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Original Article

Dry Seasons Feeding Regimes for Ruminants and Their Rumen Degradation Characteristics in a Semi-Arid Environment of Nigeria

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ABSTRACT

The experiment was conducted at the university of Maiduguri teaching and research farm and ten formulations were developed using wheat offal, sorghum husk, and cowpea husk as energy sources and cottonseed cake, poultry litter as protein sources. The result from the rumen degradation shows that at 6, 12, 18, 24, 36 and 48 hours formulation 7 recorded highest ($P<0.05$), while formulation 2 recorded lowest ($P>0.05$) percent degradability. At 72 hours formulation 8 recorded highest ($P<0.05$) percent degradability, followed by formulation 7 and the lowest was recorded in formulation 2. The highest cost of production was recorded in formulation 8, while the lowest cost was recorded in formulation 1 and 4. The study shows that formulation 7 which has (82%) degradability rate at 72 hours of incubation, with crude protein of 12.08% and with moderate cost of ₦3, 800.00/100kg has been recommended to be used for feeding ruminant's animal during the dry seasons when the pasture are of poor quality, which limit their performance.

Keywords: Feeding regimes, Rumen degradation, Semi-arid.

INTRODUCTION

Poor nutrition is a major constraint to livestock production in Sub-Saharan Africa (Osuji *et al.,* 1993). Most ruminants in tropical Africa are raised on natural pastures which decline rapidly in quantity and quality during the dry season and such seasonal variation in nutritional status result in irregular growth and weight gain in animals (Ademosun, 1973 and Mbahi *et al.,* 2006). To be able to reduce this irregular growth rates, crop residues and other unconventional feedstuffs are relied upon by small scale farmers (Smith *et al.,* 1991). According to Tuah *et al.,* (1993), most small scale farmers depend on crop residues as feed for their ruminants and these residues are generally low in nitrogen and minerals. Malau-Aduli *et al.,* (2003) noted that goats are able to subsist and make appreciable gains in long dry season with crop-residue-based diets that compared favorably with conventional concentrate rations. As noted by Odunlami (1988), some of the crop residues and by-

products available are potentially good feed resources which degrade readily in the rumen. Some others, however, have shown poor degradability and hence require some treatments before they can contribute to animal nutrition (Smith *et al.,* 1988). FAO (1986) recommended a degradability of 40-50% as a range for any feedstuff to be considered acceptable and that any feedstuff with degradability of 10-30% after 48hours should not be fed directly to ruminant animals except after further treatment. However, Smith *et al.,* (1988) recommended a minimum rumen degradability of 60% for a proper utilization of a potential feedstuff by ruminant stock. Feed evaluation is important to farmers in deciding which feeds to procure and for livestock planners to assess prospective production levels to plan for food import and export strategies (Ørskov, 2000). The smallholder farmers in developing countries have limited resources available for feeding to their ruminant livestock thus, study was designed to evaluate the nutritive values of local feed ingredients, the rumen degradation and digestibility of the formulated rations using local feed ingredients and to determine the cost of production of each formulation of the crop residues so as to determine the most nutritive and justify the investment into their collection and storage for use by ruminant stock.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Livestock unit of the University of Maiduguri Teaching Research Farm, Maiduguri, Borno State. Maiduguri is situated at latitude 1105'N, longitude 1309'E and an altitude of 354m above sea level. The area falls within the Sahel (semi-arid) region of West Africa, which is noted for its great climate and seasonal variation. It has very short period (3-4 months) of rainfall giving 645.9mm/annum with a long dry period/season of about 8-9 months. Relative humidity is 45% in August which usually lowers to about 5% in April and May.

Feed Formulation

All feed Ingredients used to formulate the rations were divided into energy sources and protein sources. The energy sources includes sorghum husk, Cowpea Husk and wheat offal while the protein sources are cotton seed cake and poultry litter by using the standard guide of 60:40 energy to protein ratio. Poultry litter is properly stored after sun drying in order to destroy some pathogenic microorganisms like E. coli and salmonella as suggested by (Mohammed et al., 2007). The ingredients are then supplied at varied measures and different ingredients are mixed to produce the 10 different 100kg rations, F1,…, F10.

Rumen Degradation Study

This is an in vitro digestibility involving the insertion of nylon bags with feed inside into the rumen and monitoring the digestibility over a specified period of time usually between 0-120 hours (church, 1977). The nylon bag (in vitro) technique for determination of the degradation of feedstuff in the rumen at various incubation periods can be used to screen feeds at initial stages of assessing their nutritive value (Taun *et al.,* 1996). The balance of nutrients potentially made available from and the digestibility of the dry matter in the rumen are the most important criteria of the potential of a basal diet. Digestibility primarily establishes the intake of the basal diet (feed0once nutrient deficiencies for the rumen microbes have been corrected (Minson, 1982). However intake is affected by climate and a range of other factors.

Washing Loss

Soluble portion of the feed was determined by weighing 5 g of the feed samples into nylon bags in replicates. It was soaked in warm water at 40 °C for one hour, removed and washed under a running tap for 15 minutes in two circles till clear water was obtained. The bags were oven dried at 60˚C for 48 hours to constant weight (Orskov *et al.,* 1980).

Chemical Analysis

Feed samples were analyzed for Dry Matter (DM), Crude Protein (CP), Crude Fiber (CF) and Ash using the methods of AOAC (1999).

Statistical Analysis

Data collected were subjected to analysis of variance (Steel and Torrie, 1980). Significant differences between means were tested using LSD. The results of the DM degradation were also fitted into the equation P = a + b (i-e-ct) where P = amount degraded at time (t), a =

rapidly soluble fraction, b = amount which in time will degrade, c = fractional rate constant at which the fraction 'b' will be degraded, e = natural logarithm, and t = time.

Application of The Technique

The rumen bag may be used to explore many features of the degradation process that occur within the rumen. Not only is it a powerful tool for indexing the relative degradabilities of feedstuffs, it may also be used to improve our understanding of rumen fermentation (Mehrez *et al.,* 1977).

RESULTS AND DISCUSSION

From Table 1, the percentage DM, CP and CF ranged from 82.50 - 96.30 % DM, 3.85 - 13.06 % CP and 17.0 – 55.0% CF respectively. The % DM in this study is similar to what was reported by Mubi *et al.,* (2013), who reported highest percentage DM of 95.4 %DM but in contrast to 93.80 - 98.70 % DM reported by Zarah *et al.,* (2014) while the CP content was moderate and slightly below the range of 10.9 – 14.8 % CP reported by Onwuka but within the range of 11 – 13 % CP reported by Mohammed *et al.,* (2007) who used similar feed ingredients and this may be attributed to the high level of cottonseed cake used, which have a high crude protein content (40.10 %CP) as reported by (NCPA,2002). The CF content is within the range of 10.5 - 41.0 % CF reported by Zahra *et al.,* (2014) but higher than 6.0 – 9.5 % CF reported by Ibrahim *et al.,* (2011). The high percentage of crude fibre in most of the formulations is attributed to the high level of cowpea husk, wheat offal and cotton seed cake used in the formulations. The Crude fiber content of the formulations are within the fibre ranges of 11.0 - 23.0% Olumu, (1996); Imade, (2004). The fibre content is high and varies depending on the amount of unit left in cotton seed cake Orskov, (1992) used in the formulation. This also gives the ash content of the formulation a range of about 1.0 - 9.0 % ash, and this is in line with the work of Kinfemi *et al.,* (2009) who recorded up to 7.64% Ash in cowpea husk and Sansoucy *et al.,* (1986) with 7 – 8 % ash but different from Mohammad and Baulube (2004). The % EE ranged from 1.0 - 6.0% while the energy content of the formulation ranges from 3.50 - 3.90 MJ/kg.ME and the energy content were increasing from formulation F1 through to F10.

Table 2, Summarizes the percentage dry matter degradation. At 6, 12, 18, 24, 36, and 48 hours formulation F7 recorded the highest ($P<0.05$) percentage dry matter degradability compared to all the other formulations while F5 (65.50 %) recorded least after 48 hours of incubation with no significant differences amongst the formulations. Since all the formulations recorded above 40% dry matter degradability at 24 hours of incubation period, most available nutrients in the formulations will be released and in the rumen for utilization McDonald *et al.,* (1988). The reason for this variation in degradability of the formulations could be due to their high fibre content as a result of high concentration of fibrous nature of the feed ingredients used in the formulations MacDonald *et al.,* (1995). Mean degradation of all the formulations at 48hours is slightly below the range of 83.20 – 95.80% dry matter degradation reported by Zarah *et al.,* (2014). At 72 hours F8 had the higher (85.84%) percentage dry matter degradability, which attributed to the higher level of wheat offal in this formulation and the lowest was recorded in F2 which had higher content of sorghum husk. Effective rumen degradation depends on how long the food remains in the rumen which is also a function of the quantity of the feed fed to the animal Reddy (2001). In addition longer incubation period, the reason for this degradability pattern is as a result of the inclusion level of feed ingredients used in the formulations. This finding is in concord to 82.00% recorded by Mbaya *et al.,* (2012). Graphical representation of the formulation is shown by Figure 1.0 below.

The graph in fig. 1.0 gives the graphical representation of the rumen degradation of all the formulations, F1, F2, …, F10.

Table 3 summarizes the cost effectiveness of the formulations in 100kg and these costs were determined based on current prices of feed ingredient Maiduguri cattle market and the level of inclusion of the ingredient in the formulation. F8 recorded highest (₦6, 000) production cost followed by F2 and F5 (₦5, 400), F9 (₦4, 900), F10 (₦4, 500), F3 and F6 (₦4, 300.0), F7 (₦3, 800) production cost. Formulation F1 and F4 with (₦3, 200) recorded least production cost.

Table 1: Proximate composition of the formulations

Prox. Comp.	Formulations									
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
DM (%)	95.40	96.40	82.50	96.00	94.60	95.70	95.10	96.20	95.70	96.30
CP (%)	3.85	6.13	4.90	7.35	7.18	8.05	12.08	13.66	12.08	7.00
CF (%)	47.0	43.0	37.0	55.0	43.0	12.0	19.0	36.0	17.0	28.0
EE (%)	1.0	1.0	1.0	1.0	2.0	2.0	1.0	6.0	1.0	1.0
Ash (%)	8.0	6.0	8.0	9.0	5.0	6.0	1.0	4.0	4.0	6.0
Energy (MJ/kg.ME)	3.50	3.55	3.58	3.62	3.67	3.71	3.75	3.81	3.87	3.90

Table 2: percent dry matter degradation of the formulations

Hours	Formulations									
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
6	24.34^{b}	16.34^{b}	17.00^{b}	26.84^{b}	21.84^{b}	17.83^{b}	51.00^{a}	29.50^{b}	30.67^{b}	31.17^{b}
12	30.50^{bc}	31.17^{bc}	26.50^{bc}	35.84^{b}	27.17^{bc}	23.17^{c}	55.17^{a}	31.83^{bc}	36.17^{b}	31.83^{bc}
1 8	39.67^{abc}	37.17^{bc}	35.83^{bc}	50.00^{ab}	30.00^{c}	28.17^{c}	56.00^{a}	39.00^{abc}	41.67^{abc}	41.89^{ac}
24	48.67^{ab}	47.50^{ab}	48.67^{ab}	54.00^{ab}	39.00^{b}	38.17^{b}	65.00^{a}	43.00^{ab}	49.34^{ab}	46.34^{ab}
36	53.84	54.17	59.50	58.34	42.50	47.17	69.50	56.67	57.67	55.17
48	71.67	65.67	72.00	69.67	65.50	71.84	76.17	73.17	69.67	70.50
72	77.17^{ab}	69.50^{b}	75.00^{ab}	75.84^{ab}	79.34^{ab}	81.00^{a}	82.00^{a}	85.84^{a}	79.50^{ab}	80.50^{ab}

NB: All superscript (a, b and c) with different alphabet within the rows are significantly difference (P<0.05).

Table 3: Cost of production of the formulations based on (100kg)

Ingredients	Formulations										
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Total
Sorghum husk	₦2,400	₦2,400	₦2,400	-	-	-	-	-	-	₦800	₦8,000
Cowpea husk	-	-	-	₦2,400	₦2,400	₦2,400	-	-	-	₦800	₦8,000
Wheat offal	-	-	-	-	-	-	₦3,000	₦3,000	₦3,000	₦1,000	₦10,000
Poultry litter	₦800	-	₦400	₦800	-	₦400	₦800	-	₦400	₦400	₦4,000
Cottonseed cake	-	₦3,000	₦1,500	-	₦3,000	₦1,500	-	₦3,000	₦1,500	₦1,500	₦15,000
Total (₦)	₦3,200	₦5,400	₦4,300	₦3,200	₦5,400	₦4,300	₦3,800	₦6,000	₦4,900	₦4,500	₦45,000

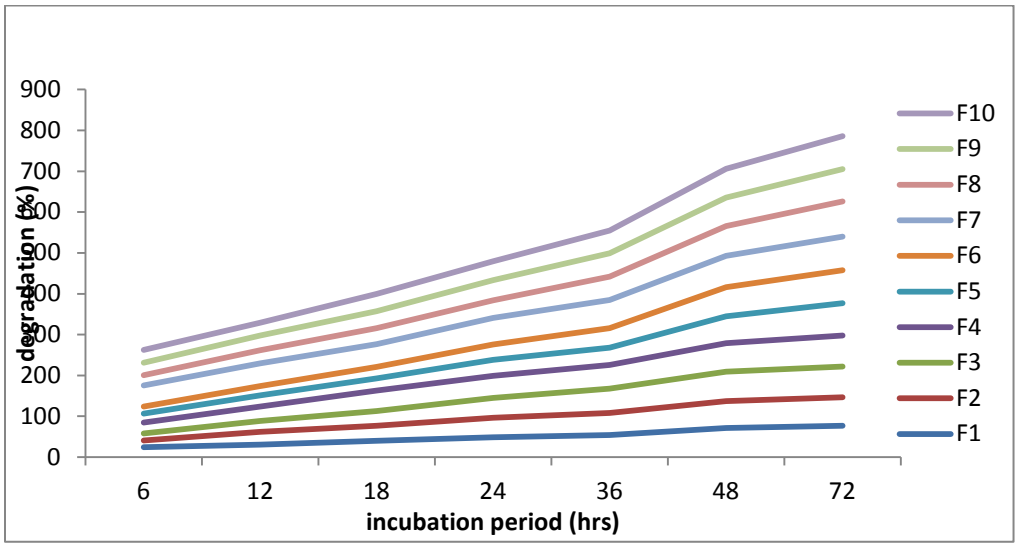

Figure 1: graph of percent Dry matter degradability

The variation in cost of production of these formulations is as a result of inclusion level of the ingredients most of which are very expensive. The high cost of cotton seed cake, poultry litter, cowpea husk and sorghum husk is the main reason for the high production cost of most of the formulations similar to production cost attributed to the high cost of the ingredients

incurred by Ibrahim *et al.,* (2011). This is in agreement to what was reported by lamidi *et al.,* (2006) who stated that the high cost and availability of such feed ingredients during the dry season are the major limitation to its wide spread and utilization and another reason is that the inclusion of cottonseed cake is very expensive and scarce as described by the RIM (1992).

CONCLUSION

Based on the findings of this study, it can be concluded that the combination of locally available feed ingredients ruminant feeds formulation based on such as sorghum husk, cowpea husk, wheat offal, poultry litter and cottonseed cake can meet up the nutritional requirement of ruminants at an affordable production cost especially during the dry season when the pasture grasses are of poor quality, which limit the performance of these ruminants.

RECOMMENDATION

Based on the experiment carried out, using locally available feed ingredient and choice of formulation with the lowest cost effectiveness, high nutrient composition, dry matter degradability of the feed ingredient that will be digested within a specific period and thus, could be utilized by the animal is very important. Hence, formulation F7 which has (82%) degradability rate at 72 hours of incubation, with high crude protein of 12.08%CP, gross energy of 3.75 MJ/kg.ME and at the same time has a moderate production cost of ₦3, 800 /100kg which could be utilized by local agro pastoralists to meet ruminant requirements at a low or no cost.

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