NUTRIENT DIGESTIBILITY AND NITROGEN BALANCE BY YANKASA RAMS FED TREATED SUGARCANE BAGASSE SUPPLEMENTED WITH VARYING LEVELS OF YEAST

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ABSTRACT

A study was conducted to evaluate nutrient digestibility and nitrogen balance of Yankasa rams fed varying inclusion levels of yeast in bagasse based diet. Twenty (20) growing Yankasa rams were used for the study; the rams were allotted to four (4) dietary treatments in a completely randomised design. The metabolism trial lasted 21 days. The yeast was included at the rate of 0, 5, 6 and 7 g/kg respectively and the diets were offered at 3 % body weight. Data generated were analysed using general linear model procedure and significant differences were compared using Tukey test and contrast analysis. The crude protein (CP) content of experimental diet varied between 13.0 and 13.75 % while neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) ranged from 68.30 to 69.04 %, 32.60 to 33.53 % and 11.28 to 33.52 % respectively. The results of apparent nutrient digestibility showed that rams fed diet with 7 g/kg inclusion level had significantly higher (p<0.05) dry matter digestibility (DMD), crude protein (CPD), acid detergent fibre (ADFD), neutral detergent fibre (NDFD) and acid detergent lignin (ADLD) which were at par with rams fed diet with 0 g/kg inclusion level. Moreover, rams fed 6 g/kg inclusion of yeast had significantly higher (p<0.05) nitrogen retention and nitrogen retention as percentage intake which were at par with rams fed 0 and 5 g/kg inclusion of yeast. Conclusively, the study showed that increasing the inclusion of yeast increased the nutrient digestibility and nitrogen retention of Yankasa rams.

Keywords: Bagasse, Nutrient digestibility, Yankasa rams, Yeast

INTRODUCTION

One of the major factor limiting the productivity of small ruminants in developing countries is the over-dependence on low digestible feeds which at certain periods of the year cannot meet even the maintenance requirements of these animals. The incidence of tse-tse fly is another factor affecting the production and distribution of animals. Cattle, sheep and goat distribution in Nigeria are limited by tsetse fly incidence and by the availability of forage. The semi-arid ecological zone of Nigeria is virtually tsetse fly free, but has the lowest forage resources. Over

70 % of the total population of livestock in Nigeria are concentrated in the guinea and Sudan zones (Gefu, 2002). Ugwu (2007) reported problems of small ruminant producers were disease, feeding problem, accommodation constraint, inadequate capital, destructive habit of the animals and predators, among others.

The use of agro-industrial by-products as livestock feed is becoming increasingly popular in Nigeria. The sustainability of grain offal (dusa) and crop residues in feeding ruminant are documented (Ahamefule *et al.,* 2002). In Nigeria, large quantities of agro-industrial by-products are produced and many of them have potentials as non-conventional feedstuffs (Adeniji and Ehiermere, 2003). Such by-products include corncobs, cassava peels, rice polishing, rice husk, brewers' grain, molasses and sugarcane bagasse. Bagasse is one of the most important by-products of the sugar industry. It is the residual fibre resulting from the extraction of sugarcane juice.

Feed additives are important components used in improving nutritional quality of feed which is influenced not only by nutrient content but also by other aspects such as hygiene, digestibility, palatability and pH stabilization (Yirga, 2015). These additives comprise of probiotics, antibiotics and enzymes. Probiotics are live microorganism that when administered in adequate amounts confer benefit to the host. They have also been reported to influence the production of livestock in terms of digestibility, growth rate, pH balance and feed efficiency (Rahman *et al*., 2013; Mookiah *et al*., 2014). *Saccharomyces cerevisiae* is one of the common probiotics used in ruminant diets and known to improve productivity, better nutrient digestion and prevent acidosis (Bajagai *et al*., 2016). Several studies have demonstrated that yeast supplementation can influence digestive processes in the rumen (Jouany, 2001; Mruthunjaya *et al*., 2003; Galip, 2006; Chevaux and Mazzia-Fabre, 2007), while others have shown no promising effect on digestive processes (Newbold *et al*., 1995; Kholif and Khorshed, 2006).

Therefore, with this regard and the availability of the sugarcane bagasse in the study area, this study was aimed at validating the use of sugarcane bagasse and yeast in the diets of ruminant animals.

MARERIALS AND METHODS

Experimental Site: The experiment was conducted at 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. (Wikipedia, 2018). It is situated at an altitude of 686 m above sea level and lies within the Northern Guinea Savannah zone. The mean relative humidity is 21 and 72 % during the harmmattan and wet season respectively. Annual rainfall ranges from 1102 to 1904 mm in late April or early May to mid-October. The mean temperature fluctuates from 31°C maximum during the dry season to 18°C minimum during the wet season (IAR, 2018).

Source of Bagasse and Treatment: Sugarcane bagasse was sourced from sugarcane juice producer in Makarfi Local Government Area of Kaduna State, Nigeria. The bagasse was sun dried for three days and ground into smaller particle sizes of approximately 5 mm and then treated with urea at 5 % (50 g of urea was dissolved in one litre of water to treat one kg of bagasse). The treated bagasse was then parked in a Pardue Improved Cowpea (PIC) storage bags for two weeks, after which it was opened and aerated before inclusion in the diet.

Source of Animals and Management: The animals were purchased from Anchau Central Market in Kubau Local Government Area of Kaduna State, Nigeria. Prior to the arrival of the rams, the pens were cleaned and disinfected; the rams were quarantined for 2 weeks and treated with Ivomectin (Ivomec) and antibiotics (Tetracycline L.A) at a dose of 1 ml/10kg BW against internal and external parasites.

Experimental Design and Diets: Twenty (20) Yankasa rams with an average live weight of 13 ± 2 kg were used for the experiment. The rams were allotted to four dietary treatments

(Diets 1 – 4) in a completely randomized design, to compare the effect of urea treated bagasse with different inclusion levels of yeast diet on the performance of Yankasa rams. The yeast was included at the rate of 0, 5, 6 and 7 g/kg of the diets respectively for diets 1 – 4. Other feed ingredients include maize offal, cotton seed cake, bone meal, salt and premix. Five rams were assigned per treatment; the experimental diets were formulated to be isonitrogenous and isocaloric (Table 1). The trial lasted for 21 days.

Nutrient Digestibility Study: At the end of the feeding trial, three rams were randomly selected from each treatment group and housed in metabolic crates for easy collection of faecal and urine samples as described by Osuji *et al*. (1993). The rams were allowed 14 days for adjusting to the condition of the metabolic crates before commencement of sample collection which lasted for 7 days. The rams were fed experimental diets at 3 % of their body weight daily. Daily faecal output was weighed and 10 % of each day collection was sub sampled and oven dried at 60°C for dry matter (DM) determination (AOAC, 2005). Daily urine output was collected in a plastic container containing 10 ml 0.1N H_2SO_4 placed under the metabolic crates. At the end of the 7^{th} day collection period, 10 % of the urine taken from each ram was bulked and sub sampled and stored in the refrigerator pending nitrogen determination (AOAC, 2005).

Chemical Analysis: Proximate analysis of individual feed ingredients (urea treated bagasse, untreated bagasse, maize offal, cotton seed cake) and faecal samples were carried using AOAC (2005) procedures. Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined in all the feed ingredients using the methods of Van Soest and Wine (1967).

Statistical Analysis: All data collected were analysed using GLM procedure of statistical Analysis system (SAS, 2002). Significant differences in treatment means were compared using Tukey test and contrast analysis.

RESULTS

Effect of Inclusion Levels of Yeast in Bagasse Based Diet on Nutrient Digestibility: The effect of inclusion levels of yeast in bagasse based diet on nutrient digestibility of growing Yankasa rams indicated that there were significant differences ($p<0.05$) in digestibility coefficients of DM, OM, CP, NDF, ADF and ADL among the treatment groups (Table 2). CP digestibility increased by 11 % in grower rams fed diet containing 7 g inclusion level of yeast than in those on control diet. Rams fed 6 g inclusion level of yeast had 9 % increases in CP digestibility compared to those on 5 g inclusion level of yeast. ADF, NDF and ADL digestibilities followed similar trend with 11, 12 and 19 % increase in ADF, NDF and ADL digestibilities respectively for rams fed 7 g inclusion level of yeast than those on the control group. Results of the pairwise comparison are presented in Table 3. The results showed significant differences ($p<0.05$) in NDF and ADL between rams on control diet and 5 g inclusion levels of yeast. Rams fed control diet and those fed 6 g inclusion level of yeast also showed significant differences ($p<0.05$) in CP, NDF, ADF and ADL. Moreover, significant differences ($p<0.05$) were observed in all digestibility parameters measured between rams fed control diet than those on other treatments.

Effect of Inclusion Levels of Yeast in Bagasse Based Diet on Nitrogen Balance: The result of effect of inclusion level of yeast in bagasse based diet on nitrogen balance of growing Yankasa rams indicated significant differences ($p<0.05$) in nitrogen intake and faecal nitrogen among the treatment groups (Table 4). Nitrogen intake of grower rams fed 7 g inclusion level of yeast was 16 % higher than those on control group. Results for nitrogen absorbed, nitrogen retained and nitrogen retained as percentage intake were statistically similar ($p>0.05$) among treatment groups. However, grower rams fed 7 g inclusion level of yeast had 32 % increase in nitrogen retained than those on the control diet, while nitrogen retention as percentage intake was increased by 15 % in rams fed 7 g inclusion level of yeast than those on 5 g inclusion level of yeast.

Table 1: Gross composition of bagasse based diets fed to Yankasa rams

Parameters	Levels of yeast (g/kg)			
	Diet 1 (Control)	Diet 2	Diet 3	Diet 4
Maize offal	36.93	36.93	36.93	36.93
Bagasse	30.00	30.00	30.00	30.00
Cotton seed cake	29.80	27.00	27.00	27.00
Bone meal	2.00	2.00	2.00	2.00
Yeast	0.00	5.00	6.00	7.00
Salt	1.00	1.00	1.00	1.00
Premix	0.27	0.27	0.27	0.27
Total	100.00	100.00	100.00	100.00
Calculated % CP	14.00	14.00	14.00	14.00
CF %	15.20	15.20	15.20	15.20
M.E(Kcal/kg)	2342.00	2342.00	2342.00	2342.00

M.E= Metabolizable energy, Note: The yeast supplementation is not part of the formulated diet

Table 2: Effect of inclusion levels of yeast in bagasse based diet on nutrient digestibility

Parameters (%)	Inclusion levels of yeast (g/kg)			
	Diet 1 (Control)	Diet 2	Diet 3	Diet 4
Dry matter	53.08 ± 2.02^{ab}	53.19 ± 2.02^{b}	58.61 ± 2.02^{cd}	59.64 ± 2.02^{d}
Organic matter	52.27 ± 2.10^{b}	52.09 ± 2.10^{ab}	58.85 ± 2.10^{cd}	59.23 ± 2.10^{d}
Crude protein	67.33 ± 1.47^{ab}	67.80 ± 1.47^{b}	73.68 ± 1.47^{cd}	74.19 ± 1.47^{d}
Neutral detergent fibre	67.27 ± 1.60^{ab}	70.18 ± 1.60^{bc}	71.05 ± 1.60^{c}	74.41 ± 1.60^{d}
Acid detergent fibre	67.38 ± 2.58^{ab}	67.88 ± 2.58^{bc}	71.92 ± 2.58^{cd}	75.36 ± 2.58^{d}
Acid detergent lignin	57.51 ± 3.54^{bc}	62.56 ± 3.54^{c}	62.74 ± 3.54^{cd}	68.21 ± 3.54^{d}

^{a,b,c,d,} Means with different superscript across treatment differ significantly ($p<0.05$)

Table 3: Contrast analysis of the different diets combinations fed to Yankasa rams

Contrast	Combinations	P-values					
		DMD	OMD	CPD	NDFD	ADFD	ADLD
0 vs. 5 g	Control vs. low level	0.98	0.97	0.89	0.03	0.25	0.04
0 vs. 6 g	Control vs. medium	0.27	0.18	0.03	0.03	0.04	0.03
0 vs. 5 and 6 g	Control vs. low and medium	0.52	0.43	0.28	0.30	0.45	0.66
0 vs. 5 and 7 g	Control vs. low and high	0.00	0.04	0.02	0.03	0.04	0.02
0 vs. 5, 6 and 7 g	Control vs. all levels	0.03	0.03	0.01	0.01	0.01	0.03
5 vs. 6 and 7 g	Low vs. medium and high	0.01	0.01	0.05	0.02	0.03	0.02

DMD=Dry matter digestibility, OMD=Organic matter digestibility, CPD=Crude protein digestibility, NDFD=Neutral detergent fibre digestibility, ADFD=Acid detergent fibre digestibility, ADLD=Acid detergent lignin digestibility

Table 4: Effect of inclusion levels of yeast in urea treated bagasse based diet on nitrogen balance by Yankasa rams

Parameters	Inclusion Levels of yeast (g/kg)			
	Diet 1 (Control)	Diet 2	Diet 3	Diet 4
Nitrogen Intake (g/d)	13.84 ± 0.69^{b}	13.88 ± 0.69^{bc}	16.14 ± 0.69^{c}	16.99 ± 0.69^{d}
Urinary Nitrogen (g/d)	3.66 ± 0.50^{a}	3.65 ± 0.50^{a}	3.69 ± 0.50^{a}	4.15 ± 0.50^{b}
Faecal Nitrogen (g/d)	4.51 ± 0.15^{d}	4.40 ± 0.15^{c}	3.65 ± 0.15^{a}	4.13 ± 0.15^{b}
Total Nitrogen output (g/d)	8.17 ± 0.50^{c}	8.05 ± 0.50^{b}	7.34 ± 0.50^{a}	8.28 ± 0.50^{d}
Nitrogen Absorbed (g/d)	9.33 ± 1.26^{a}	9.48 ± 1.26^{a}	12.49 ± 1.26^{b}	12.86 ± 1.26^{c}
Nitrogen Retained (g/d)	5.67 ± 0.80^{a}	5.83 ± 0.80^{b}	8.80 ± 0.80^{d}	8.71 ± 0.80^{c}
Nitrogen Retained as % intake	40.96 ± 6.17^{a}	42.00 ± 6.17^{b}	54.52 ± 6.17^{d}	51.26 ± 6.17^{c}

^{a,b,c,d} Means with different superscript across treatment differ significantly ($p<0.05$)

The results of the pairwise comparism between treatment groups indicated significant differences ($p<0.05$) in nitrogen absorbed, nitrogen retained and nitrogen as percentage intake between rams fed control diet and other rams fed yeast inclusion diets and also between rams fed 5 and those fed 6 and 7 g inclusion level of yeast (Table 5).

Table 5: Contrast analysis of the different treatment combinations on nitrogen balance by Yankasa rams

Contrast	Combinations	P-values				
		NI	NO	NA	NR	NR %
0 vs. 5 g	Control vs. low level	0.97	0.87	0.93	0.90	0.98
0 vs. 6 g	Control vs. medium	0.09	0.53	0.33	0.06	0.62
0 vs. 5 and 6 g	Control vs. low and medium	0.29	0.78	0.54	0.22	0.78
0 vs. 5 and 7 g	Control vs. low and high	0.93	0.78	0.72	0.59	0.71
0 vs. 5, 6 and 7 g	Control vs. all levels	0.42	0.07	0.01	0.03	0.02
5 vs. 6 and 7 g	Low vs. medium and high	0.29	0.93	0.04	0.01	0.02

NI = Nitrogen intake, NO = Nitrogen output, NA = Nitrogen absorbed, NR = Nitrogen retained, NR % = Nitrogen retained as percentage intake

DISCUSSION

The significant difference in apparent digestibility coefficients of DM, OM, ADF, NDF and ADL across the inclusion levels of yeast in diets was observed in this study. This may however be attributed to the addition of yeast which resulted in the stimulation and proliferation of rumen micro-organism which in turn lead to enhancement of cell wall digestion (Kamel *et al*., 2000). Also yeast offers several important nutritional benefits such as naturally high levels of protein, a wide array of amino acids, a high concentration of the B vitamins and several minerals necessary for maintaining healthy animals (Habeeb *et al*., 2017). It has also been reported that yeast produces enzymes which assist animal digestion as well as nutrients which stimulate digestive bacteria found in the gut. Yeast also improved digestion by providing the digestive enzymes amylase for starch digestion, protease for protein digestion, lipase for fat digestion and cellulase for butterfat synthesis (Kowalik *et al*., 2011). This is in line with the work of Gaafar *et al*. (2009) who observed that yeast supplementation increased digestibility of DM, OM, CP, NDF and ADF of tomato pomace where the gross digestibility derived from the supplementation was superior for 4g yeast inclusion compared to the control group. Moreover, Elseed and Abusamra (2007) observed that yeast supplementation increased organic matter digestibility (OMD) and neutral detergent fibre digestibility (NDFD) in Nubian goat kids fed sorghum hay supplemented with 2.5 and 5 g of yeast.

Rams fed diet with 7 g inclusion level of yeast had higher nitrogen intake, nitrogen absorbed, nitrogen retained and percent nitrogen retention compared to rams fed diet with no yeast inclusion level. Nitrogen balance was positive for rams in all the treatments. This indicated that all the nitrogen absorbed was well tolerated and utilized, however, the lower level of nitrogen retained in diets containing no yeast and 5 g inclusion level of yeast may be due to the presence of urea being hydrolyzed into ammonia more rapidly than the ammonia could be fixed into microbial protein. This may account for the greater urinary nitrogen loss and the higher blood urea nitrogen in rams fed diet with no yeast and 5 g inclusion levels of yeast.

Nitrogen retention is a major indicator used to assess the protein nutritional status of ruminant livestock (Abdu *et al*., 2012). Increase in nitrogen absorbed and retained as percentage intake in rams fed diet containing both 6 and 7 g inclusion levels of yeast was in agreement with the report of Sarwar *et al*. (2003) that nitrogen retention depends on good digestibility of nutrients and / or utilization.

Conclusion: From this study, yeast supplementation at 6 g/kg improved the nutrient digestibility and nitrogen balance of Yankasa rams. Therefore, farmers should include yeast in treated bagasse at 6 g/kg diet for improve performance.

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