

## DEVELOPMENT OF TOTAL MIXED RATIONS FOR RUMINANTS AND THEIR RUMEN DEGRADATION CHARACTERISTICS IN A SEMI ARID ENVIRONMENT OF NIGERIA

G. Fabian<sup>1</sup>, I. H. Malgwi<sup>1\*</sup>, H.D Nyako<sup>2</sup>, M.M.Yahaya<sup>2</sup>, and I.D. Mohammed<sup>1</sup>

<sup>1</sup>Department of Animal Science, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria.

<sup>2</sup>Department of Animal Science and Range Management, Modibbo Adama University of Technology, P.M.B 2076, Yola. Nigeria.

Corresponding author:- zeekofficial@yahoo.com

This experiment was carried out at the University of Maiduguri Livestock Teaching and Research farm. Six different rations were formulated (F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> and F<sub>6</sub>) using locally available feed ingredients (maize bran, wheat bran, cowpea husk as energy sources; cotton seed cake, poultry litter, acacia dried pods, groundnut haulms, urea fertilizer as protein sources, while salt and bone meal, served as sources of mineral. The formulated diets were subjected to rumen degradability study for the following hours: 6, 12, 18, 24, 36, 48 and 72. The results of proximate analysis of formulations showed that the dry matter content recorded varied from 94.7% to 91.2%. The corresponding crude protein content ranged from 12.43% to 6.56% and crude fibre varied from 27.5% to 21.0% for formulations F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub>, and F<sub>6</sub> respectively for formulations F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub>, and F<sub>6</sub> respectively. The rumen degradation of the formulations (F<sub>1</sub> to F<sub>6</sub>) showed that they are significantly different (P<0.05) from each other with more than 50% of the formulated diets degraded at 48 hours. Thus, utilizing crop residues in appropriate proportions can meet the requirements of ruminant at a very minimum production cost with increase in their performance.

**Key word:** Formulation, Mixed Ration, Rumen Degradation, Semi-arid

Inadequate nutrition is a major factor limiting ruminant productivity in the semi arid zones of West Africa due to shortage of feed resources which can meet their nutrient requirements. Competition between man and

his animals on the consumption of feed grain is another factor (McDonald et al., 1995). In the semi arid region where there is low and short duration of rainfall, the quantity and quality of grazing fall rapidly. Preston et al. (1986) cited in Mohammed et al. (2009) indicated that the effect on ruminants of imbalanced nutrient supply, in particular fermentable nitrogen and protein, include low calving, low birth weight, high calf mortality; low weaning weight and reduced milk production. Kibon (1989) reported that in an attempt to upgrade the quality of low roughage by chemical and physical methods as well as supplementation has not found wide acceptance by livestock formers because it's expensive and uneconomical. During the dry season, the most widely available low cost feedstuff for ruminants in the semi arid zone are natural pasture, crop residue, animal waste and Agro-industrial by-product (Alhassan et al., 1984; Onwuka et al., 1999; Mohammed et al., 2007). In spite of research and development effort for improving range and common grazing lands, there has not been any serious increase in feed resources from these resources. Abbator (1990) and Maibe (2008) reported that un-supplemented cattle on natural grass in the semi arid zone of Borno state loss between 200 - 600 g of body weight per head per day. To increase the productivity of ruminant animal, alternative nutritional practice should be developed by the small scale farmer in developing nations or countries as cited by Mohammed (2007). To achieve a higher rate of improvement in ruminant production, despite the unavailability of quality feed, small scale farmers can make

use of non-conventional feeds in order to reduce the cost of feeding as they are cheaply obtained. It will also minimize the competition between livestock and humans for conventional grains. Thus, the objective of the study was to determine the nutritional composition of the formulated diets and to evaluate the cost effectiveness of producing each formulation.

## **MATERIALS AND METHODS**

### **Experimental site**

The experiment was carried out at the University of Maiduguri teaching and research farm. The area is situated at latitude 11o5' North, longitude 30o5' east and at altitude of 354m above sea level. It falls in the Sahelian Region (Semi-Arid Zone) of West Africa, which is characterized by short duration of 3 –4 month of rainfall. Rainfall varies from 300 – 500 mm; ambient temperatures are higher by April and May, which ranges from 35 – 45% (Alaku,1983).

### **Samples collection and preparation**

Maize bran, wheat bran, millet bran, cowpea husk, Urea, cotton seed cake, were all purchased from Maiduguri local market while poultry litter was collected from the University of Maiduguri poultry house. Acacia pods (dried) were collected from the University Research Farm stores. The Acacia pods were pound with mortar and pestle to obtain medium particle size and maintain a final uniform mix of the finished feed formulation. Samples were immediately labeled using local names and numbers for easy identification i.e. the samples were tagged and put into nylon bags. To ensure homogenous mixture, all ingredients were added one after the other (Mohammed et al., 2006).

### **Chemical (proximate) analysis**

The formulations were analyzed for the following according to AOAC (2000): Dry matter (DM), Crude protein (CP), Crude fiber (CF), Ether extract (EE), Ash and Nitrogen free extract.

### **Management of the experimental bull**

A cross bred bull weighing 370.52 kg and about 2.5 year old fitted with rumen cannula of size 90 mm internal diameter, at the University of Maiduguri Livestock Teaching and Research farm, Borno state was used for

the research. The bull was housed in a separate animal stall. The host animal was provided with a diet that was able to meet the rumen microbial requirement for essential nutrients. About 6 kg of feed was given to the animal every day comprising of sorghum bran (6.7%), groundnut haulms (33.3% and some quantity of browse (50.0%); and allowed to feed for 1-2 hrs every day on lush grass pasture. The aim of feeding the diet was to stabilize the rumen environment for optimum microbial activity during the rumen degradation study.

### **Preparation of feed samples for incubation**

Three (3) grams of feed samples were weighed from the bulk using sensitive balance, dried at 60<sup>0</sup>c for 24 hours and packed in a well labeled nylon bags. A total of 42 samples were prepared from the different treatments with 7 atheist samples from each treatment. The weight of bags plus samples was recorded and the bags were attached firmly using a strong string.

### **Incubation in the rumen**

The incubation timing was given as follows 6, 12, 18, 24, 48 and 72 hours for all the formulated rations. These are the hours required to measure the potential degradation of feed samples. The Nylon bags with the feed samples attached with the string were pushed slowly but gently into the rumen and the cannula cap tightened. Bags were left in the rumen and withdrawn after the stated incubation times (Orskov et al., 1980; and McDonald, 1981).

### **Withdrawal of bags from rumen, washing and drying**

The Nylon bags together with its contents were removed at the specified hours, the withdrawal was done carefully to avoid damaging the samples. The samples were washed under running tap water for 5 minutes until the water obtained from the bags was clear. They were then dried in an oven at 70<sup>0</sup>C for 48 hours to determine dry matter loss.

### **Washing loss (solubility)**

The washing loss is the soluble material of the feed and was determined by weighing 3 grains of sample into a nylon bag and soaking it in warm water (40<sup>0</sup>C) for one hour

before washing the bags under running tap water for 5 minutes or till water obtained from the bags was clear (Orskov et al., 1980).

#### Data Analysis

One way ANOVA was used on the treatments of the means of data generated using SPSS 12.0 Windows 2007.

### RESULTS AND DISCUSSION

The proximate compositions of the formulations are presented in Table 1. The dry matter content of the formulations was 94.7%, 93.6%, 94.4%, 96.0%, 94.4% and 91.2% for formulations F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub>, and F<sub>6</sub> respectively. The corresponding crude protein were 7.35%, 6.56%, 8.29%, 12.43% 9.97% and 7.79% and ether extract 4.0%, 2.5%, 4.5%, 2.5%, 3.5% and 2.0%. The highest dry matter and crude protein (96.0 and 12.43%) was recorded for F<sub>4</sub> and the lowest (91.2 and 6.56%) for F<sub>6</sub>. This in line with what was reported by (Ibrahim, 2006 and Maibe, 2008). Ash content ranged from (1.5% to 8.0%). The highest value for ash was recorded in F<sub>6</sub> (8.0%) and the lowest (1.5%) in F<sub>4</sub>. This may be due to the quantity of cowpea Husk and acacia pods used in the formulation. It was high in F<sub>6</sub> and low in F<sub>4</sub>.

Means within columns with different

superscripts are significantly different (p<0.05)

The percentage degradability of the formulations at different incubation period is presented on Table 2. The highest (P<0.01) percentage degradability obtained after 6 and 7 hours of incubation of the six (6) formulations in the rumen was recorded for F<sub>6</sub> (58.70 % and 66.30 % respectively) while the lowest percentage degradability value was recorded for F<sub>1</sub> and F<sub>3</sub> (45.40 % and 50.00 % respectively) while at 18, 23 and 36 hours F<sub>1</sub> highest percentage (P<0.05) dry matter degradability. The reason could be due to the amount of crude fibre and fat (22.5 and 2.0%) contained in formulation F<sub>6</sub> and the ability rumen microbes of the experimental bull to effectively digest these levels of fibre more than the other formulations (F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub>). While the lowest percentage degradability was recorded for formulation F<sub>1</sub> (45.4%) due to the high level of crude fibre percentage and fat percentage. Thus, the microbes will require more resident time for them to efficiently digest the level of fibre and fat contained in the formulations Wanapat, (1990). The degradability pattern of formulations at 6 – 72 hours of incubation were lower than the range of 74.00 % highest percentage dry matter degradability

Table 1: Proximate composition of the formulated feeds.

Samples	% dry Matter	% moisture content	% crude protein	% Fat	% crude Fibre	% Ash
F1	94.7	5.3	7.35	4.0	22.0	3.5
F2	93.6	6.4	6.56	2.5	21.0	2.5
F3	94.4	5.6	8.29	4.5	21.5	2.5
F4	96.0	4.0	12.43	2.5	23.5	1.5
F5	94.4	5.6	9.97	3.5	27.5	3.5
F6	91.2	8.8	7.79	2.0	22.5	8.0

Table: 2: Percentage degradation of the feed formulation using nylon bag technique

Rations	Incubation Hours						
	6	12	18	24	36	48	72
F <sub>1</sub>	45.60 <sup>d</sup>	52.40 <sup>b</sup>	69.73 <sup>a</sup>	71.83 <sup>a</sup>	76.43 <sup>a</sup>	79.43 <sup>a</sup>	73.77 <sup>b</sup>
F <sub>2</sub>	50.37 <sup>b</sup>	60.94 <sup>a</sup>	67.83 <sup>a</sup>	55.53 <sup>cd</sup>	68.77 <sup>b</sup>	74.70 <sup>ab</sup>	71.93 <sup>c</sup>
F <sub>3</sub>	48.40 <sup>c</sup>	50.00 <sup>b</sup>	50.60 <sup>c</sup>	51.03 <sup>d</sup>	52.93 <sup>e</sup>	76.37 <sup>a</sup>	66.13 <sup>d</sup>
F <sub>4</sub>	48.77 <sup>c</sup>	65.67 <sup>a</sup>	60.10 <sup>b</sup>	62.40 <sup>bc</sup>	64.73 <sup>c</sup>	70.47 <sup>bc</sup>	78.33 <sup>a</sup>
F <sub>5</sub>	53.63 <sup>b</sup>	63.73 <sup>a</sup>	65.50 <sup>b</sup>	69.37 <sup>ab</sup>	73.80 <sup>f</sup>	78.73 <sup>a</sup>	74.23 <sup>b</sup>
F <sub>6</sub>	58.70 <sup>a</sup>	66.30 <sup>a</sup>	66.30 <sup>b</sup>	66.87 <sup>bc</sup>	68.10 <sup>d</sup>	69.03 <sup>c</sup>	74.60 <sup>b</sup>
S.E.M.	1.12	4.99	1.64	2.00	4.95	1.07	0.91

Table 3: Cost effectiveness of the feed formulation/kg

INGREDIENT	F1	F2	F3	F4	F5	F6
cowpea husk	184	184	92	92	92	368
millet bran	40	40	60	60	60	-
wheat bran	267	267	400.5	400.5	534	-
maize bran	173.32	173.32	173.32	173.32	129.99	173.32
poultry litter	80	50	40	20	10	-
cotton seed cake	-	249.6	192	192	96	-
acacia pods	-	-	51.2	76.8	25.6	179.2
Urea	-	-	-	100	100	-
groundnut haulms	-	-	-	-	200	50
bone meal	-	12	-	-	-	-
total (₦)	744.32	975.92	1009.02	1114.62	1247.59	770.52

at 6 hours and 90.20 % at 72 hours recorded by Zarah et. al., (2014) due to the microbial digestion of the fibre and protein of the diet. At 48 hours, highest degradability was recorded at F1 followed by F5, 79.03 % and 78.73% respectively while at 72 hours, F4 recorded highest percentage degradability 78.33 %. The degradability pattern of the formulations are lower than the high value obtained by Oni et al.(2008) in a dry matter degradation characteristics experiment of some agro industrial by products but in agreement value obtained by Larbi et al. (1996). Thus, the nutrients available in the formulations will be released in the rumen for optimal utilization by the animal since they are components of the dry matter content of the formulations (McDonald et al., 1988).

The cost effectiveness of the six (6) formulations (F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub>, and F<sub>6</sub>) is shown in table 3, using the current price of the feed ingredients and when USD \$1 is sold at ₦ 155. The cost effectiveness of producing kg mixture was recorded in formulation F<sub>5</sub> ₦1247.59 (equivalent to \$8.1) having the highest cost of production when compared with the other formulations, while F<sub>1</sub> recorded least production cost of about ₦744.32 (equivalent to \$4.80). The high cost of production of some of these formulations is attributed to the inclusion levels of some of the expensive ingredients such as wheat bran's and cotton seed cake.

## CONCLUSION

This experiments show that locally available ingredients (crop residues) can be combined

in appropriate ratios to meet the nutritional requirement of ruminant animals and will reduce the ruminant production cost mostly incurred in purchasing of conventional feeds which are mostly expensive and unaffordable by local Agro-pastoral farmers. Looking at cost, nutrient composition, and digestibility, formulations F<sub>1</sub> and F<sub>6</sub> are better to be used in the semi arid zone of Nigeria which is characterized by low duration of wet season, protein supplement is one of the major constraints lacking in the feed of these livestock animals. Thus, Formulations F<sub>4</sub> and F<sub>5</sub> are recommended for feeding ruminants because due to their reasonable amount of crude protein content and highly degradability even at 48 hours of incubation.

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