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Performance, Mineral intake and Nutrient Digestibilty of Uda Rams fed Different form of Kanwa Based Mineral Lick

Abdulkarim, A[1]., Aljameel, K. M*[2]., Maigandi, S. A[2], Na-Allah, Y[2] and Ibrahim, S[1]

[1]*Department of Animal Science, Federal University Dutse, Nigeria*
[2]*Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria*

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Corresponding Author: **Aljameel, K. M** | E-Mail: **(muhdkjameel@gmail.com)**

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ABSTRACT

At the Teaching and Research Farm of Usmanu Danfodiyo University, Sokoto, a study was conducted to evaluate the mineral intake and performance of Uda rams offered different kanwa-based mineral licks. Twenty (20) apparently healthy yearling Uda rams were used for the experiment, with age determined by dentition. Each animal served as a replicate, and the rams were randomly allocated to five treatments, with four (4) rams per treatment. The treatments consisted of Kanwan Bai-Bai, Kanwan Kolo, Hogga, Balma, and a traditional mineral lick. Data on performance, mineral intake, and nutrient digestibility were subjected to analysis of variance (ANOVA). The study assessed growth performance, mineral consumption, and nutrient utilization of Uda rams fed the different kanwa-based mineral licks. Results showed that rams in Treatment 2 (Kanwan Kolo) recorded significantly ($P < 0.05$) higher values for all production parameters measured compared to the other treatments. Nutrient digestibility was also higher in animals fed Kanwan Kolo than those in Treatments 1, 3, and 4. The results showed animals in T2 to have higher digestibility values in all parameters; there was no difference between T2 and T3 with regards to Crude Protein, Crude Fibre and fibre fractions digestibility; the result also shows no difference between T1 and T2 in terms of ash, Acid Detergent Fibre and cellulose digestibility. The study conclude that Kanwan-kolo offered the better result in terms of some productive parameters such as weight gain, average daily gain, digestibility and final weight of the animals.

Keywords: *Performance, Mineral Intake, Kanwa, Uda rams, Nutrient Digestibility.*

INTRODUCTION

The low ruminant animal's productivity is due to many limitations, the most apparent being the inadequate and poor-quality feed (lacking in protein, energy, minerals) which consequently result in poor growth and low reproductive performance [1;2]. Ruminant animals obtain most of their mineral requirements from the feeds and forages they consume; therefore, mineral intake is largely influenced by factors that affect the availability of minerals in plants [3]. Plant mineral composition is determined by several factors, including plant species and stage of growth, as well as climatic conditions such as soil type, rainfall, soil fertility, and seasonal variations. The relative importance of these factors varies depending on the specific mineral element involved and their interactions with crop and pasture management practices. Such practices include fertilizer application, soil amendments, irrigation, crop rotation, intercropping, and the type of cultivars used [3].

In order to satisfy their demand and need for mineral elements, major signs that indicate a mineral-deficient ruminant animal is by licking the walls, licking fellow animals, eating rags and food packaging materials including polythene bags. This abnormal behaviour necessitates supplementation and addition of external sources of minerals.

Common sources of mineral supplements include limestone for calcium, dicalcium phosphate for phosphorus, common salt for sodium, calcined magnesite for magnesium, and sodium selenite for selenium, among others. In the Sudan and Sahel vegetation zones of Nigeria, trona locally known as *kanwa* (Hausa), *kaun* (Yoruba), and *kaun* (Igbo) is the most commonly used mineral supplement. It is often erroneously referred to as "potash," despite containing relatively low levels of potassium compared to sodium [4]. *Kanwa* is a dry lake salt which is largely hydrated Sodium carbonate (Na_2CO_2 $NaHCO_3.2H_2O$) [6;7], which occurs as a common deposit of saline lakes. *Kanwa* deposits are usually covered by shallow water of less than two feet deep [8]. Various types of *Kanwa* have been extensively used by Cattle and Sheep farmers, which include *Hogga, Balma, Kanwan Baibai, Kanwan Kolo, Jar Kanwa, Gallu, Kurhua, Budus* etc. This study investigated the different types of *Kanwa* as sources of mineral supplements in sheep nutrition through evaluation of their utilisation of some common types by livestock farmers, chemical composition, including the mineralogical contents and their effects on sheep production.

Studies have been conducted on *Kanwa*[8;9;10] but most of the studies reviewed were restricted to only one type of *Kanwa (Ungurnu)*, and were largely carried out on humans. Different types of *Kanwa* (hydrated sodium carbonate) have been extensively used by sheep herders to serve different purposes. They offer them either as free access or incorporated in the diet of animal under the traditional husbandry system in Northern Nigeria. However, there has been no sufficient scientific investigation about the status of utilization of *Kanwa* by animal farmers and the mineralogical and chemical contents of the various types of *Kanwa*. The extensive studies conducted on the *Ungurnu* type of *Kanwa* were restricted to humans, thus the need to evaluate *Kanwa* utilization in sheep production.

MATERIALS AND METHODS

Description of the Experimental Site

The study was carried out in the Department of Animal Science's Livestock Teaching and Research Farm at Usmanu Danfodiyo University in Sokoto, Nigeria (13°00′ N; 5°15′ E). Sokoto is situated around 350 meters above sea level in the Sudan Savannah ecological zone. The region has a tropical climate with distinct dry (October to April/May) and wet (May/June to September/October) seasons. Rainfall averages between 500 and 700 mm per year. While ambient temperatures range from 14°C to 41°C, with a mean yearly temperature of roughly 29°C, relative humidity fluctuates from 51–79% during the rainy season and 10–25% during the dry season.

Kanwa-based Mineral block Formulations

Table 1 shows the composition of the Kanwa-based mineral lick, the varieties of kanwa and other ingredients were sourced from Kara Market Sokoto.

Table 1: Formulation of the Kanwa-based mineral lick

Ingredient (%)	1	Treatments 2	3	4	5
*Kanwa*n bai bai	75	-	-	-	-
*Kanwa*n kolo	-	75	-	-	-
Balma	-	-	75	-	-
Hogga	-	-	-	75	-
Gum Arabic	10	10	10	10	-
Locust bean powder	15	15	15	15	-
Total	100	100	100	100	-

Note: *Treatment 5 (control) represent Conventional mineral lick.*

Composition of a Conventional Mineral Lick

Contents Quantity (mg)
Manganese oxide 145
Cobalt 15
Zinc 230
Copper 162
Iron 800
Selenium 5
Iodine 10

Analytic constituents Percentage (%)

Sodium as Sodium chloride 37.6
Magnesium as Magnesium oxide 0.32
Ash 85

Source: HEBEI NEW CENTURY PHARMACEUTICAL CO. LTD

Formation of *Kanwa*-based mineral lick blocks

The kanwa mineral lick blocks were molded using a rubber pan (mudu). Five hundred grams (500 g) of gum Arabic were dissolved in two liters of water and thoroughly mixed with the other ingredients (Table 1). The resulting mixture was homogenized, poured into wooden molds lined with polythene sheets, and allowed to air-dry at room temperature until solid blocks were formed.

Plate 1. Formulated Kanwa blocks

Experimental Animals and Their Management

The experiment employed twenty (20) yearling Uda rams that were aged by dentition and appeared to be in good health. The animals were placed in a two-week quarantine, dewormed with Banmith II (12.5 mg/kg body weight), and given ivermectin (1 mL/10 kg body weight) to treat endoparasites and ectoparasites. A prophylactic dose of oxytetracycline HCl (2 mL/10 kg body weight) was given. The rams were closely monitored and acclimated to cowpea hay and wheat offal for two weeks prior to the trial. The animals were administered a basic meal consisting of 12% crude protein, 19.4% crude fiber, and 2180 kcal/kg metabolizable energy after being weight-balanced and assigned to treatments (Table II). Experimental mineral blocks were provided during the 12-week feeding phase.

Table 2: Gross composition of the experimental basal diet

Ingredient	Composition (%)
Maize	14.00
Soybean meal	15.00
Cowpea husk	30.00
Wheat offal	25.00
Rice Milling Waste	15.00
Salt	1.00
Total	100

Energy: *2181kcal/kg; Crude protein 12%; Crude fibre 19.4%*

Treatments and Experimental Design

The experimental animals were assigned to treatments using a completely randomized design. Treatments 1, 2, 3, and 4 were represented by Kanwan-Baibai-mixed Lick (KBM), Kanwan-Kolo-mixed Lick (KKBM), Balma-mixed Lick (BMK), and Hogga-mixed Lick (HMK), respectively; treatment 5 (control) was Conventional Mineral Lick (CML).

Mineral Lick Intake

The mineral blocks were weighed weekly and mineral lick intake was determined by taking the difference in weight between the present and the previous week.

Feed Intake

Feed intake for each treatment was measured on daily basis by subtracting the left over from the quantity

offered to the animals. Adequate measures were put in place to safeguard against feed wastage.

Live Weight

All rams were weighed individually on weekly basis using a weighing scale (100kg clock-type).

Data Analysis

Analysis of variance was used on the collected data [11]. The means were separated using the least significant difference (LSD).

RESULTS

Performance of Growing *Uda* Rams Offered Different *Kanwa* Blocks

Table 3 showed the performance of Uda rams given various Kanwa-based mineral blocks. The findings indicated that every parameter tested, with the exception of beginning weight and feed conversion ratio (FCR), had a significant (P<0.05) difference. Across all treatments, the average daily Kanwa-block lick and consumption were comparable (P ≥0.05). All measured parameters were significantly (P<0.05) greater in animals on T2; weight gain and average daily gain (ADG) did not differ between animals in T1 and T2. Additionally, in terms of final weight, between T1, T2, and T3.

Mineral Intake (mg/kg Bw/day) of Growing *Uda* Rams Fed Different *Kanwa* Blocks

The result of the mineral intake of different formulated *Kanwa*-based blocks by *Uda* rams was presented in table 4. The result showed significant difference in the minerals intake. Rams fed T2 had higher Sodium intake compared to other treatments. Rams fed T3 consume higher sodium than those fed T1, T4, and T5. Rams in T1 and T5 consumed same amount of Sodium and Iron. Rams in T2 had higher Na, K, P, Mg, Ca, Zn, Mn and Cu compared to T1, T3, T4 and T5. Rams offered T4 and T5 had similar K, P, Mg, and Zn intake. K, P, Zn and Mn intake were similar for rams fed T1 and T3. There was no significant difference between T2, T3 and T5 in terms of Cu intake.

Table 3: Performance of Uda Rams fed Different Kanwa Blocks

Parameter	Treatments 1 2 3 4 5					SEM
Average daily dry matter Intake (kg)	0.97^{ab}	1.2^{a}	0.93^{b}	0.8^{b}	1.0^{ab}	0.07
Initial body weight (kg)	18.33	18.33	18.4	18.33	18.33	1.37
Final body weight (kg)	26.2^{ab}	28.0^{a}	25.17^{ab}	24.83^{b}	24.67^{b}	0.81
Weight gain (kg)	7.87^{ab}	9.67^{a}	6.76^{b}	6.5^{b}	6.33^{b}	0.69
Average daily weight gain (g/day)	94^{ab}	115^{a}	81^{b}	77^{b}	75^{b}	0.82
Feed conversion ratio	10.56	10.86	11.57	10.49	13.2	1.06
Kanwa block licked (kg)	0.83	1.53	1.02	0.	0.6	0.39
Average daily *Kanwa* block licked (g/day)	9.88	18.21	12.14	5.95	7.14	4.74

a,b,c means in the same row with different superscripts are significant (P<0.05) different. 1= Kanwan Bai Bai block, 2= Kanwan Kolo block, 3= Balma block, 4= Hogga block, 5 = Conventional Lick.

Digestibility of *Uda* Rams fed Different *Kanwa*-based Mineral Blocks

Table 5 showed the digestibility results of Uda rams fed various Kanwa-based mineral blocks. With the exception of Ether Extract digestibility, all evaluated metrics exhibited a significant (P<0.05) difference.

Animals in treatment 2 had greater dry matter digestibility (P<0.05) than those in treatments 1, 3, and 4. The findings demonstrate that all parameters (Dry Matter, Ash, Crude Protein, Ether Extract, Crude Fiber, Acid Detergent Fiber, Nutrient Detergent Fiber, Hemicellulose, Cellulose, Lignin) had greater (P<0.05) digestibility values in animals in treatment 2. There is no difference (P>0.05) between treatment 2 and 3 with regards to CP, CF and *fibre* fractions digestibility. The result showed no significant difference (P>0.05) between treatment 1 and 2 in terms of Ash, ADF and Cellulose digestibility. Animals in treatment 5 have lower digestibility values of CP and NDF. There was no significance (P>0.05) difference between animals placed in treatment 1, 4 and 5 in terms of CP and NDF digestibility.

Table 4 Mineral Intake mg/kg Bw/day of Growing Uda Rams fed Different Kanwa Blocks

Treatments	Na	K	P	Mg	Ca	Cu	Zinc	Mn	Fe
1	163.55^{c}	130.91^{b}	0.50^{b}	19.69^{c}	190.82^{b}	0.06^{a}	0.07^{b}	0.09^{b}	17.49^{c}
2	395.52^{a}	297.91^{a}	0.70^{a}	36.07^{a}	387.3^{a}	0.026^{b}	0.12^{a}	0.25^{a}	26.98^{a}
3	248.38^{b}	123.95^{b}	0.51^{b}	26.14^{b}	176.3^{c}	0.020^{b}	0.08^{b}	0.10^{b}	20.72^{b}
4	151.73^{d}	101.75^{c}	0.33^{bc}	11.92^{d}	69.62^{e}	0.012^{c}	0.02^{c}	0.50^{b}	11.70^{d}
5	161.79^{c}	108.96^{c}	0.29^{c}	14.30^{d}	132.68^{d}	0.024^{b}	0.02^{c}	0.60^{b}	11.99^{c}
RV	90-180	50-80	160-380	120-180	200-820	7-10	20-33	20-40	30-50
SEM	1.41	3.95	0.04	1.03	3.67	0.004	0.004	0.09	0.41

1= Kanwan Bai Bai block, 2= Kanwan Kolo block, 3= Balma block, 4= Hogga block, 5 = Conventional Lick.

Table 5 Digestibility of Uda Rams fed Different Kanwa-based Mineral Blocks (%).

Parameter (%)	T1	T2	T3	T4	T5	SEM
DM	70.71^{c}	76.73^{a}	71.39^{c}	69.69^{c}	73.91^{b}	0.73
ASH	84.07^{ab}	85.47^{a}	80.93^{b}	82.02^{ab}	83.49^{ab}	1.07
CP	80.26^{bc}	83.19^{a}	80.7^{ab}	79.62^{bc}	77.65^{c}	0.81
EE	98.47	97.69	97.64	97.43	96.64	0.54
CF	52.67^{b}	59.54^{a}	60.11^{a}	55.79^{b}	61.13^{a}	1.15
ADF	57.94^{ab}	59.25^{ab}	60.94^{a}	57.47^{b}	58.05^{ab}	1.05
NDF	60.73^{c}	73.55^{a}	69.68^{ab}	60.14^{c}	65.06^{bc}	1.87
HEMCEL	73.07	75.87	75.29	69.92	73.52	2.60
CELL	57.68^{ab}	60.83^{ab}	61.07^{ab}	55.16^{b}	63.11^{a}	1.5
LIGNIN	50.87^{b}	53.82^{a}	53.01^{a}	50.06^{b}	52.61^{ab}	0.58

a,b,c means in the same row with different superscripts are significantly (P<0.05) different. 1= Kanwan bai bai block, 2= Kanwan Kolo block, 3= Balma block, 4= Hogga block, 5 = Conventional Lick. DM= Dry Matter, CP= Crude Protein, EE= Ether Extract, CF= Crude Fibre, ADF= Acid Detergent Fibre, NDF= Nutrient Detergent Fibre, HELL= Hemicellulose.

DISCUSSION

Performance of *Uda* Rams fed Different *Kanwa*-based Mineral Blocks

The result shows that *Kanwa* can be used to replace the conventional mineral block that is mostly offered to livestock animals. Findings of this study has shown that rams offered *Kanwan Kolo* (also known as *Kanwan shanu*) performed better than those given the conventional mineral li ck and other *Kanwa*-based formulations in terms of final weight, weight gain and average daily gain; this might have been influenced by the high consumption of the *Kanwa* as indicated in the result of this trial. Also, it might be as a result of high Sodium concentration in the serum of the experimental animals compared to other treatments. The study shows that *Kanwa* can influence feed intake and other performance parameters, this is in contrast with the findings of Igboke and Jibike [12] who reported that *Kanwa* supplementation depress weight gain and produce clinical sign such as transient self-limiting diarrhoea, nasal discharge, increase in thirst and frequent urination. This might be due to the type of *Kanwa* used as there are different types of *Kanwa* with different composition. The result showed little variation with regards to feed intake, such trend was also reported by Muhammad *et al.* [13] when Sheep were supplemented with Sodium chloride. The result shows no variation in feed conversion ratio (FCR) between the different types of *Kanwa*-based mineral blocks and the conventional mineral block fed. The result also showed that the range of 11.9 – 39.43g/day of *Kanwa* and mineral block lick intake which is above the NRC [14]. According to Sansoucy et al. [15], block hardness and palatability have an impact on block intake, which varies by animal type and is lower for harder blocks. The current results are in line with those of Salman [16], who documented live weight increases of 100–150 g/day in sheep fed a basic diet of rice straw supplemented with multi-nutrient blocks in Iraq. Similarly, Baribari goats fed complete feed blocks based on rice straw showed live weight increases of 110–150 g/day., according to Samanta et al. [17]. However, sheep fed untreated rice straw supplemented with different amounts of multi-nutrient blocks have been shown to have lower development rates [18;19;20] according to other authors [20;21,22;23].

Mineral Intake (mg/Kg Bw/day) by Growing *Uda* Rams fed different *Kanwa*-based Mineral Blocks

The mineral intake which is affected by Dry Matter Intake (DMI) of the animals shows that Sodium intake was slightly below the range of 900 -1800mg/Kg requirements of Sheep [14] except for T5. Potassium content across all treatments ranged from 500 to 800 mg/kg, indicating levels within permissible limits.

Iron concentrations exceeded the recommended requirement of 30–50 mg/kg but remained well below the maximum tolerable level of 500 mg/kg for sheep [24]. Intakes of copper, magnesium, zinc, and manganese were low in all treatments. Overall, the results indicate a positive effect of kanwa blocks on animal performance, which may be more pronounced under low planes of nutrition, particularly in animals fed crop residues or cereal straw-based diets. This is in conformity with Jian *et al.* [25] who found that multi-nutrient blocks can be used to improve the productive performance of animals with access to roughages of low nutritive value.

Digestibility of Growing *Uda* Rams fed Different *Kanwa*-based Mineral Blocks

The dry matter digestibility ranged from 69.69% for the *Hogga* mineral block to 76.73% for *Kanwan Kolo* mineral block. It is well known that mineral blocks produce an effective rumen ecology that is conducive to the digestion of fiber [20]. Similar dry matter digestibility values were observed by Ojo et al. [26] when multi-nutrient blocks were added to sheep. The current study's DM digestibility values fell within the range of values reported by Maigandi and Abubakar [27]. The study's Crude Protein (CP) digestibility levels (82.64–88.86%) are similar to those published by Maigandi and Abubakar [27]. Feed digestibility was divided into three categories by the FAO (2017): high (>60), medium (40–60), and low (<40). As a result, all of the nutrients in the current study had high digestibility. The digestive coefficient in respect of all the nutrients was high. The result from this study shows that *Kanwa* blocks stimulates CP digestibility (79.62 – 83.19%) better than conventional mineral lick (77.65%). The supplementation of *Kanwan Kolo* blocks result in improved CP and DM digestibility compared to the other treatments which might be the reason for higher body weight gain compared to the other treatments.

CONCLUSION

Of the four types of *Kanwa* researched in this study, *Kanwan-kolo* offered the better result in terms of some productive parameters such as weight gain, average daily gain, digestibility and final weight of the animals.

REFERENCES

1. Oswaldo, R. R. (1983). *Nutritional Factors Affecting Mineral Status and Long-term Carry-over Effects in Ruminants*. Ph.D. Thesis, Department of Animal Science, University of Florida.
2. Adegbola, T. A. (2004). Utilizaing Proven Alternative Feed Ingredients in Livestock Industry. In: Tukur, H. M., Hassan, W. A., Maigandi, S. A., Ipinjolu, J. K., Daneji A. I., Baba, K. M. and Olorede, B. R. (eds.): Sustainable Livestock Production Under Changing Economic Fortunes. Proceedings of the 29th NSAP Conference, held at Usmanu Danfodiyo University, Sokoto, Nigeria. March 21st – 25th, 2004. Pp 370 – 373.
3. Marai, I. F. M., Bahgat, L. B., Shalaby, T. H., and Abdel-Hafez, M. A. (2000). Fattening performance, some behavioral traits and physiological reactions of male lambs fed concentrates mixture alone with or without natural clay under hot summer of Egypt. *Annual Arid Zones*, 39, 449–460.
4. FAO (2017). FAO Statistics database (FAOSTAT): Agricultural Production and Production Indices Data (Nigeria). Food and Agriculture Organization of the United Nations (FAO). Accessed at; http://apps.fao.org/ag/htm. Retrieved; October 18, 2017.
5. Makanjoula A.A. and Beetlestone J.G. (1975). Some Chemical and Mineralogical notes on 'Kaun'. *Journal of Mineral and Geology*. 10: 1- 2.

6. Ekanem, E.J. (1997). Preliminary analysis of samples of "*Kanwa*" for Sodium, Potassium and other materials. Unpublished MSc. Thesis. Department of Chemistry, Ahmadu Bello University, Zaria.\
7. Davidson,N. M, Trevitt, L. and Parry, E. H. (1974). Peripartum Cardiac Failure: an Explanation for the Observed Geographic Distribution in Nigeria.Bulletin of the World Health Organization, 51(2):203 – 208.
8. Oyeleke, O.A and Morton I.A. (1981). Improvement of lysine availability from cowpeas cooked with '*Kanwa*'. *Nigerian Journal of Nutrition and Science*. (1): 2- 123.
9. Muhammad, A.S., Saidu, Y., Bilbis, L.S., Onu, A., Isezuo, S. A. and Sahabi, S. (2014). Effect of Dried Lake Salt (*Kanwa*) on Lipid profile and Heart Histology of Female Albino Rats. *Nigerian Journal of Basic and Applied Science*, 22(3and4): 73-78.
10. Imafidon, K.E., Egberanmwen, I.D. and Omoregie, I.P. (2016). Toxicological and biochemical investigations in rats administered "kaun" (*Trona*) a natural food additive used in Nigeria. *Journal of Nutrition* and *Intermediary Metabolism,* 6, 22—25.
11. LatLong.net. (2018). Sokoto, Nigeria Map. Website: retrieved on 11th February 2018. https://www.latlong.net/place/sokoto-nigeria-21027.html
12. Igbokwe. I. O. and Jibike, G. I. (1989). Clinical effects of "Mangul" feeding in Sheep. *Annals of Borno*. 6(7): 268-272
13. Muhammad, A., Umar, A., Jude, N. E., Elisha, Z. J. and Isa, G. M. (2016). Performance of young Sheep fed maize bran and groundnut hay supplemented with Sodium chloride. *International letters of Natural Sciences*. 60: 52-58
14. National Research Council.(2005). Mineral tolerance of animals, Second revised edition. National Research Council of the National Academies The National Academies Press, Washington, D.C., U.S.A.
15. Sansoucy, R., Aart G. and Leng, R.A. (1986): Molasses urea blocks as a multi-nutrient. *World animal review*, 57: 39 – 48.
16. Salman, A. D. (2007). The Role of Multinutrient Blocks ForSheep Production in an Integrated Cereal-livestock. Farming System in Iraq. IPA Agricultural Research Centre. Baghdad, Iraq.
17. Samanta, A. K., Singh, K. K., Das, M. M., Maity, S.B. and Kundu, S. S. (2003). *Small Ruminant Research*, 48 :95-102
18. Leng, R.,Preston, T.R, Sansoucy, R. and George Kunju, P. (1991). *World Animal Review*,67:11-19.
19. Ma, W. H., Hans, S. J., Wang, D. C., Wang, L H., Liu, C. and Chen L.X. (1995). *Chinese Feed* 15:23.
20. Leng, R. A. (1983). The Potential of Solidified Molasses-based Block For The Correction Of Multi-Nutritional Deficiencies In Buffaloes And Other Ruminants Fed Low-Quality Agro-Industrial By-Products In: *The Use OfNuclear Techniques To Improve Domestic Buffalo Production Of Asia*, IAEA, Vienna, Austria.Pp 135-150.
21. Ibrahim, M.N. and Schiere, J. B (1985). Rice Straw and Related Feeds in Ruminant Rations. *Proceedings of International Workshop* Held 24-28 March 1985 In Kandy, Sri, Lanka. Wageningen Agricultural University. TheNetherlands, Pp 37-50.
22. Wanapat, M. (1995). Improving Rice Straw Quality as Ruminant Feed by Urea Treatment in Thailand. In: *Relevance of Crop Residues as Animal Feeds in Developing Countries* (Editors, M. Wanapat and K. Sommart) Khon Kaen University, Thailand.
23. Wanapat, M., (1999). Methods for Improving the Nutritive Values of Fibrous feeds and Utilization of Agricultural Crop Residues for Ruminants. In: *Feeding of Ruminants in the Tropics Based on Local Feed Resources* (Editor M Wanapat). Khon Kaen Publishing Company Limited, Khon Kaen, Thailand.
24. Merchen, N. R. (1995). Digestion absorption and excretion in ruminants. In D. C. Church (Ed.), *The Ruminant Animal Digestive Physiology and Nutrition,* (p. 172). Prentice Hall, Englewood Cliffs, New Jersey.
25. Jian, X ., Yao, M. W., Xu, M. D., Jun, Y., Ying, Y. Z. and Yu, J. V.C. (1995). *Livestock Research for Rural Development* 7(2): 32-36.
26. Ojo, A., Kibon, A., Abbator, F. I., and Mohammed, I. D. (2001). Effects of Browse and Cottonseed Cake Supplementation on Intake and Digestibility of Sorghum by Goats. *Proceedings of the 6th Annual Conference of Animal Science Association of Nigeria,* Sept. 17 19, 2001. University of Maiduguri.Pp21-30.
27. Maigandi, S. A. and Abubakar, S. (2004). Nutrient Intake and Digestibility By Sokoto Red Goats Fed Varying Levels of Faidherbia Albida Pods. In *Proc. of the 29th Annual Conference of the Nigerian Society for Animal Production.* (pp. 325–328.).