

**Growth Performance of Red Sokoto Bucks Fed Inclusion levels of Raw and Soaked Roselle (*Hibiscus sabdariffa* L.) Seeds in Rice Offal Based Diets.**

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**Target Audience:** Livestock researchers, Ruminant nutritionist, Goat Farmers.

**Abstract**

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*This study was carried out to evaluate the growth performance of red Sokoto bucks fed two (2) inclusion levels of raw water soaked and lime soaked Hibiscus sabdariffa seeds in rice offal based diets. A total of twenty one (21) red Sokoto bucks were randomly allotted into seven treatments with three (3) bucks per group while a group with zero inclusion of the seeds served as a control diet in a 2x3 factorial arrangement using a completely randomized design (CRD). The results showed there was a significant ( $P < 0.05$ ) difference in all parameters except for daily water intake. The increase in dietary inclusion levels for water soaked and lime soaked Hibiscus sabdariffa seeds increased significantly ( $P < 0.05$ ) the feed intake total weight gain and feed conversion ratio when compared to the control group while a decrease in performance was observed with increase in dietary inclusion levels of raw Hibiscus sabdariffa seeds. It could be concluded that the dietary inclusion levels of 10% and 20% water soaked and lime soaked and 10% raw Hibiscus sabdariffa seeds improved growth performance of Red Sokoto bucks compared to the 20% inclusion level of raw Hibiscus sabdariffa seeds and the 20% dietary inclusion levels of water soaked Hibiscus sabdariffa seeds was found to be the best in terms of growth performance and feed intake.*

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**Keywords:** *Hibiscus sabdariffa* seeds, Soaking, Red Sokoto bucks, Performance

**Description of problem**

In Nigeria, small ruminants represent about 63.7% of total grazing domestic livestock (1). The indigenous breeds of goat in order of importance are Red Sokoto (50%), West African Dwarf (45%) and Sahel (5%) (2) the vast majority of these small ruminants (about 70%) are found in the northern part of the country (1). Similarly, goats contribute

about 24% of Nigeria meat supply (3).

Goats, like other ruminants in the tropics and sub-tropics experience marked seasonal fluctuations in feed supply which results in a seasonal pattern of wet season live weight gain and dry season live weight loss until animals reach marketable weight (4). This is due to the scarcity of good quality feed during the dry season. Feed intake is one of the

important factors that may influence animal's live performance, health and carcass characteristics (5). Increasing demand and subsequent cost of conventional animal feed ingredients in the tropics has created the sustainable alternative, particularly natural feed resource indigenous to the region (6). The search for alternative feed resources has over the past decades rekindle research interest in the use of tropical browse, herbs and medicinal plants as sources of nutrient for ruminant (7).

*Hibiscus sabdariffa* plant, being a herbaceous plant is one of the alternative feed resources that has been found to thrive on a wide range of tropical soil conditions, and can perform satisfactorily well on relatively infertile soil (8). It is popularly called “Yakuwa” in Hausa and belongs to the family of *Malvaceae* and is a popular vegetable in Indonesia, India, West Africa and many tropical regions (9 & 10). The vegetable is widely grown in the North-Eastern and Middle belt regions of Nigeria (11).

*Hibiscus sabdariffa* is widely cultivated for its pleasant red color calyx, used in making a local drink (sobo) and wine (12). Although abundant seeds are produced, they are highly underutilized. The seeds were reported to have high content of oil and protein. (12) reported that seeds contained 25.20% CP while (13) reported a value of 23.46% CP. However, the utilization of *Hibiscus sabdariffa* seeds as an alternative feed source for ruminant livestock may be limited due to the presence of some anti-nutritional factors such as tannin, phytic acid, and trypsin inhibitor activity (14 & 13), as well as gossypol (14). Despite the

activities of microbes in the rumen, the antinutrients in plant feed materials if above threshold level, still limit their voluntary intake and utilization by ruminant animals. Hence, the need for processing in order to improve the quality and utilization of plant feed materials by ruminants.

Many studies have focused on the evaluation of different feedstuffs and feed additives in the nutrition of animals; there is relatively little work done to investigate the performance indices within breeds of goats fed *Hibiscus* seeds, therefore, there is a need to establish the pattern of feeding *Hibiscus sabdariffa* seeds to ruminants in Nigeria. The objective of the study was therefore, to evaluate the growth performance and some blood profile of Red Sokoto bucks fed inclusion levels of raw and soaked *Hibiscus sabdariffa* seeds in rice offal based diets.

## Materials and Methods

### Site Description

The study was conducted at the Small Ruminant 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, on latitude 11° 14' 44" N and longitude 7° 38' 65" E, at an altitude of 610m above sea level. The climate is relatively dry with annual rainfall of 700-1400mm, occurring between the months of April and September (15).

### Sourcing and processing of *Hibiscus sabdariffa* seeds

The seeds of Red variety of *Hibiscus* (*Hibiscus sabdariffa* L.) were purchased

from an open market in Yobe state during the harvest period. The seeds were cleaned to remove impurities before processing.

**Lime soaked**

The *Hibiscus sabdariffa* seeds were treated with lime at six percent (6%). 20kg of *Hibiscus sabdariffa* seeds were soaked in 50L plastic containers containing the lime solution at 6% for 24hrs. At fourth day, the seeds were then removed, washed and sun dried for 72h. The dried treated seeds were then stored in an airtight polythene material, until required for diet formulation.

**Water soaked**

20kg of *Hibiscus sabdariffa* seeds were soaked in clean water for four days in 60L of water, into a 100L clean plastic container so as to completely submerge the seeds. The water was drained at every 24h and another 60L of clean water added. At fourth day the seeds were then removed, washed and sun dried for 72h. The dry seeds were then stored in an airtight polythene material, until required for diet formulation.

**Experimental diets**

The raw and soaked *Hibiscus sabdariffa* seeds were included at 10% and 20% levels to obtain iso-nitrogenous and iso-caloric diets, other ingredients in the diet are as presented in table 3.

**Experimental animals, design and management**

The experimental animals were purchased from an open market in Anchau, Kubau Local Government Kaduna State. Twenty one (21) growing Red Sokoto bucks of about 8-10 months old and weighing 9-13kg were randomly allotted into seven (7) groups

with three (3) animals per group while a group with zero inclusion of the seeds served as a positive control diet in a 2x3 factorial arrangement with a CRD.

The experimental animals were housed in individual pens and treated against endo and ecto parasites using Acaricide and Albendazole<sup>®</sup> according to the manufacturer's recommendation, after which the animals were placed on experimental diets for 14 days adjustment period before the commencement of the experiment. At the commencement of the experiment, the animal's body weights were taken using a spring balance for three consecutive times and average value recorded. After balancing for weight, they were fed the experimental diets at 3% of live weight daily at 8:00am in single dose and the leftover of the previous day recorded. Each animal was provided with two liters of drinking water daily and daily intake recorded. The animals were weighed every fourth night and their rations were adjusted according to live weight changes. The growth trial period lasted for twelve weeks.

**Chemical analysis and Metabolisable energy**

The proximate analysis of the experimental diets, raw seeds, water soaked and lime soaked *Hibiscus sabdariffa* seeds were determined according to standard methods of (16). Dry matter of the samples was determined in an oven at 105°C for 48 hours. Nitrogen determination was done by the Micro Kjeldahl Method, while the Soxhlet Extraction Procedure was used for Ether Extraction. Crude

Fibre was determined by alternate refluxing with weak solutions of H<sub>2</sub>SO<sub>4</sub> and NaOH. Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) were determined according to the method described by (17). The Pyhtic acid was determined according to the method of Wheeler and Ferrel (1971), while Tannin was determined Colorimetrically as described in (16). The total oxalates concentration in the samples was determined by Titrimetric Method of (18). The mineral analyses (Calcium, Phosphorus, Potassium, Iron and Magnesium) were carried out by atomic absorption spectrophotometer. Metabolisable Energy (ME) was determined by the equation of (19).

$$\text{ME (Kcal/kgDM)} = 37 \times \% \text{CP} + 81.8 \times \% \text{EE} + 35 \times \% \text{NFE}$$

### Statistical analysis

All data collected at the end of the experiment were subjected to statistical analysis using general Linear Models (GLM) procedure of Statistical Analysis System (20) and significance was declared at P<0.05. Significantly different means were compared using Duncan Multiple Range Test (21).

## Results and Discussions

### Chemical composition of experimental diets

Table 4 present the chemical composition of the experimental diets. The analysed crude proteins for the diets were found to be slightly lower than the calculated crude proteins for all the dietary treatments; though, the analyses verified the iso-nitrogenous and iso-caloric nature of the formulated diets.

**Table 1. Chemical composition of raw and soaked *Hibiscus sabdariffa* seeds**

Parameters (%)	Raw	WSS	LSS
Dry matter	94.67	94.09	92.90
Crude protein	25.18	27.88	30.98
Crude fibre	27.26	26.22	23.97
Ether extract	15.18	9.22	8.97
Ash	9.18	12.00	10.66
Nitrogen Free Extract	21.40	29.12	23.42
Acid Detergent Fiber	35.98	21.32	20.33
Neutral Detergent Fiber	62.89	48.81	45.40
Hemicellulose	11.59	9.01	8.41
Processing cost ₦/kg	0.00	7.00	15.00

WSS=Water Soaked Seeds, LSS= Lime soaked Seeds

### Effect of Processing on Animal Performance

Table 5 showed the performance of Red Sokoto bucks fed raw and soaked *Hibiscus sabdariffa* seeds in rice offal

based diets as partial replacement for cotton seed cake (CSC). The partial replacement of CSC with raw and soaked *Hibiscus sabdariffa* seeds had no effect on weight gain and water intake.

**Table 2. Antinutrient and mineral compositions of raw and soaked *Hibiscus sabdariffa* seeds**

Parameters (%)	Raw	WSS	LSS
Phytate	0.17	0.15	0.16
Tannin	2.40	1.17	1.58
Oxalate	1.46	0.87	1.04
(g/l)			
Calcium	1.10	1.73	2.57
Phosphorus	4.30	5.56	7.71
Magnesium	0.56	0.41	0.44
Iron	0.36	1.80	2.16
Potassium	11.98	8.30	3.83

WSS= water Soaked Seeds, LSS= Lime soaked Seeds

**Table 3. Ingredient composition of experimental diets.**

Ingredients (%)	CSC	Raw		WSS		LSS	
		10%	20%	10%	20%	10%	20%
HSS	0.00	10.00	20.00	10.00	20.00	10.00	20.00
Cotton seed cake	39.00	29.00	19.00	24.00	9.00	25.00	13.00
Maize offal	19.5	19.50	19.50	24.50	29.50	23.50	25.50
Rice bran	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Bone meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Common salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis (%)							
Crude protein	14.10	14.10	14.10	14.10	14.10	14.04	14.26
Crude fiber	21.35	23.10	24.85	23.15	24.95	23.14	24.91
Cost ₦/kg feed	34.95	33.90	32.90	32.80	30.70	34.20	34.10

CSC= cotton seed cake, WSS=Water Soaked Seeds, LSS= Lime soaked Seeds, *Hibiscus sabdariffa* seeds.

**Table 4. Chemical composition of experimental diets**

Parameters (%)	CSC	Raw		WSS		LSS	
		10%	20%	10%	20%	10%	20%
Dry Matter	89.57	90.30	89.93	89.53	90.23	90.20	89.80
Crude Protein	12.56	12.38	12.50	12.88	12.31	12.98	12.64
Crude Fiber	22.69	23.83	22.86	24.78	20.91	18.69	25.52
Ash	8.91	8.74	9.00	7.92	8.00	9.80	7.84
Ether Extract	3.98	4.23	4.42	4.07	4.18	4.36	4.63
NFE	51.86	50.82	51.22	50.35	54.60	54.17	49.37
ADF	27.40	29.52	27.77	28.04	29.62	28.76	30.01
NDF	46.59	48.20	48.96	44.76	50.01	49.28	49.04
Hemicellulose	10.56	11.08	13.06	12.76	11.88	9.96	10.17
ME (kcal/kg)	2605.38	2582.77	2616.76	2571.74	2708.39	2732.86	2574.36

CSC=Cotton Seeds Cake, LLS= Lime Soaked Seeds, WSS=Water Soaked Seeds, NDF= Neutral Detergent Fiber, ADF= Acid Detergent Fiber

However, the partial replacement with water soaked *Hibiscus sabdariffa* seeds were noted to increase significantly ( $P<0.05$ ) the feed intake, this could be attributed to the increase in the nutritional values as a result of decreased in antinutrients of the seeds similar to earlier report (22, 23 & 24). The partial replacement with raw *Hibiscus sabdariffa* seeds in the diets expressed the least significant ( $P<0.05$ ) feed intake which on the contrary may be due to low palatability of the diet

resulting from high level of antinutrients. The partial replacement with lime soaked *Hibiscus sabdariffa* seeds had no effect on feed intake when compared to the inclusion level of CSC only. Also, similar trends were observed for feed conversion ratio and cost per gain, except that the cost per gain for water and lime soaked *Hibiscus sabdariffa* seeds were statistically similar but significantly ( $P<0.05$ ) higher than the partial replacement with raw *Hibiscus sabdariffa* seeds and the inclusion level of CSC only.

**Table 5. Performance of Red Sokoto bucks fed raw and soaked *Hibiscus sabdariffa* seeds in rice offal based diets.**

Parameters	CSC	Raw	WSS	LSS	SEM
Initial weight(kg)	11.50	11.58	11.42	11.33	0.70 <sup>NS</sup>
Final weight(kg)	13.33	13.67	14.30	14.33	0.88 <sup>NS</sup>
TWG (kg)	1.83	2.08	2.88	3.00	0.67 <sup>NS</sup>
TFI (g/day)	939.80 <sup>b</sup>	891.00 <sup>c</sup>	1037.70 <sup>a</sup>	939.60 <sup>b</sup>	5.02*
ADFI (g/head/day)	313.27 <sup>b</sup>	296.99 <sup>c</sup>	345.90 <sup>a</sup>	313.27 <sup>b</sup>	3.83*
FCR (feed/gain)	10.83 <sup>b</sup>	17.56 <sup>c</sup>	6.71 <sup>a</sup>	10.65 <sup>b</sup>	1.63*
ADWI(lit/head/day)	0.56	0.58	0.47	0.58	0.17 <sup>NS</sup>
ADCFC (₦)	10.95	9.92	10.93	10.70	-
Feed cost ₦/kg gain	334.45 <sup>b</sup>	348.92 <sup>c</sup>	214.17 <sup>a</sup>	199.87 <sup>a</sup>	7.2*

<sup>abc</sup>—Means with different superscript along rows show significant difference ( $P<0.05$ ), SEM=Standard Error of Mean, FCR=Feed conversion ratio, ADFI=Average daily feed intake, ADWI=Average daily water intake, ADCFC=Average Daily Cost of Feed Consumed, CSC=Cotton Seeds Cake, LLS= Lime Soaked Seeds, WSS=Water Soaked Seeds, TWG= Total weight gain(kg), TFI= Total feed intake(g/day)

### Effect of Inclusion effect

The effect of two inclusion levels on performance of Red Sokoto bucks fed *Hibiscus sabdariffa* seeds in rice offal based diets as partial replacements for CSC is presented in table 6. There was no effect observed for weight gain and water intake with increase in the inclusion levels of *Hibiscus sabdariffa* seeds as partial replacement for CSC, but effect was noted in feed intake, feed conversion ratio and costs per gain with the 10% dietary inclusion of *Hibiscus*

*sabdariffa* seeds significantly ( $P<0.05$ ) higher for feed intake (967.40g/day) and lower for costs per gain (206.34N/kg) than animal on the other dietary treatments; though, statistically similar to the dietary inclusion of CSC only for feed utilization. This may be owing to the increased palatability of the diets resulting from better synergistic effect of the nutrients at 10% inclusion of *Hibiscus sabdariffa* seeds as partial replacement for CSC.(25) reported an increase feed intake with increasing

Roselle seed cake as replacement for groundnut cake in the diet of lamb but no significant effect on daily gain, feed conversion efficiency and final body weight while the incorporation of Roselle seed in the lamb diets up to 20%

has a satisfactory live weight gain and feed conversion efficiency(26) though, the current study showed a decrease in feed intake and utilization at 20% inclusion, this may be due to the difference in the composition of the diets.

**Table 6. Effect of inclusion levels on performance of Red Sokoto bucks fed *Hibiscus sabdariffa* seeds in rice offal based diets.**

Parameters	CSC	10%	20%	SEM
Initial weight(kg)	11.50	11.45	11.45	0.58 <sup>NS</sup>
Final weight(kg)	13.33	14.41	13.79	0.72 <sup>NS</sup>
Total weight gain(kg)	1.83	2.97	2.34	0.53 <sup>NS</sup>
Total feed intake (g/day)	939.80 <sup>b</sup>	967.40 <sup>a</sup>	944.77 <sup>b</sup>	6.32*
ADFI (g/head/day)	313.27 <sup>b</sup>	322.46 <sup>a</sup>	314.93 <sup>b</sup>	3.65*
FCR (feed/gain)	10.83 <sup>ab</sup>	9.72 <sup>a</sup>	13.59 <sup>b</sup>	1.35*
ADWI(lit/head/day)	0.56	0.55	0.50	0.13 <sup>NS</sup>
ADCFC (₦)	10.95	10.84	10.20	-
Feed cost ₦/kg gain	334.45 <sup>c</sup>	206.34 <sup>a</sup>	302.31 <sup>b</sup>	5.86*

<sup>abc</sup>=Means with different superscript along rows show significant difference (P<0.05), SEM=Standard Error of Mean, FCR=Feed conversion ratio, ADFI=Average daily feed intake, ADWI=Average daily water intake, ADCFC= Average Daily Cost of Feed Consumed , CSC=Cotton Seeds Cake.

**Interaction effects between processing methods and inclusion levels.**

Table 7 indicated the interaction between processing methods and inclusion levels of raw and soaked *Hibiscus sabdariffa* seeds in rice offal based diets on performance of red Sokoto bucks. There were significant (P<0.05) effects observed in all parameters except for water intake. The results showed that the dietary inclusion level of *Hibiscus sabdariffa* seeds at 10% was independent of whether or not soaked when compared to the dietary inclusion of CSC only for weight gain. While soaking had effect on increase dietary inclusion levels of *Hibiscus sabdariffa* seeds up to 20% as observed in this study, there was no observable

effect noted with 20% inclusion of raw *Hibiscus sabdariffa* seeds in comparison with the dietary inclusion of CSC only. However, the significantly (P<0.05) higher feed intake noted with 20% dietary inclusion of water soaked *Hibiscus sabdariffa* seeds as compared to other treatments as seen in this study could be attributed to the method of processing given rise to higher palatability of the diets which may not necessarily affect the utilization of the feed but rather caused a significant (P<0.05) decrease in the costs per weight gain. The lower weight gain observed with 20% dietary inclusion of raw *Hibiscus sabdariffa* seeds may be associated with low feed intake and poor nutrient utilization thereby resulting into higher cost of feeding the animals for a

similar weight like in soaked and CSC only to be produced. The higher feed cost per weight gain noted for 20%

dietary inclusion of lime soaked *Hibiscus sabdariffa* seeds as against 10% inclusion may strongly resulted from high processing costs of the seeds.

**Table 7. Interaction between processing methods and inclusion levels of raw and processed *Hibiscus sabdariffa* seeds in rice offal based diets on performance of Red Sokoto bucks.**

Parameters	CSC	Raw		WSS		LLS		SEM
		10%	20%	10%	20%	10%	20%	
Initial weight(kg)	11.50	11.50	11.67	11.67	11.17	11.17	11.50	0.56 <sup>NS</sup>
Final weight(kg)	13.33 <sup>ab</sup>	14.67 <sup>a</sup>	12.67 <sup>b</sup>	14.24 <sup>a</sup>	14.37 <sup>a</sup>	14.33 <sup>a</sup>	14.33 <sup>a</sup>	0.68*
TWG(kg)	1.83 <sup>b</sup>	3.17 <sup>a</sup>	1.00 <sup>b</sup>	2.57 <sup>ab</sup>	3.20 <sup>a</sup>	3.17 <sup>a</sup>	2.83 <sup>a</sup>	0.49*
TFI(g/day)	939.80 <sup>d</sup>	956.60 <sup>c</sup>	825.40 <sup>f</sup>	975.40 <sup>b</sup>	1100.00 <sup>a</sup>	970.20 <sup>b</sup>	908.90 <sup>c</sup>	5.15*
ADFI(g/head/day)	313.27 <sup>c</sup>	318.85 <sup>c</sup>	275.13 <sup>c</sup>	325.13 <sup>b</sup>	366.67 <sup>a</sup>	323.39 <sup>b</sup>	302.98 <sup>d</sup>	2.97*
FCR ( feed/gain)	10.83 <sup>b</sup>	13.49 <sup>c</sup>	21.62 <sup>d</sup>	7.08 <sup>a</sup>	6.42 <sup>a</sup>	8.58 <sup>ab</sup>	12.72 <sup>bc</sup>	1.22*
ADWI(lit/head/day)	0.56	0.61	0.55	0.47	0.48	0.56	0.48	0.14 <sup>NS</sup>
ADCFC (₦)	10.95	10.81	9.05	10.66	11.21	11.06	10.33	-
Feed cost ₦/kg gain	334.45 <sup>d</sup>	191.16 <sup>a</sup>	506.72 <sup>e</sup>	232.29 <sup>c</sup>	196.06 <sup>a</sup>	195.58 <sup>a</sup>	204.15 <sup>b</sup>	2.51*

<sup>abcd</sup>—Means with different superscript along rows show significant difference (P<0.05), SEM=Standard Error of Mean, ADWG=Average daily weight gain, FCR=Feed conversion ratio, ADFI=Average daily feed intake, ADWI=Average daily water intake, ADCFC=Average Daily Feed Cost Consumed, CSC=Cotton Seeds Cake, LLS= Lime Soaked Seeds, WSS=Water Soaked Seeds. TWG= Total weight gain(kg), TFI= Total feed intake(g/day)

### Conclusion and Application

From the result of this study, it can be concluded that:

1. Dietary inclusion of *Hibiscus sabdariffa* seeds at 10% in rice offal based diet gives a satisfactory live weight performance and feed utilization in growing red Sokoto bucks at low cost.
2. Water soaked *Hibiscus sabdariffa* seeds at 20% inclusion in rice offal based diets in growing small ruminants is recommended.

### References

1. FDLPCS, (1992). Federal Department of Livestock and Pest Control Services. (FDLPCS) Nigeria Livestock Resources. National Synthesis, II: Pp.440.
2. Ajala, M.K., Lamidi, O.S. and Otaru, S. M. (2008). Peri-Urban Small Ruminant Production in Northern Guinea Savanna, Nigeria. *Asian Journal of Animal and Veterinary Advances*, 3(3): 138-146.
3. Oni, O. O. (2002). Breeds and genetic improvement of small ruminants. In: Lakpini, C. A. M., Adamu, A. M., Ehoche, O. W. and Gefu, J. O. (Eds). Small Ruminant Production Training Workshop Held at the National Animal Production Research Institute, Ahmadu Bello University, Shika-Zaria, Nigeria. Pp: 1-7.
4. Poppi, D. P. and McLennan, S. R. (1995). Protein and Energy Utilization by Ruminants at Pasture. *Journal of Animal Science*, 73: 278-290.
5. Bawa, G. S., Tegbe, T.S.B., Ogundipe, S. O., Dafwang, I.I. and Abu, E.A. (2003). The effect of duration of cooking lablab seeds on the level of some anti-nutritional factors. In: Ogundipe, S. O., Dafwang, I. I., Abu, E. A. and Bawa, G. S. (Eds) *28<sup>th</sup> Proceedings of the Annual*



- conference of the Nigeria Society for Animal Production (NSAP) Held in Ibadan, 16-20<sup>th</sup> March 2003. Pp 213-215.
6. Sodeinde, F. G., Asaolu, V., Oladipo, M. A., Akinlade, J. A., Ige, A. O., Amao, S. R. and Alalade, J. A. (2007). Mineral and antinutritional contents of some forage legumes consumed by small ruminants in the derived savanna of Nigeria. *Research Journal of Agronomy*, 1(1): 30 - 32.
  7. Okoli, I.C., Ebere, C.S., Uchegbu M.C., Uddah C.A. and Ibeawuchi, I.I. (2002). Survey of the diversity of plant utilized for small ruminant feeding in south eastern Nigeria. *Agriculture Ecosystem and Environment*, 45(6): 25-29.
  8. Adanlawo, I.G. and Ajibade, V.A. (2006). Nutritive values of two varieties of *Hibiscuss sabdariffa* Seeds calyxes soaked in wood ash. *Pakistan Journal of Nutrition*, 5(6): 555-557.
  9. Tindall, H. D. (1986). *Vegetable in the Tropics*. Macmillan Education Ltd., Houndmills, Basingstoke, Pp: 256.
  10. Fibatunde, F.E. (2003). Intercrop productivity of *Hibiscuss sabdariffa* in Nigeria. *African Crop Science Journal*, 11: 43-47.
  11. Akanya, H.O., Oyeleke, S. B., Jigm, A. A. and Lawal, F. F. (1997). Analysis of sorrel drink Zoborodo. *Nigeria Journal of Biochemistry*, 12: 77-81.
  12. Al-wandawi, H., Aisackly, K. and Abdulrahman, M. (1984). *Hibiscuss sabdariffa* seeds: A new protein source. *Journal of Agriculture and Food Chemistry*, 32: 510-512.
  13. Abdu, S.B., Adegoke, T.F., Abdulrashid, M., Duru, S., Yashim, S. M. and Jokthan G.E. (2008). Effect of cooking duration on chemical composition of Roselle (*Hibiscus sabdariffa*) seed. In: Bawa, G.S., Akpa, G.N., Jokthan, G.E., Kabir, M. and Abdu, S.B. (Eds) *Proc. of the 13<sup>th</sup> Annual Conference of Animal Science Association of Nigerian (ASAN)*, at A.B.U. Zaria 15<sup>th</sup> September 2008. Pp 521-523.
  14. Abu-Tarboursh, H. M. and Basher Ahmed, S. A. (1996). *Studies on Karkade (Hibiscus subdariffa) Protease inhibitors, Phytate, in vitro protein digestibility and gossypol content*. *Journal of Food Chemistry*, 56: 15-19.
  15. Ovimaps, (2014). Ovi location map; Ovi earth imagery date; July 15th, 2014.
  16. AOAC. (2005). Official methods of Analysis, 15<sup>th</sup> ed. Association of Official Analytical Chemistry, Washington, D. C.
  17. Van Soest, J.P. (1991). The use of detergents in the analysis of fibrous feeds. Determination of plant constituents. *Journal of Association of Agricultural Chemistry*, 50: 50-55.
  18. Oke, L. O. (1966). Composition of some Nigeria leafy vegetables. *Journal of Animal Dietetic Association*, 53: 130-132.

19. Pauzenga, U. (1985). Feeding parent stock. *Zootecnica International*, Pp 22–24.
20. SAS (2002). SAS/START. User's guide. 6.03 Edition. Inc. Cary, NC.U.S.A.
21. Duncan, D.B. (1955). Multiple range and Multiple F-tests. *Biometrics*, 11: 1-42.
22. Bishnoi, S., Khetarpaul, N. and Yadav, R. K. (1994). Effect of domestic processing and cooking methods on phytic acid and polyphenol contents of pea cultivars (*Pisum sativum*). *Plant Food for Human Nutrition*, 47: 381-388.
23. Vijayakumari, K., Siddhuraju, P. and Janardhanan, K. (1996). Effect of soaking, cooking and autoclaving on phytic acid and oligosaccharide contents of the tribal pulse (*Mucuna mansperma*). *DC. Ex. Wight. Food Chemistry*. 55(2): 173-177.
24. Vijayakumari, K., Siddhuraju, P. and Janardhanan, K. (1998). Effect of soaking and heat processing on the level of anti-nutrients and digestible protein in seeds of *Vigna aconitifolia* and *Vignasinensis*. *Food Chemistry*. 63(2): 259-264.
25. Beshir, A. A. and Babiker S. A. (2009). Performance of Sudanese Desert Lambs Fed Graded Levels of *Hibiscus sabdariffa* (Hibiscus subdariffa) Seeds Instead of Groundnut Cake. *Pakistan Journal of Nutrition*, 8(9): 1442-1445.
26. Beshir, A. A. (1996). Use of roselle (*Hibiscus sabdariffa*) seed in lamb feeding. M.Sc. Thesis, Faculty of Animal Production, University of Khartoum