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ORIGINAL RESEARCH ARTICLE

Nutrient Digestibility and Nitrogen Retention by Red Sokoto Bucks fed Urea-Molasses Treated Maize Cob Supplemented with Different Protein Sources

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ABSTRACT

The study evaluated the nutrient digestibility and nitrogen retention by Red Sokoto bucks fed urea-molasses treated maize cob supplemented with different protein sources. Twelve (12) Red Sokoto bucks were randomly allotted to four (4) dietary treatments containing treated maize cob with cotton seed cake (CSC), poultry litter (PL), rosell seed cake (RSC), and brewers dried grain (BDG), respectively with four bucks per treatments in a completely randomized design. The maize cob was treated with 2% urea and 5% molasses and ensiled for a period of 2 weeks. The result of chemical analysis showed that treatment of maize cob with urea-molasses increased its crude protein content and decreased the neutral detergent fibre content. Nutrient digestibility varied (P<0.05) across the treatments. Dry matter and crude protein digestibility were higher (P<0.05) in bucks fed CSC diet (95.24%, 91.88%) and PL diet (92.40%, 86.77%), compared to other treatments. Organic matter digestibility was higher in bucks fed CSC (88.28%) diet and least in bucks fed PL (77.43%) diet. Crude fibre digestibility was different (P<0.05) with highest value in animals fed CSC (83.72%) diet. Nitrogen intake was higher (P<0.05) and better in bucks fed CSC (6.84g/day) and RSC (5.98g/day) diets compared to other treatments. Nitrogen absorbed and retained were similar (P<0.05) in bucks fed CSC (3.12 and 2.36g/day) and RSC (2.97 and 2.19g/day) diets with the least value in bucks fed PL (1.95 and 0.62g/day) diet. Conclusively, diets containing urea-molasses treated maize cob with CSC gave better digestibility and nitrogen retention. Farmers should treat maize cob with urea at 2%, molasses at 5% and supplement with CSC for better feeding value.

Keywords: Digestibility, Maize Cob, Molasses, Nitrogen Retention, Protein and Urea

INTRODUCTION

Crop residues are useful sources of ruminant animal supplementary feeds in the dry season in the tropics (Oroka and Omoregie, 2015). In West Africa and other parts of the tropics, where maize, sorghum, millet and rice are the major cereal crops their residues constitute an important source of ruminant animal feed (Ehoche, 2002; Singh *et al.*, 2003). Maize cob has been reported to contain: 92.96% dry matter, 7.5% ash and 4.97% crude protein (William, 2012). Despite this low value, their wide availability, easy and cheap procurement, and also their large cellulose and hemicellulose reserves enhance utilization as energy sources in ruminant feed, particularly in areas or during times where better feed resources are not available (Adebowale, 1992). In Nigeria, for instance, maize cobs are an important crop residue used by livestock farmers during the dry season, at a period when they are relatively available and abundant (Ogunleke *et al*., 2014).

Various treatment (physical, chemical and biological) methods have been used to improve utilization of cereal crop residues and other low quality forages (Abebe *et al.*, 2004). Among the various methods, chemical (NaOH, CaOH, NH_3, urea) treatment have been found to be more effective. Wanbui *et al.* (2006) reported that treatment of cereal straw alone is not sufficient to meet the animal's maintenance and production requirement. Supplementation to provide essential nutrients is therefore an important means of improving their utilization (Fadel-Elseed, 2005). Supplementing low quality forage based diet with nitrogen sources elevates ruminal ammonia nitrogen concentration to provide rumen bacteria with their requirement to achieve maximum rates of fermentation (Fike *et al.*, 1995). Some of the various materials used as supplements includes browse plants, agro-industrial-by-products (oil seed cakes, citrus pulps, Tomato Pomace, Maize gluten meal etc).

Agro industrial by products refer to the by-products derived from the industry due to processing of agricultural products. They are less fibrous and highly nutritious as compared to crop residues (Aguilera, 1989). Thus, feeding agro industrial by product like molasses will help to decrease feeding cost especially in developing countries like Nigeria. Molasses, in either liquid or solid form, is often used as a carrier for urea and other additives (Perez, 1995). It can be combined with urea, minerals and vitamins to make solid bricks called molasses-urea blocks or multi-nutrient blocks (Forsberg *et al.*, 2002).

In Nigeria, large quantities of maize cobs are produced after grain harvest, and are usually left in the field to be grazed by agropastoral herds. Grazing of maize cob by animals without regard to processing and supplementation leads to poor utilization and wastage. Fermentable energy and protein deficiencies in maize cob coupled with its low digestibility impair intake, ruminal functions and thus animal productivity (Jabbar *et al.*, 2009). Supplementation using alternative protein sources like poultry litter, rosell seed cake, brewer's dried grain, cotton seed cake, blood meal and leucaena has been reported to improve performance (Hunter *et al*., 1993). The supply of crop residues and agro-industrial by-products at reasonable prices could enhance production and reduce cost of compounded feeds without adversely affecting the performance of the animals (Onyeonagu and Njoku, 2010). The objectives of this study were to determine the apparent nutrient digestibility and nitrogen retention by growing Red Sokoto bucks fed urea-molasses treated maize cob supplemented with different protein sources.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University Zaria, located on latitude 11° 11' N and longitude 07° 38' E (Ovimaps, 2017). It is situated at an altitude of 686m above sea level and lies within the northern guinea savannah zone. The mean relative humidity is 21 and 72% during the dry and raining season respectively. The annual rainfall is between 1100-1200mm and temperature fluctuates within the range of 14.5-39.5^{0}C (IAR, 2017).

Preparation of feed

Maize cobs were obtained as post-harvest waste from farms around Samaru and Shika. The maize cob was grounded, and treated with urea at 2% (i.e. 20g urea dissolved in1liter of water to treat 1kg of maize cob). To prepare urea molasses treated maize cob, 20g of urea was added to a liter of water and stirred very well until urea was dissolved and clumps of urea disappear from the solution. Then 5% of molasses was added and stirred very well until the molasses and the urea solution gets mixed up (Chenost, 1995). The solution was uniformly sprayed and thoroughly mixed with the ground maize cob. The urea-molasses treated maize cob was then ensiled in Purdue Improved Cowpea Storage (PICS) triple bags for a period of two weeks. The ensiled urea-molasses treated maize cob was then air dried before feeding to the animals.

Cowpea shells were bought from farmers immediately after harvest from Shika. Deep litter broiler poultry litter was sourced from the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University Zaria, the poultry litter was sun-dried for four days to reduce moisture content and also to kill pathogenic microbes that may be present in it, the poultry litter was sieved and stored in a cool dry place before being incorporated into the diet. The other ingredients (CSC=cotton seed cake, PL=poultry litter, RSC=rosell seed cake, BDG=brewers dried grain, BM=bone meal, urea and molasses.) were sourced from commercial feed mills in Samaru and were milled before incorporation into the supplementary concentrate diets. The experimental diets were formulated to contain approximately 13% crude protein and each protein source serves as treatment (Table 1).

Table 1: Gross composition of concentrate diet

Ingredients	*Treatments*			
	CSC	PL	RSC	BDG
Maize offal	27.75	30.75	30.75	27.75
Rice offal	17	17	18	17
Bone meal	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25
Salt	0.5	0.5	0.5	0.5
CPS	30	30	30	30
Protein sources	23	20	19	23
Total	100	100	100	100
Calculated analysis				
Crude protein	13.20	13.40	13.30	13.40
ME (Kcal/kg)	2002.30	1982.00	2083.50	2150.00
Cost /kg diet (₦)	43.70	32.50	46.50	46.50

CSC= Cotton seed cake, PL= Poultry litter, RSC=Rosell seed cake, BDG=Brewer's dried grain, CPS=Cowpea shell, ME = metabolizable energy

Experimental animals and management

Twelve 12 bucks aging between 15-21 months weighing 12 – 14 kg were used for this experiment. The experimental animals were fed the same basal diet and the concentrate supplement containing different protein sources was formulated to contain approximately 13% crude protein. Prior to the commencement of the experiment, the bucks were dewormed using Albendazole 10% suspension and dipped in acaricide (Amitix®) solution one week before the commencement of the digestibility trial to control endo and ecto-parasites. Fresh drinking water was made available at all times in other to give the animals the right to hygienic water and freedom from thirst. The fecal and ort were removed daily, drinkers and feeders were cleaned daily and environment kept clean to maintain good sanitary condition throughout the experimental period.

Digestibility study

Three bucks per treatment were housed in individual metabolic crates ideal for easy separate faecal and urine collection as described by Osuji *et al.* (1993). The animals were allowed 14 days for adjusting to the condition of the metabolic crates before commencement of the collection period which lasted for 7 days. They were fed the supplementary concentrate diet at 1.5% body weight and basal diet of urea-molasses treated maize cob. Daily faecal output were collected and weighed and 10% of each day collection was sub sampled and oven dried at 60°C for DM determination. This was later bulked for laboratory analysis. Daily urine output was collected in a plastic container containing 10mls 0.1N H_2SO_4 placed under metabolic crates. Ten percent (10%) of daily urine was sub sampled from each buck and bulked for the 7 days collection period and 10% of the bulked urine from each buck was sub sampled and stored in the refrigerator pending nitrogen determination.

Chemical analyses

Treated maize cob, untreated maize cob, supplementary concentrate diets and faecal samples were analysed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash according to the method of AOAC (2005). Acid detergent fibre (ADF) and Neutral Detergent fibre (NDF) were determined according to the method describe by Van Soest (1991). Urinary nitrogen was determined using the method of AOAC (2005). Metabolisable energy (ME) was calculated from Alderman and Cottril (1985) equation:

ME (MJ/Kg) =11.78 + 0.0064 CP+(0.000665EE)² - CF (0.00414EE)-0.0118A

Where: CP = crude protein; EE = ether extract; CF = crude fibre; A = ash

Statistical analyses

Data collected were analyzed using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS, 2002) package. Significant difference among treatment means was compared using Duncan's Multiple Range Test in the SAS Package (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical Composition of Experimental Diets Containing Different Protein Sources Fed to Red Sokoto Bucks

Chemical composition of experimental diets containing different protein sources fed to Red Sokoto bucks is shown in Table 2. The dry matter (DM) content of the experimental diet ranged between 90.22 and 94.61%. The crude protein (CP) content obtained in this study ranged from 16.97 to 13.32%. Ether extract content was high (2.00%) in PL and lowest (1.26%) in BDG. Poultry litter (PL) had the highest ash content (18.55%), which was lowest in RSC (2.75%). The ash content ranged from 2.75 to 18.55%. Nitrogen free extract (68.99%) was high in BDG, while the least was recorded in CSC (56.14%). Neutral detergent fibre and acid detergent fibre ranged between 44.50 to 57.12% and 33.59 to 49.73%, respectively. Lignin content was higher in CSC (12.28%), followed by RSC (11.34%) and lower in PL (10.85%).

The high dry matter content of the experimental diets indicates a higher concentration of nutrients for the animals (Table 2). The highest CP value from cotton seed cake (CSC) obtained in this study was lower to the CP (25.05%) value recorded by Arigbede *et al*. (2006). The nutritional value of CSC, RSC and BDG are affected by plant variety, geographical source, weather, processing conditions and level of endogenous substances. The CP of the experimental diets were within the range reported by Aduku (2004) to meet the nutrients requirement for growing ruminants. The higher CF obtained from BDG may be attributed to the cereal grain variety, species and source. The values of ether extract in the diets were observed to be low, as excess or high values lead to quick spoilage of animal feed as a result of rancidity. The highest ash content found in PL shows that it is richer in mineral content than other supplements which may be due to the high amount of mineral supplementation in poultry diet. The nitrogen free extract values obtained in this study indicates that there was an appreciable fermentable carbohydrate for energy production. The NFE value is appreciably higher than 26.97% to 31.02% reported by Maigandi and Abubakar (2004) for Red Sokoto goats fed varying levels of *Faidherbia albida* pods.

Table 2: Chemical composition of experimental diets containing different protein sources fed to Red Sokoto bucks

	Treatments			
Parameter (%)	CSC	PL	RSC	BDG
Dry matter	94.21	90.22	93.41	94.61
Crude Protein	16.97	14.33	14.52	13.32
Ether extract	1.85	2.00	1.90	1.26
Ash	10.37	18.55	2.75	5.30
Nitrogen free extract	56.14	60.46	66.03	68.99
Neutral detergent fibre	44.50	56.36	52.43	57.12
Acid detergent fibre	39.87	33.59	45.60	49.73
Lignin	12.28	10.85	11.34	10.97

CSC=cotton seed cake, PL=poultry litter, RSC=Rosell seed cake, BDG=brewers dried grain

Apparent Nutrients Digestibility by Red Sokoto Bucks Fed Urea-Molasses Treated Maize Cob Supplemented with Different Protein Sources

The result of apparent nutrients digestibility is presented in Table 3. It was revealed from the result of this study, that there were significant (P<0.05) differences in feeding different protein sources on apparent nutrient digestibilities of dry matter, organic matter, crude protein, crude fibre, neutral detergent fibre and acid detergent fibre. Dry matter digestibility was significantly (P<0.05) higher (95.24%) in CSC, followed by PL (92.40%) and the least in RSC (89.85%). Organic matter digestibility was significantly (P<0.05) higher in CSC supplemented diet (88.28%), and the least in PL (77.43%) which was similar with RSC (77.87%). Crude protein and crude fibre digestibilities were significantly (P<0.05) higher in CSC (91.88 and 83.72%, respectively), followed by PL (86.77 and 73.25%), respectively and the least in BDG (82.20 and 64.32%, respectively) which was similar with that of RSC (80.58 and 67.23%), respectively. Neutral detergent fibre digestibility was significantly (P<0.05) higher in CSC (81.30%), followed by PL (75.69%) which was similar with BDG (73.24%) and the least in RSC (67.83%). Acid detergent fibre digestibility was observed to be higher in CSC (80.47%), and the least in PL (61.40%).

Dry matter digestibility by bucks fed CSC was 2.98%, 4.01% and 5.66% higher than bucks fed PL, BDG and RSC, respectively. Crude protein digestibility by bucks fed CSC was 5.56%, 10.54% and 12.30% higher than PL, BDG and RSC, respectively. Apparent nutrient digestibility values obtained in this study for all the dietary treatments were higher; this could be as a result of adequate protein supplementation in each of the treatments. Abubakar *et al.* (1998) reported that protein supplementation enhanced digestibility of feeds in animals. Better nutrient digestibility in animals on CSC could be as a result of higher crude protein intake while animals on RSC had the lowest digestibility of nutrients. This could be as a result of tannin in RSC. McDonald *et al.*, (2011) reported that digestibility is much reduced when a ration contains little protein in proportion to the amount of readily digestible carbohydrate. Nsinamwa *et al*. (2005) concur on the fact that the higher the fibre fractions, the lower the digestibility. The digestibility coefficients obtained in this study were higher than the values reported by Sani (2014) when Yankasa sheep were fed *Brachiaria ruziziensis* supplemented with different protein sources.

Nitrogen Retention in Red Sokoto Bucks Fed Urea-Molasses Treated Maize Cob Supplemented with Concentrate of Different Protein Sources

The result of nitrogen balance is presented in Table 4. Nitrogen balance was significantly (P<0.05) affected by supplementation with concentrate of different protein sources on nitrogen intake, faecal nitrogen loss, urinary nitrogen loss, total nitrogen output, N absorbed, N retained and N retained as % intake. Nitrogen intake was significantly (P<0.05) higher (6.84 g/day) in bucks fed diets with CSC, followed by bucks fed diet with RSC (5.98g/day) which was similar with bucks fed diets with BDG (5.51g/day) and the least was observed in bucks fed diets containing PL (4.84g/day).

Faecal nitrogen loss was higher in bucks fed CSC (3.61g/day), followed by bucks fed BDG (3.37g/day) and the least in PL (2.89g/day) which was at par with bucks fed RSC (3.03g/day). Urinary N loss was significantly (P<0.05) higher in bucks fed diets containing PL (1.14g/day), while CSC (0.87g/day), RSC (0.78g/day) and BDG (0.73g/day) were statistically similar. Total N output was significantly (P<0.05) higher in bucks fed CSC (4.49g/day), followed by bucks fed PL (4.22g/day) which was significantly similar with bucks fed BDG (4.10g/day) and the least in bucks fed RSC (3.80g/day). N absorbed and N retained were significantly (P<0.05) higher in bucks fed CSC (3.12 and 2.36g/day) diet.

Nitrogen retention (Table 4) is the major indicator for assessing the protein nutritional status of ruminant livestock (Abdu *et al*., 2012). It is also the proportion of nitrogen utilized by farm animals from the total nitrogen intake for the body process, hence the more nitrogen consumed and digested the more nitrogen retained and vice versa (Okeniyi *et al*., 2010). The higher nitrogen absorbed and retained in bucks supplemented with CSC could be attributed to higher nitrogen intake of (6.84 g/day). It is logical to infer that superior nitrogen absorbed and retained in CSC compared to PL,

Table 3: Apparent nutrients digestibility in Red Sokoto bucks fed urea-molasses treated maize cob supplemented with concentrate of different protein sources

	Treatments				
Parameters	CSC	PL	RSC	BDG	SEM
Dry matter	95.24^{a}	92.40^{b}	89.85^{d}	91.42^{c}	0.48*
Organic matter	88.28^{a}	77.43^{c}	77.87^{c}	80.35^{b}	0.96*
Crude protein	91.88^{a}	86.77^{b}	80.58^{c}	82.20^{c}	0.88*
Crude fibre	83.72^{a}	73.25^{b}	67.23^{c}	64.32^{c}	1.59*
Ether extract	99.77	99.79	99.61	99.51	0.05^{NS}
Neutral detergent fibre	81.30^{a}	75.69^{b}	67.83^{c}	73.24^{b}	1.63*
Acid detergent fibre	80.47^{a}	61.40^{d}	64.88^{c}	70.38^{b}	1.23*

[a,b,c,d] Means with different superscripts along same row differed significantly at 0.05% SEM=standard error of means, CSC=cotton seed cake, PL=poultry litter, RSC=Rosell seed cake, BDG=brewers dried grain,

Table 4: Nitrogen retention in Red Sokoto bucks fed urea-molasses treated maize cob supplemented with concentrate of different protein sources

	Treatments				
Parameters	CSC	PL	RSC	BDG	SEM
Nitrogen intake (g)	6.84^{a}	4.84^{c}	5.98^{b}	5.51^{b}	0.08*
Faecal Nloss (g)	3.61^{a}	2.89^{c}	3.03^{c}	3.37^{b}	0.09*
Urinary N loss (g)	0.87^{b}	1.14^{a}	0.78^{b}	0.73^{b}	0.03*
Total N output (g)	4.49^{a}	4.22^{b}	3.80^{c}	4.10^{b}	0.08*
N Absorbed (g)	3.12^{a}	1.95^{c}	2.97^{ab}	2.18^{bc}	0.11*
N Retained (g)	2.36^{a}	0.62^{c}	2.19^{ab}	1.41^{bc}	0.10*
N Retained (as % intake)	45.56^{b}	40.26^{c}	49.52^{a}	40.07^{c}	1.67*

[a,b,c] Means with different superscripts along same row differed significantly at 0.05% SEM=standard error of means, CSC=cotton seed cake, PL=poultry litter, RSC=Rosell seed cake, BDG=brewers dried grain,

RSC and BDG was due to efficient nitrogen utilization. Significantly ($P<0.05$) higher nitrogen intake, nitrogen absorbed and nitrogen retained in the body of animals fed CSC could be as a result of crude protein intake from the diets. Bucks fed diets containing CSC had 34.50%, 12.57% and 19.44% higher nitrogen intake than bucks fed PL, RSC and BDG. Nitrogen retained obtained from bucks fed CSC was 73.73%, 7.20% and 40.25% higher than bucks on PL, RSC and BDG, respectively. The significant higher nitrogen retention in bucks fed CSC and RSC might be due to high nitrogen intake which helped rumen microbes to digest dietary nitrogen and hence absorption and retention in the body of host animal (Afele, 2016). The values of N-retained indicate that all the bucks were in positive nitrogen balance.

Conclusion and Recommendation

Digestibility of nutrients (DM, OM and CP) and nitrogen retention values were better in bucks fed diets containing cotton seed cake compared to other sources of protein supplement (PL, BDG and RSC).Hence, it was therefore recommended that livestock farmers should supplement with cotton seed cake.

CONFLICT OF INTEREST

Authors hereby declare that there is no conflict of interest on the result of the study presented in this paper.

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