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Evaluation of malted *Njigari* sorghum cultivar (*Sorghum bicolor* (L) Moench) as a replacement of maize on the performance, carcass characteristics and internal organ weights of weaner rabbit

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Abstract
Thirty (30) weaner rabbits of mixed breeds and sexes were used to evaluate the effect of malted *njigari* sorghum cultivar as a replacement of maize on the growth performance, carcass characteristics, internal organ weights and economics of production. The weaner rabbits were randomly allotted to five treatment groups of six rabbits per treatment. The dietary treatments were replicated three times with each replicate having two (2) weaner rabbits. The weaner rabbits were fed five diets compounded using malted *njigari* sorghum cultivar (MNSC) to replace maize in diets at 0, 25, 50, 75 and 100% as. There were no significant ($P>0.05$) difference in the parameter evaluated for growth performance, carcass characteristics and organ weights. Feed cost/ kg significantly ($P<0.05$) reduced from N140.67 /kg in T1 (0%) to N80.54 /kg in T5 (100%) replacement level MNSC. Feed cost /kg gain (N/gain) was observed to higher in the maize based diet (control) compared those fed MNSC. The study showed that inclusion of malted *njigari* sorghum in weaner rabbit diet did not adversely affect growth performance, carcass characteristics, internal organ weights. It was concluded that malted njigari sorghum can be used to substitute maize in the diets of weaner rabbits.

Keywords: Growth, carcass, malted sorghum

Introduction
Rabbit production has been advocated a means of bridging the deficiencies of animal protein consumption in developing countries (Omole *et al.*, 2007 and Wafar *et al.*, 2018) [12, 20]. The advantages of rabbit production over other livestock are anchored on low capital investment and space requirement, short gestation period, rapid growth rate, prolificacy and ability to utilize low quality feedstuff (Olumo *et al.*, 2019) [11]. Over the years, rabbit production has not been fully harnessed in most developing countries. This has been attributed to high cost of feedstuff especially energy and protein sources which is as a result of competition between man and his livestock.

Maize is one of the major feed ingredients used as a source of energy in rabbit r production. However, its production in Nigeria is not sufficient for both human consumption and as animal feed ingredient (Adegbola and Okonkwo, 2002) [3]. Several studies have been conducted in Nigeria in an effort to substitute maize with cheaper and available ingredient so as to reduce cost and over dependence on maize in rabbit production (Abubaker *et al.*, 2006, Yakubu *et al.*, 2008 and Yakubu *et al.*, 2017) [1, 19, 16]. One of such ingredients is sorghum. The plant can thrive well even in areas with limited moisture. There is therefore opportunity to expand the cultivation of this crop. Sorghum cultivar such as Ugandan *sekedo* (Kyarisiima *et al.*, 2005) [7], *masakwa* (Yakubu *et al.*, 2008) [19] have used in livestock feeding.

Yakubu *et al.* (2008) [19] reported that sorghum is cheaper than maize confirming earlier finding of FAO, (1996) that the cost of sorghum is always 5% lower than maize. The use of sorghum cultivar is limited due to the presences of polyphenolic substances (tannin) which have reported to lower feed utilization and performance of livestock (Kyarisiima *et al.*, 2005) [7]. Various methods have been used to reduce tannin contents in sorghum. Among these methods, malting has proven to increase crude protein, lysine and also reduces tannin contains

(Sluis, 2008 and Yakubu *et al.*, 2008) [19]. The use of malted *njigari* sorghum cultivar in replacing maize of rabbit production has not been documented. This study was therefore designed to evaluate the effect of malted *njigari* sorghum cultivar as a replacement of maize on the growth performance, carcass characteristics, internal organ weights and economics of production.

Materials and Methods

Location of the study

The study was carried out in Yola, Adamawa State. Yola is located at latitude 7° 11' North and Longitude 11° 14' East and at an elevation of 364m above sea level in the north eastern part of Nigeria. Average relative humidity is within the ranges of 30 - 50% with a minimum as low as 10% in February to March and a maximum of about 90% in August. The maximum temperature can reach 38 ^{0}C particularly in April, while minimum temperature can be as low as 18 ^{0}C (Adebayo, 1999) [2].

Processing of *njigari* sorghum cultivar

Njigari sorghum cultivar was purchased at Jimeta agro products market where it is readily available. Malting procedure was adopted using the modified methods describe by Yakubu *et al.*, (2008) [19]. The *njigari* sorghum grain was soaked for 24hrs in water after which it was drained and spread on a concrete floor. A polythene material was used to cover the grain to preserve moisture. Germination was arrested after 24hrs by spreading the grain under the sun to dry.

Experimental animals, their management and design

Thirty (30) weaner rabbits sourced within the study area were used for the study. They were allotted to the five dietary treatments of six rabbits per treatment i.e two rabbits per replicate in a completely randomize design. Each replicate was housed in cage measuring fitted with feeder and drinker. The experimental animals were dewormed using ivomectin at 0.30ml/kg. Five diets were compounded using malted *njigari* sorghum cultivar (MNSC) to replace maize in diets at 0, 25, 50, 75 and 100% as shown in Table 1.

Table 1: Ingredient and percentage composition of experimental diets

Replacement levels of malted *njigari* sorghum cultivar					
Ingredients	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100)**
Maize	49.00	36.75	24.50	12.25	0.00
MNSC	0.00	12.25	24.50	36.75	49.00
Soybean meal	26.00	26.00	26.00	26.00	26.00
Groundnut haulms	10.00	10.00	10.00	10.00	10.00
Maize offal	12.00	12.00	12.00	12.00	12.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated analysis					
Crude protein	17.34	17.67	17.89	18.00	18.03
Crude fiber	8.49	8.67	8.99	8.01	8.07
Calcium	1.08	1.06	1.09	1.06	1.07
Phosphorus	0.73	0.71	0.74	0.72	0.73
ME kcal/kg	2987.45	2897.89	28645.67	2822.45	2812.56

Vitamin- Mineral premix (Bio-mix) provided per kg include the following: Vitamin A 500 IU; Vitamin D_3, 888,000 iu; Vitamin E, 12,200mg; Vitamin K_3 15,000mg; Vitamin B_1, 100mg; B_2, 200mg; B_6, 1500mg; Niacin, 1200mg; Pantothenic acid, 2000mg; Biotic, 100mg; Vitamin B_{12}, 3000mg; Folic acid, 1500mg; Chlorine chloride, 60,000mg; Manganese, 10,000mg; Iron, 1500mg; Zinc, 800mg; Copper, 400mg; Iodine, 80mg; Cobalt, 40mg; Selenium, 8000mg.

Data collection

Growth performance measurements

Feed intake was determined as the difference between the quantity of feed offered and feed leftover. Similarly, total body weight gain was determined as the difference between the final body weight and initial body weight recorded at the beginning of experiment. Feed conversion ratio was calculated the ratio of feed intake to weight gain.

Economics of production

Carcass and internal organs evaluation

At the end of the experiment, one rabbit was randomly selected from each replicate for carcass and internal organs evaluation according to the method described by Yakubu and Wafar, (2014) [17]. The rabbits were weighed individually, slaughtered and de-pelted completely to obtain pelt weight. The internal organs were removed carefully and weighed. The internal organs were expressed as percentages of their live bodyweight. The dressing percentage was calculated as a ratio of carcass weight and live weight multiplied by 100.

Laboratory analysis

The proximate and composition of un-malted and malted *njigari* sorghum cultivar were determined according to methods described by AOAC (1990) [4].

Statistical analysis

All data was subjected to analysis of variance using statistical package for social sciences (SPSS) software. significant difference between means were separated using Duncan's multiple range test option the same software.

Results and Discussion

Proximate composition and tannin content of un-malted and malted *njigari* sorghum cultivar

The proximate composition and tannin content of un-malted and malted *njigari* sorghum cultivar are shown in Table 2. The crude protein (CP) content were 11.03 and 11.75 % for

un-malted and malted *njigari* sorghum cultivar. Malted *njigari* sorghum cultivar produced the highest CP of 11.75% while un-mated recorded 11.03%. Un- malted *njigari* sorghum cultivar had the highest crude protein compared to the malted *njigari* cultivar. However, there was there decreased in the crude fibre content after malting. The tannin content of un-malted and malted *njigari* showed that malted *njigari* recorded lower value of 2.00mg/100g while malted had 3.41mg/100mg. The study showed that malting improved the nutrient and reduced the ME and tannin content. This result confirms the findings of Yakubu *et al.* (2009) [15] who reported improved in nutrient composition and reduction of tannin content when high tannin sorghum was subjected to malting. The result of the study confirmed the finding of Shayo *et al.*, (2001) [15] that germination or malting is an effective method in improving the nutritional and functional qualities of sorghum.

Table 2: Proximate Composition of Un-malted and Malted *njigari* sorghum cultivar

Parameter	Un-malted	malted
Dry matter	91.25	85.15
Crude Protein	11.03	11.75
Crude fibre	3.15	2.03
Ether extract	6.23	4.32
Ash	1.25	1.20
Nitrogen Free Extracts	69.59	65.85
ME Kcal/kg	3383.185	3122.345
Anti-nutritional factor (mg/100g)		
Tannin	3.41	2.00

Metabolizable Energy = ME (kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE. Calculated according to the formula of Pauzenga, (1985)

Growth performance of weaner rabbits fed replacement levels of malted *njigari* sorghum cultivar

The growth performance of weaner rabbits fed replacement levels of malted *njigari* sorghum cultivar for maize is presented in the Table 2. No significant differences (P>0.05) was recorded for the parameter evaluated. The final body weight (FBW) and average daily weight gain (ADWG) were between the ranges of 1318.22g/rabbit in T2 to 1366.48 in T5 and 14.45g in T2 to 15.22g in T5, respectively. Similarly, feed conversion ratio was similar across replacement levels. However, the replacement levels of MSC for maize in the diets of weaner rabbit did not influenced the palatability of the diets. This account for the uniformity in the feed intake across the dietary treatments. Similar result was reported by Yakubu *et al.* (2008) [19] when they fed partially germinated *masakwa* sorghum cultivar to weaner rabbits. The average daily feed intake (ADFI) recorded however, were higher than 55.50 – 65.46g/rabbit/day reported by Doma *et al.* (1999) [5], 50.57 – 60.67g/rabbit/day reported by Abubakar *et al.* (2006) [1] and 30.95 – 33.40g/rabbit/day reported by Yakubu *et al.* (2008) [19]. Higher ADFI recorded in this study could be attributed to the processing method employed and the sorghum cultivar. Yakubu *et al*, 2009 [15] soaked *masakwa* sorghum cultivar in water for 6hours and germination was arrested after 12hrs by spreading the grain in the sun to dry while in this study, njigari sorghum cultivar was soaked for 24hours and germination was arrested after 24 hours. In regard to the cultivar, red sorghum and *masakwa* have been reported to contain high tannin (Murriu *et al.*, 2002 and Yakubu *et al.*, 2009) [9, 15]. This suggest that duration and time of germination employed in this study reduce the tannin contain of the MSC thereby increase the palatability. Tannins have reported to impaired feed intake due to its astringent properties (Ogbu *et al.*, 2015) [10].

Table 3: Growth performance of weaner rabbits fed replacement levels of malted Njigari sorghum cultivar

Replacement levels of malted *Njigari* sorghum cultivar							
Parameters	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**	**SEM**	**P-value**
Initial body wt. (g)	515.55	514.44	517.44	515.33	514.00	13.26	0.43
Final body wt. (g)	1351.56	1318.22	1331.63	1359.18	1366.48	46.26	0.76
Average daily weight gain (g)	14.92	14.35	14.54	15.06	15.22	0.87	0.92
Total feed intake (g)	3828.07	3914.82	3410.00	3575.93	3701.37	0.45	0.87
Average daily feed intake (g)	68.35	69.90	65.05	63.85	66.09	7.49	0.97
Feed conversion ratio	4.61	4.87	4.25	4.23	4.40	0.48	0.84

SEM = Standard error mean

Economic analysis of feeding weaner rabbits with Njigari sorghum cultivar

the economic analysis of feeding weaner rabbits with Njigari sorghum cultivar is shown in Table 3. Feed cost/ kg significantly (P<0.05) reduced from N140.67 /kg in T1 (0%) to N80.54 /kg in T5 (100%) replacement level MNSC. Feed cost /kg gain (N/gain) was observed to higher in the maize based diet (control). This could be attributed to the relative cheaper price of sorghum than maize as reported by Abubakar *et al.*, (2006) [1]. to the relative cheaper price of sorghum than maize as reported by Abubakar *et al.* (2006) [1]. Yakubu *et al.*, 2008 [19] reported similar finding when broiler when weaner rabbits were fed partial replacement of malted *Masakwa* sorghum cultivar.

Table 4: Economic analysis of feeding weaner rabbits with *Njigari* sorghum cultivar

Replacement levels of malted *njigari* sorghum cultivar							
Parameter	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**	**SEM**	**P- value**
Total feed intake (Kg/bird)	3.82	3.914	3.41	3.57	3.70	0.15	0.43
Feed cost /Kg (N)	140.67	120.43	113.78	97.68	80.54	4.88	0.21
Cost of feed intake (/Kg)	538.49	471.46	387.98	349.29	298.10	1.80	0.08
Total weight gain (Kg/bird)	0.83	0.80	0.81	0.84	0.85	0.03	0.13
Feed cost/ Kg gain (N /Kg)	644.12	586.55	476.53	413.93	349.69	2.19	0.23
Cost saving (N)		57.56	167.58	230.19	294.42	5.14	0.89

SEM = Standard error mean

Carcass characteristics and internal organ weights of weaner rabbits fed replacement levels of malted Njigari sorghum cultivar

Table 4 shows the result of carcass characteristics and internal organ weights of weaner rabbit fed replacement levels of malted Njigari sorghum cultivar. There was no significant influence by the levels of replace for all the parameters measured. (P>0.05). the dressing percentage range from 64.25 – 66.45%. The dressing percentage recorded in this study were higher than that of Oteken and Igene, (2006) [13], 50.70 – 58.50% by Memieth *et al*. (2004) and 41-00 – 47.00% by Yakubu *et al*. (2008) [19]. These variation in the dressing percentage could be attributed to age of slaughter and differences in the test diet. Oteken and Igene, (2006) [13] reported that dressing percentages were significantly affected by age of slaughter when they reported lower values of dressing percentage for rabbits slaughtered at 10 weeks compared to those slaughtered at 16 and 23 weeks respectively. Replacement levels of MNSC did not significantly (P>0.05) influenced internal organ weights. Yakubu *et al*., (2008) [19] also reported a similar result. The organs such as liver and kidney that are known to be involved detoxification were similar across the dietary treatments. This suggests that MNSC is safe for feeding rabbit.

Table 2: Carcass characteristics and internal organ weights of weaner rabbits fed replacement levels of malted Njigari sorghum cultivar

Replacement levels of malted *njigari* sorghum cultivar							
Parameters	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**	**SEM**	**P-value**
Pre slaughter body weight (g)	1297.51	1264.17	1277.58	1285.13	1292.13	46.32	0.76
Dressed weight (g)	842.72	813.39	826.90	854.35	861.47	0.92	0.07
Dressing percentage	64.94	64.34	64.72	66.47	66.67	1.25	0.28
Internal organs (% pre slaughter body weight)							
Heart	0.48	0.43	0.51	0.48	0.49	0.06	0.61
Kidney	0.52	0.50	0.56	0.53	0.56	0.07	0.01
Lungs	0.85	0.88	0.87	0.86	0.85	0.05	0.97
Liver	2.49	2.27	2.30	2.54	2.53	2.45	1.84
Ceacal weight	2.17	2.11	2.43	2.12	2.56	0.30	0.98
Ceacal lenght	20.29	21.45	20.44	20.41	20.12	0.76	0.09
Small intestine weight	5.77	5.17	5.18	5.14	5.16	0.26	0.15
Large intestine weight	7.52	7.71	7.42	7.46	7.34	0.35	0.09
Small intestine length (cm)	210.42	211.00	211.73	212.73	212.12	1.84	0.40
Large intestine length (cm)	24.37	27.86	25.46	26.45	24.67	1.19	0.08

SEM = Standard error mean

Conclusion

The study showed that the inclusion of malted njigari sorghum in weaner rabbit diet did not adversely affect growth performance, carcass characteristics, internal organ weights but increases economics of production. It could be concluded that malted njigari sorghum can be used to substitute maize in the diets of weaner rabbits. It is therefore recommended that rabbit farmer, animal nutritionist and feed milling industry can use malted sorghum cultivar as feed ingredient.

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