and leucocytes counts were done using a light microscope under magnification of 40. The PCV was measured by centrifuging the blood at 12,000 rpm in a micro-haematocrit centrifuge, followed by reading the percentage of packed cells using a Hawksley micro-haematocrit reader. Concentration of haemoglobin was measured using a haematometer.

Statistical analysis

The data obtained above was subjected to analysis of variance using the GLM procedure of the SAS programme (SAS 1996). The means were separated by the Duncan's multiple range test using the SAS programme.

The model of analysis was: $Y_{ijk}=\mu+\alpha_i+\beta\lambda_{jk}+\varepsilon_{ijk}$

Where Y=observation μ=population mean α=block

(weaning weight)

B=grain type λ=protein level βλ=grain type protein level interaction and ε=the residual error.

RESULTS

The tannin content of the grains was found to be 0.05, 0.52 and 5.6% chatechin equivalents for maize, white and brown sorghum, respectively. The results on the effect of the diet on the average daily feed intake (ADFI) ADG and FCE are shown on table 3. No significant count differences in ADFI were observed between animals taking different diets. Rabbits taking diets 5 (brown sorghum, 16% CP) and 6 (brown sorghum, 18.5% CP) showed significant differences ($p<0.5$) in ADG in comparison with those taking diet 4 (white sorghum, 18.5% CP). It was also observed that animals taking diets based on maize and white sorghum had significantly higher ($p<0.01$) FCE compared with those taking brown sorghum.

The effect of grain type on feed intake, weight gain, feed conversion efficiency and the digestibility of various feed components are presented in table 4. Dry matter intake (DMI) was similar regardless of the type of grain used in the diet, however, white sorghum was relatively more preferred to maize, which in turn was more preferred to brown sorghum. The ADG, FCE and CP digestibility values for brown sorghum were significantly inferior ($p<0.01$) to those of maize and white sorghum. The digestibility of crude protein decreased linearly with increasing tannins in the diet digestibility.

Although there were no significant differences between treatments, animals fed on brown sorghum diets had relatively lower values for all the blood variables considered.

Table 5 shows the effect of protein level on feed intake, weight gain, feed conversion efficiency and digestibility of various components in growing rabbits. The results indicated that the level of protein did not significantly affect the feed intake and digestibility of various components except crude protein whose digestibility significantly ($p<0.05$) increased with increase in the concentration of protein in the diet (table 5). It was also noted that increase in protein in the diet, significantly ($p<0.05$) improved the FCE. However, there was no significant interaction effect between protein level and grain type.

The effect of grain type on the number of erythrocytes and leucocytes, haemoglobin concentration and the packed cell volume in blood is represented in table 6. There were no significant differences observed in physiological parameters between rabbits fed diets based on different grains. However, it was noted that brown sorghum tended to depress the physiological parameters of blood in the animals.

DISCUSSION

The six diets used in this experiment were of different grain types and protein concentration (figure 1). Sixteen percent is the mean protein content of commercial rabbit feeds sold in Kenya. Protein concentration of 18.5% was used in order to find out whether it could have a positive effect on the utilization of the different types of grains.

The type of grain and concentration of protein in the diet did not affect the palatability of the feedstuffs. It is possible that rabbits do not have strong sense of taste that can be able to differentiate the taste of different grains used in the experiment. This is in conformity with Arnold and Dudzinskit's (1978) assertion that different animals have varying ability to detect the taste of different feedstuff. Animals taking diet based on maize and white sorghum showed superior values in ADG, FCE and CP digestibility when compared with rabbits consuming diets based on brown sorghum. This could be as a result of the higher level of tannins in the brown sorghum. Douglas et al. (1993), reported that increasing the tanning level in the diet linearly depressed weight gains of turkeys and increased their feed conversion efficiencies. Experiments with rats (Schaffert et al., 1974), pig (Wahome et al., 1992) and broilers (Mbugua, 1995) have also highlighted the inferiority of brown sorghum on weight gain and feed conversion efficiency.

Digestibility of crude protein decreased linearly with increasing tannins in the diet. Similar trends have been observed in studies where rabbits were fed on other tannin-containing feed stuffs such as black locust leaves (Ayers et al., 1996) and grape pumice (Ferreira et al., 1996). According to El Maki et al., 1999) tannins are probably responsible for retarding the degradation of proteins in the high-tannin sorghum cultivars. According to Makkar (1993), there is sufficient evidence that the tannins decrease the utilization of proteins, carbohydrates, amino acids, minerals and vitamins. It is thought that tannins bind proteins,

Table 3. The effect of diet on feed intake, weight gain and feed conversion efficiency of rabbits (n=36)

Parameter	Diet						SEM
	1	2	3	4	5	6	
ADFI (g)	81.6	79.7	79.6	87.2	81.2	74.0	4.67
ADG(g)	20.7^{abc}	21.5^{ab}	20.6^{abc}	23.4^{a}	16.7^{c}	17.4^{bc}	1.42
FCE	3.97^{bc}	3.73^{c}	3.86^{bc}	3.78^{bc}	4.89^{a}	4.40^{ab}	0.21

[a,b,c] Means along the same row with different superscripts are statistically different ($p<0.05$).

Table 4. The effect of grain type on feed intake, weight gain, feed conversion efficiency and the digestibility of various feed components in growing rabbits (n=36)

Parameters	Grain type			SEM
	Maize	White sorghum	Brown sorghum	
DM intake* (g)	630.41	676.83	622.14	32.50
ADG (g)	21.13[a]	22.02[a]	17.01[b]	0.88
FCE	3.85[a]	3.82[a]	4.63[b]	0.10
Digestibility (%)				
DM	65.02	64.88	65.35	0.31
OM	66.29	66.26	66.66	0.32
CP	78.62[a]	77.81[a]	75.20[b]	0.75
EE	79.42	78.66	80.43	1.41
CF	25.57	26.19	25.48	1.55
Ash	51.59	49.78	51.81	1.77
NFE	71.49	71.59	72.70	0.56

[a,b,c] Means along the same row that have different superscripts are significantly different ($p<0.05$).

* Dry matter digestibility during the digestibility trial.

Table 5. The effect of protein level on feed intake, weight gain, feed conversion efficiency and the digestibility of various feed components of growing rabbits (n=36)

Parameters	Crude protein level (%)		SEM
	16.0	18.5	
DM intake*	647.78	638.47	26.53
ADG (g)	19.35	20.77	0.72
FCE	4.28[a]	3.97[b]	0.08
Digestibility (%)			
DM	65.19	64.98	0.25
OM	66.36	66.44	0.26
CP	75.55[a]	78.88[b]	0.61
EE	80.19	78.81	1.15
CF	26.21	25.28	1.26
Ash	51.50	50.61	1.47
NFE	72.24	71.61	0.45

[a,b] Means along the same row that have different superscripts are significantly different ($p<0.05$).

* Dry matter intake during the digestibility trial.

Table 6. Effect of grain type on the physiological parameters of blood of rabbits (n=36)

Parameter	Grain type			SEM
	Maize	White sorghum	Brown sorghum	
Erythrocytes (10^6/ml)	3.67	3.56	3.07	0.27
Leucocytes (10^3/ml)	3.88	3.38	2.91	0.42
Haemoglobin (mg %)	9.98	10.27	8.99	0.57
Packed cell volume (%)	27.83	26.92	24.08	2.64

including digestive enzymes thus decreasing protein digestibility (Kumar, 1992). In the current study, the tannins could, therefore, have interfered with various metabolic processes that led to decreased growth rates of rabbits fed brown sorghum.

IMPLICATIONS

White sorghum is similar to maize in all the variables considered in this study and therefore, can substitute maize in the diets of growing rabbits. Brown sorghum on the other hand is inferior in certain respects and, therefore, may not be in the diets of growing rabbits without compromising their performance. Increasing the protein level from the recommended level (16%) to 18.5% may not be employed as a strategy to overcome the deleterious effects of high-tannin sorghum.

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