PERFORMANCE AND NUTRIENT UTILIZATION OF WEANER RABBITS FED BOILED SORREL SEED (*HIBISCUS SABDARIFFA* L) BASED DIETS

Aliyu[1*] A.M., Shehu[1] B.M., Bello[2] T.K. and Ibrahim[1] N.B.
[1]National Agricultural Extension and research Liaison Services (NAERLS), ABU, P.M.B 1067, Zaria.
[2]National Animal Production Research Institite (NAPRI), Shika, Zaria.
*Corresponding Author's E-mail: layi5821@gmail.com,
Phone number: 08065733087

ABSTRACT
An experiment was conducted to evaluate the effect of boiled sorrel seed meal (BSSM) diets on growth performance and nutrient digestibility of weaner rabbits. Thirty weaner rabbits of mixed breeds and both sexes with an average weight of 800 ± 76.0g (mean ± SD) were used for the experiment which lasted for 8 weeks. The rabbits were randomly allotted to five (5) dietary treatments containing the control diet, raw seed diet (BSS0) and boiled sorrel seeds in already boiled water per batch for 15 (BSS15), 30 (BSS30) and 45 (BSS45) minutes, respectively. Completely randomized design (CRD) was used with six (6) rabbits per treatment and two (2) rabbits per replicate. The results of the experiment showed that there was significant difference (P<0.05) in average daily feed intake but none (P>0.05) in other performance indices evaluated. Feed conversion ratio was better in rabbits fed BSS30 (6.28) compared to rabbits fed BSS45 (7.69). The final weight increased as boiling duration increased but later declined at 45 minutes duration (1360.00, 1286.67, 1293.33, 1386.67 and 1306.00g/rabbit). All parameters studied for nutrient digestibility were significantly affected (P<0.05) by duration of BSSM except for dry matter (DM) and ash. This indicated that the feed was better utilized and also had better nutrient digestibility. Based on the results of the study, it was therefore concluded that grower rabbits could tolerate sorrel seed meals up to 30 minutes duration of boiling without negatively affecting performance (daily feed intake) and poor nutrient digestibility (CP, CF, EE and NFE). Boiling beyond 30 minutes can lead to poor performance and utilization of the nutrients due to reduced B-carotene in the seeds. Given the economic potential of sorrel seed as a non-conventional feedstuff, histopathological studies are recommended to investigate any deleterious effects on rabbits fed sorrel seed-based diets.

KEYWORDS: Sorrel seed (*Hibiscus sabdariffa L.*), performance, nutrient digestibility, rabbits

INTRODUCTION
Rabbits have been recognized to have a very important role to play in the supply of animal protein to Nigerians, especially, in the rural and some part of urban areas. They are good converters of feed to meat and can utilize up to 30% crude fibre as against 10% by most poultry species. (Egbo *et al.,* 2001). Rabbits recently have come under focus as they are animals with several potentials such as short gestation periods, small body sizes, highly prolific, fast growth rate, and forage utilizers. Rabbit meat as an economic source of high-quality animal protein in the nutrition of human populations in the most of the tropical regions is gradually expanding (Amadi *et al.,* 2016). In recent years, it is economically nonviable and practically unsustainable for agricultural industry to solely depend on conventional feed (Merino *et al*., 2010). Limited supply, increasing demand and high price of conventional feed ingredients have been the motivating factors to explore alternative sources for livestock feed production (Odetola and Eruvbetine, 2012). The use of cheap, non-conventional feedstuff such as sorrel seeds maximize its potential as a feedstuff and further reduce the cost of producing animal protein while ensuring a continual development of the industry (Maikano *et al*., 2014). Sorrel seeds in their raw state are known to have bitter taste which is attributed to anti-nutritional factors present in them. The unprocessed seed have been reported to contain total phenols, phytic acid as common anti-nutrients and these have been shown to have detrimental effects on the health and performance of animals (Dairo *et al.,* 2011; Keyembe, 2011; Kwari *et al.*, 2011) and tannin; the major anti-nutrient which is known to impair feed intake, nutrient digestibility and growth of poultry and young animals. The seed also contain traces of saponin which reduces palatability and this can be reduced by repeated washing in water according to Nityanand (1997). Boiling as a processing method appears to be a more effective method of tannin reduction in sorrel seed than roasting or soaking in water. Boiling decreases tannin in sorrel seed to about 68% (Duwa *et al.,* 2012). Sorrel seeds contain high amount of protein, dietary fibre, and mineral such as phosphorus (P), calcium (Ca) and magnesium (Mg) (Ismail *et al*., 2008). The seeds contain about 35.90% crude protein (CP), 10.14% ether extract (EE), 10.09% ash and 15-17% crude fibre (CF) (Dashak and Nwanegbo, 2002). Kwari *et al.* (2011) also reported raw sorrel seeds to contain 5.18% arginine, 16.5% CF, 13.5% EE and 38.57% CP. Abdu *et al*. (2008) reported 23.46% CP value in the raw seeds. However, Nyameh *et al.* (2012) reported that boiled sorrel seeds contain 22. 84% CP, 8.50% CF, 6.50% EE, 6.50% ash, 45.66% NFE and 91.70% DM. while Maikano *et al.* (2014) reported a

value of 21.84% CP, 3.60% CF, 5.85% EE, 5.39% ash, 90.40% DM, 53.72% NFE, 1.12% Ca and 0.56% P. There is still paucity of information on the effect of utilizing non-conventional feedstuff in rabbit's diet. The experiment was therefore designed to investigate the performance and nutrient digestibility of feeding weaner rabbits with boiled sorrel seed meal-based diet.

METHODOLOGY

The Study area: The experiment was carried out at the Rabbitry Unit of the Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Zaria. Zaria is within the Northern Guinea Savanna zone of Nigeria, with Latitude 11º 09′ 01.78″N and Longitude 7º 39′ 14.79″E at an altitude of 671m above sea level (Ovimaps, 2015).

Experimental diets and proximate analysis:
Sorrel seeds and other ingredients used were purchased from an open market in Sabon Gari, Zaria. Fifteen kilogrammes (15kg) of raw sorrel seeds were thoroughly cleansed and milled to be incorporated into the diets of rabbits. Another 15kg of the seeds were cleansed and poured into 30litres of already boiled water at 100^0C per batch for 15, 30 and 45 minutes, respectively. The boiled seeds were later sundried for 3 days and milled into powder using hammer mill. It was bagged and stored for experimental diet formulation purpose.
Five (5) experimental diets (Table 1) were formulated to meet the requirements of rabbits according to National Research Council (1994). Treatment 1: Control diet (sorrel seed free diet); Treatment 2: Raw sorrel seeds diet (BSS0); Treatment 3: Diet containing sorrel seeds boiled for 15 minutes (BSS15); Treatment 4: Diet containing sorrel seeds boiled for 30 minutes (BSS30); and Treatment 5: Diet containing sorrel seeds boiled for 45 minutes (BSS45). The experimental diets were analysed for dry matter, ash, crude fibre, crude protein, ether extract, nitrogen free extract and metabolizable energy according to the methods of AOAC (2005).

Experimental design and management of animals: Thirty (30) weaner rabbits of mixed breeds and both sexes aged 7-8 weeks with an initial weight range of between 800 ± 76.0g (mean ± SD) were randomly allotted into five (5) groups of 6 animals after balancing for body weight. Each dietary treatment was replicated thrice (two animals per replicate) in a Completely Randomized Design (CRD). Before the commencement of the experiment, the rabbits were observed carefully for any ill-health and treated against ectoparasites and endoparasites using ivermectin® (0.25mg/kg/rabbit) The rabbits were housed individually in galvanized wire cages of 40 x 60 x 60cm dimension which were designed for easy collection of faeces. Each cage was equipped with a small rubber bowl drinker and an earthen pot feeder. The rabbits were fed *ad-libitum* and necessary routine management practices were duly followed. The experiment lasted for 56 days.

Data collection: Feed offered and left over were weighed to determine feed intake of the animals. After the initial weight, weekly weights were recorded, and the records were used to monitor and determine the performance parameters in terms of average feed intake (AFI), average weight gain (AWG), feed conversion ratio (FCR), final body weight and feed cost/kg gain. Mortality was also recorded as it occurred.

Digestibility study: A seven-day faeces collection from three rabbits per treatment (one per replicate) was carried out to determine the nutrient digestibility of the proximate components. Before the commencement of the digestibility trial, rabbits were weighed, confined individually in metabolism cages. Fresh, clean water and weighed quantity of feed was offered to each rabbit daily. Daily feed consumption was recorded as the difference between the quantity offered and the quantity left after 24 hours. A polythene sheet was placed under each cage to allow for individual faecal collection. The faeces were oven-dried to determine moisture content. At the end of the collection period, all faecal samples from each rabbit were bulked and preserved for proximate analysis according to A.O.A.C. (2005). The nutrient digestibility was calculated using the formula below

$$\text{Apparent Digestibility} = \frac{\text{Nutrient in feed intake} - \text{Nutrient in feacal output}}{\text{Nutrient in feed intake}} \times 100$$

Analysis: All data generated were subjected to Analysis of Variance (ANOVA) using General Linear Model (GLM) Procedure of SAS (2008) software package. Significant difference between treatment means were separated using Dunnett (Steel and Torrie, 1998).

RESULTS AND DISCUSSION

As shown in Table 2, the indices measured for growth performance showed no significant differences ($P>0.05$) except for total and average daily feed intake which were reduced significantly ($P<0.05$) as the duration of boiling increased. Rabbits fed control, BSS0 and BSS15 diets were statistically the same as compared to rabbits on BSS30 and BSS45 diets in terms of daily feed intake. It was observed that rabbits fed the BSS30 diet had the lowest average daily feed intake, highest weight gain, the least FCR and feed cost /kg weight

gain. This can be an indication that the rabbits were able to utilize and convert feed to gain. Similar results were reported by Kaga, (2013) when *Delonix regina* seeds cooked at different duration were fed to rabbits. Mortality of 0.33% was only recorded for rabbits on BSS45 diet. The FCR of rabbits fed BSS30 diet was the best although there were non-significant (P>0.05) differences when compared with control, BSS0, BSS15 and BSS45 diets. This agreed with the reports of (Musa and Ogbadoyi, 2012) who stated that boiling reduces the level of anti-nutrients and toxic substances with retention of most micro-nutrients in amount sufficient to meet animal's dietary requirement but boiling beyond BSS30 reduces B-carotene levels in seeds. Despite the anti-nutrients present in the BSS0 diet, they performed better than rabbits on BSS45 diet. This is because prolonged boiling reduces the B-carotene level in leguminous seeds and also leaching and denaturation of protein in the samples. This agrees with the findings of Kwari *et al.* (2011) who reported similar outcome when they fed raw, soaked, sprouted and boiled roselle seed meal to broiler chickens for 9 weeks. This could be as a result of better feed utilization by the rabbits on BSS0 diet. The result also supported the findings of Halimatul *et al.* (2007) who reported that the quality of two differently processed (dried and boiled) roselle seed powder are similar and affect performance significantly when the seeds were boiled at 100° C for 30 minutes. Therefore, the anti-nutrient of raw sorrel seed might not affect feed digestibility and biological value.

Nutrient digestibility parameters studied (Table 3) were significantly affected (P<0.05) by duration of BSSM except for dry matter (DM) and ash digestibilities. Rabbits fed the control and BSS30 diets showed the best result for ether extract (EE) digestibility but declined significantly (P<0.05) with increased level of boiling (BSS45) thus, rabbits fed this diet showed the poorest result. Crude protein (CP) digestibility increased as the duration of boiling increases but declined significantly (P<0.05) at BSS45 diet. Crude protein digestibility of rabbits on BSS0, BSS15 and BSS30 diets were similar and better than digestibility on control and BSS45 diets. Crude fibre (CF) digestibility was significantly affected (P<0.05) by duration of boiling as rabbits fed BSS0 and BSS30 diets had statistically the same and best result. Similarly, no difference was observed for rabbits fed control and BSS15 diets. The least value (72.32) for CF digestibility was observed for rabbits fed BSS45 diet. The best result (67.11) for NFE digestibility was obtained in rabbits on BSS15 diet. The least result (54.11) was obtained from rabbits fed the control diet.

Crude fibre digestibility and ether extract digestibility values seem to be higher in all treatment than its relative values in crude protein and NFE. This indicates that the diets contain high fibre and fat. The results obtained in this study contradict the findings of Oso *et al.* (2011) who observed decreased nutrient digestibility with increased fermented sorrel seed meal. It was also not similar with the result of Saidu, (2015) who reported a general trend of digestibility result indicating reduced nutrient digestibility with increased level of autoclaved castor seed meal. It was observed that rabbits on BSS30 diet had higher EE digestibility result while the lowest was observed in rabbits on BSS45 diet. This is similar with the result of Kaga, (2013) who reported that diets with high fat contents are better digested by animals and have better nutrient digestibility. The reduced nutrient digestibility noticed in rabbits on BSS45 diet may be as a result of dilution effect of fibre. Apart from this complex toxic effect, sorrel seeds contain relatively high amount of fibre that reduced utilization of other nutrients in the body of the rabbits when cooking duration is prolonged. This supported the reports of (Longe and Ogedenge, 1989., Attah and Nyachoti, 2017) which stated that diluting diet with fibre source contributed immensely to the bulkiness of the resultant diets hence reducing nutrient digestibilities.

Table 1: Composition of experimental diets

	Duration of boiling of sorrel seeds (mins)				
Ingredients (kg)	**Control**	**BSS0**	**BSS15**	**BSS30**	**BSS45**
Maize	45.05	36.98	38.09	38.12	38.33
Soya bean cake	12.45	5.52	4.41	4.38	4.17
Boiled sorrel seed meal	0.00	15.00	15.00	15.00	15.00
Groundnut Haulms	40.00	40.00	40.00	40.00	40.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Proximate composition of diets					
Dry Matter	89.63	90.76	90.48	90.41	90.27
Crude Protein	15.39	15.45	15.35	15.84	15.45

Crude Fibre	9.65	10.90	7.05	6.70	6.37
Ether Extract	15.45	14.90	14.50	14.40	14.00
Ash	10.36	10.04	9.44	9.00	8.71
Nitrogen Free Extract	49.15	48.71	53.66	54.06	55.47
Metabolizable Energy (kcal/kg)	3553.49	3495.32	3632.15	3656.10	3658.30

**Bio-premix supplied per kg of diet: Vit A, 12500 I.U; Vit D_3, 2500 I.U; Vit E, 50mg; Vit K_3, 2.5mg; Vit B_3, 3.5mg; Vit B_6, 6mg; Niacin, 40mg; Pantothenic acid, 10mg; Biotin, 0.8mg; Vit B_{12}, 0.25mg; Folic acid, 1mg; Choline chloride, 300mg; Manganese, 100mg; Iron, 50mg; Zinc, 45mg; Iodine, 1.55mg; Selenium, 0.1mg; Copper, 2mg; Cobalt, 20mg.
BSS0 = Raw sorrel seed based diet (0 minutes) BSS15= boiled sorrel seed based diet at 15 minutes BSS30= boiled sorrel seed based diet at 30 minutes BSS45= boiled sorrel seed based diet at 45 minutes

Table 2: Effect of different duration of boiled sorrel seed meal on performance of grower rabbits

	Duration of boiled sorrel seed (mins)						
Indices	Control	BBS0	BSS15	BSS30	BSS45	SEM	LOS
Initial body weight (g/rabbit)	853.33	800.00	813.33	876.67	855.00	48.83	NS
Final body weight (g/rabbit)	1360.00	1286.67	1293.33	1386.67	1306.00	85.91	NS
Average daily weight gain (g/rabbit)	9.05	8.69	8.57	9.11	8.07	0.90	NS
Total feed intake	3476.48^{a}	3517.36^{a}	3587.36^{a}	3178.56^{b}	3265.92^{b}	129.92	*
Average daily feed intake (g/rabbit)	62.08^{a}	62.81^{a}	64.06^{a}	56.76^{b}	58.32^{b}	2.32	*
Feed conversion ratio	6.87	7.28	7.61	6.28	7.69	0.73	NS
Feed cost per kg (₦)	100.21	95.41	95.55	95.56	95.58		
Feed cost/kg gain	688.17	694.84	727.28	600.20	735.82	69.61	NS
Mortality (%)	0.00	0.00	0.00	0.00	0.33	0.15	NS

BSS0 = Raw sorrel seed based diet (0 minutes) BSS15= boiled sorrel seed based diet at 15 minutes BSS30= boiled sorrel seed based diet at 30 minutes BSS45= boiled sorrel seed based diet at 45 minutes
abc: means with different superscript on the same row differ significantly at $p<0.05$
SEM: standard error of mean LOS : level of significance NS : Not significant NS : Not analysed

Table 3 : Effect of different duration of boiled sorrel seed meal on nutrient digestibility

	Duration of Boiled Sorrel Seeds (mins)						
Parameters (%)	Control	BSS0	BSS15	BSS30	BSS45	SEM	LOS
Dry Matter	71.92	73.81	76.12	71.78	71.82	1.66	NS
Crude Protein	65.08^{ab}	54.16^{b}	70.24^{ab}	75.97^{a}	50.56^{b}	5.27	*
Crude Fibre	75.06^{b}	78.09^{ab}	76.66^{b}	81.15^{a}	72.32^{c}	1.45	*
Ether Extract	79.83^{a}	75.63^{b}	75.44^{b}	81.54^{a}	66.42^{c}	2.02	*
Ash	79.09	80.83	80.27	82.65	80.34	1.38	NS
Nitrogen Free Extract	54.11^{b}	64.61^{a}	67.11^{a}	65.32^{a}	62.44^{ab}	2.16	*

BSS0 = Raw sorrel seed based diet (0 minutes) BSS15= boiled sorrel seed based diet at 15 minutes BSS30= boiled sorrel seed based diet at 30 minutes BSS45= boiled sorrel seed based diet at 45 minutes
abc: means with different superscript on the same row differ significantly at $P<0.05$
SEM : standard error of mean LOS : level of significance NS : Not significant

CONCLUSION AND RECOMMENDATION

Although rabbits could tolerate raw sorrel seed in their diets without negatively affecting performance and nutrient digestibility, rabbits feed sorrel seed boiled for 30 minutes had superior nutrient digestibility. However, boiling duration beyond 30 minutes resulted in a decline in their performance and led to poor utilization of the nutrients. Given the economic potential of sorrel seed as a non-conventional feedstuff, histopathological studies are recommended to investigate any deleterious effects on rabbits fed sorrel seed-based diets.

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