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Effect of molasses level on intake and in vivo digestibility of rice straw treated with urea in West African Dwarf goat (*Capra hircus*)

Tendonkeng F*, B. Fogang Zogang, J. Lemoufouet, E. Miegoue, A. Chounna and E. PamoTedonkeng

Animal Nutrition Laboratory, Department of Animal Sciences, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon.

***Corresponding Author:** F Tendonkeng, Animal Nutrition and Production Research Unit, Department of Animal Production, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Dschang, Cameroon.*

ABSTRACT

The evaluation of the effect of molasses level on the ingestion and in vivo digestibility of rice straw treated with 5% urea was carried out at the University of Dschang. The rations were distributed in a completely Randomized design comprising three groups of three West African dwarf goats ages about 12 months with a comparable average weight. These animals were housed individually in the digestibility cages. The adaptation and data collection periods were 8 and 6 days respectively. Each goat received 800 g of rice straw treated with 5% urea per day with inclusion of 0% molasses (RS5 + M0) for group 1; 5% molasses (RS5 + M5) for group 2 and 10% molasses for group 3 (RS5 + M10). A sample of 100 g of each ration, feces and 10 ml of urine was collected every morning for chemical analysis and digestibility assessment. The results of this study show that the addition of molasses enhances the digestibility of the organic matter and the digestible crud protein of the rice straw treated with 5% urea. DM, OM and NDF intake of the RS5 + M0 ration (375, 343.8 and 298 g/d) was higher than that of RS5 + M5 (322.9, 295, 3 and 246.1 g/d) and RS5 + M10 (344.5, 314.8 and 256.6 g/d). The highest apparent dry matter (55.8%), organic matter (58.4%) and NDF (65.2%) digestibility were obtained with RS5 + M5 ration. The apparent nitrogen digestibility of the RS5 + M5 ration was significantly higher (P<0.05) than that of the RS5 + M0 ration and comparable to that of the RS5 + M10 ration. These results show that the inclusion of molasses in rice straw treated with 5% urea does not significantly affect the ingestion and digestibility of DM, OM and NDF, but significantly improves digestibility of nitrogen.

Keywords: *Digestibility, Intake, Molasses, Rice straw, West African Dwarf Goat;*

INTRODUCTION

Small ruminants in sub-Saharan Africa depend on natural pasture and crop residues for the long dry season. These areas are faced with seasonal dry periods in which the quality and availability of the pastures decreases leading to an imbalance of essential nutrients resulting in low feed intake and poor performance (Pamo et al., 2007; Tendonkeng et al., 2016; Tendonkeng et al., 2018). Cereals in general, and especially rice, are not only the staple food for people in sub-Saharan Africa (Sohl, 2005), but they also produce large quantities of crop residues that are abandoned or burnt in the fields (Yaningzhang et al., 2012). Rational exploitation of these crop residues can be a promising way to overcome the quantitative and qualitative forage deficit especially during the long dry periods.Although, it is low in quality and feeding it alone does not provide enough nutrients to the small ruminants to maintain high production levels. The high level of lignifications and limited ruminal degradation of the carbohydrates and the low content of nitrogen are the main deficiencies of the rice straw affecting its value as feed for ruminants (Tendonkeng et al., 2016; Tendonkeng et al., 2018).

Rice straw is poorly fermented and has low rates of disappearance in the rumen and low rates of passage through the rumen, thereby reducing the feed intake (Van Soest, 2006). Rice straw when treated with urea or calcium hydroxide or by supplementing with protein sources, intake, digestibility and the small ruminants performances could be enhanced compared to feeding untreated rice straw alone (Fadel Elseed, 2005; Wanapat *et al.*, 2009). However, the use of rice straw in animal nutrition remains limited by its low ingestion and digestibility due to its low crude protein content, available energy and its high fiber and silica content (16%) (Drake et al., 2002; Van Soest, 2006; Hossain et al., 2010;Huyen et al., 2012;Tendonkeng et al., 2018). Several studies have shown that the treatment of 5% urea roughages improves their dietary values (Sarnklong et al., 2010, Fawzy et al., 2014). However, Hossain et al. (2010) reports that treatment with urea alone is insufficient to meet the needs of animals. Supplementation is therefore necessary in addition to treatment to achieve significant production (Upreti and Orden, 2008). Thus, molasses, which is an excellent source of rapidly fermentescible energy, optimizes the use of ammonia produced by urea, and generates minerals (especially trace elements) (Chenost and Kayouli, 1997) will be a good supplement. Despite these positive effects of molasses on the use of poor forages, no studies have been carried out on the effect of molasses level on the ingestion and digestive use of rice straw treated with 5% urea in the West African dwarf goat. The essence of this paper is to contribute to the existing knowledge which is common and cheaper on how to improve the utilization of rice straw by small ruminants in Cameroon to increase livestock production.

Materials and Methods

Study Area

The study was conducted at the Experimental Farm of the University of Dschang in Western Cameroon. The area is within the Sudano–Guinean zone of Central Africa (latitude5–7° N, longitude 8–12°E;altitude1,400masl).Theannual temperature varies between 16 and 27 °C with a relative humidity of 40–97 %. There are two main seasons: the rainy season (April–October) and the dry season (November–March). The mean annual rainfall is about 2,000 mm (Pamoet al., 2007).

Rice Straw and Treatment

The rice straw belonging to the NERICA3 variety (New Rice for Africa). This straw was collected in the plots of the former SODERIM in Santchou, transported to the experimental farm at the University, where it was manually chopped into small pieces of about 2 to 5 cm with a machete and then dried in the sun before stored in the backs for urea treatment. The urea treatment was done as describe by Chenost and Kayouli (1997).For the actual treatment, 100.08 kg of pre-chopped rice straw were spread on a black plastic film and then sprayed in superimposed layers with a solution obtained by dissolving 5.08 kg of urea in 55.88 liters of water using a watering can. This straw, thus watered, was mixed until it was completely impregnated with urea. The straw thus treated was sealed with the same plastic film which was sealed with an adhesive tape for a period of 21 days (incubation period). At the end of this incubation period, the grindstone thus formed was opened and the straw spread over the plastic film for 24 hours to allow the smelling odor of the ammonia to escape. Before serving each ration (800g straw treated with urea), we added 0, 5 or 10% molasses (relative to the weight of the ration) corresponding respectively to the RS5 + M0 (control), RS5 + M5 and RS5 + M10. This molasses came from the sugar factory of the Sugar Company of Cameroon (SOSUCAM) in Mbandjock. The molasses was dissolved in water and the volume of water used for its dilution was a function of the amount of straw to be treated at the rate of 250 ml of water for 600 g of straw (Chenost and Kayouli, 1997).

Animals

Nine adults West African dwarf goats (average weight of 18.27 ± 3.67 kg) were used to evaluate the effect ofmolasses level on digestibility of rice straw treated with 5% urea. A month before the study started, all animals weredewormed with Ivermectin® 1 %. During the adaptation period, animals were fed with the same diet to evaluate. Thisperiod allowed animals to familiarise themselves with the diet and also to know approximately the quantity of diet consumed daily per animal in order to serve a little more during the trials.

Intake and *in vivo* Digestibility

A 3×3 Latin square design was used for this study, where data collection was preceded by an adaptation period of10 days. During the data collection period (6 days), each animal received a ration of 800 g of rice straw according to its group and water *ad libitum*. The distribution of the rations to the animals was done two times (0.4 kg inthe morning at 8 a.m. and 0.4 kg in the afternoon at 4 p.m.) to avoid waste. During this test, nine goats housed in individual digestibility cages were randomly divided into three groups of three animals each as follows:

Group1: animals receiving rice straw treated with 5% urea + 0% molasses (RS5 + M0)

Group2: animals receiving rice straw treated with 5% urea + 5% molasses (RS5 + M5)

Group3: animals receiving rice straw treated with 5% urea + 10% molasses (RS5 + M10).

Intakes of different rations were calculated as the difference between the amount given and the amount refused. The apparent digestibility coefficients of dry matter, organic matter, nitrogen and crude fibre were calculated according to Sanginés-Garcia et al. (2010).

Faeces and urine from each animal were collected every morning in the collector before giving in new ration and taken tothe laboratory. Nitrogen loss from urine and bacteria growth infestation was prevented by introducing 10 ml of 10 %sulfuric acid in the collected tube. The refusals of the ration were weighed every morning.

Chemical Analyzes

Are presentative sample of each ration and feces was milled then dried in an oven at 60 °C for laboratory analysis. Standard methods as described in AOAC (1991) were used for the determination of dry matter (DM), organic matter (OM) and ash. Crude protein was assayed by the Kjeldahl method. Lipids were assayed by Soxthlet method. Neutral detergent fiber (NDF) was analyzed according to VanSoest et al. (1991). Digestibility of organic matter (OMD), digestible protein and carbohydrate were estimated according to Sauvant (1981). The energy for meat (UFV) and milk(UFL) production were calculated using the equations ofSauvant (1981).Nitrogen retention was calculated as the total N intake (g/day) minus the sum (g/day) offecal and urinary N excreted. Nitrogen retention wasalso expressed as a percentage of N intake. Apparenttotal-tract digestibility was calculated using OM,NDF, and N intake and OM, NDF, and N excreted inthe feces

Statistical Analysis

Data generated from parameters investigated were subjectedto analysis of variance (ANOVA) using the general linear modelling procedure. Significant differences between treatment means were separated using Duncan's multiple range test at 5 % level of significance.

RESULTS AND DISCUSSION

Cell wall (NDF) and total carbohydrate levels decreased with the increasing level of the molasses in the rations (Table 1).

Table1. *Chemical composition and nutritive value of the different rations.*

Chemical composition		Rations	
	RS5+M0	RS5+M5	RS5+M10
Dry matter(%)	95.4	95.6	94.7
Ash (%DM)	7.7	8.1	8.4
Organicmatter (%DM)	87.7	87.6	86.3
Crudeprotein (%DM)	13.0	14.1	14.5
Lipids (%DM)	2.2	2.6	2.4
NDF (%DM)	78.6	76.7	73.0
Carbohydrate (%DM)	72.6	70.9	69.5
OMD (%DM)	17.9	22.4	26.9
Digestible protein (g/100gOMD)	11.6	12.8	13.4
UFL/kgDM	0.6	0.6	0.7
UFV/kgDM	0.5	0.5	0.6

OMD: Organic matter digestibility; UFL: energy for milk production; UFV: energy for meat production.

Table2. *Ingestion of DM, MO and NDF of the different rations in West African dwarf goats.*

Ingestion (g/d)	Rations				
	RS5+M0	RS5+M5	RS5+M10	SEM	p
Dry matter (DM)	375.0	322.9	344.5	11.82	0.20
Organicmatter (OM)	343.8	295.3	314.8	10.89	0.19
Cellvall (NDF)	298.0	246.1	256.4	10.70	0.09

SEM: Standard error of mean, p: probability.

The contents of crude protein increased with the level of addition of molasses. Digestible protein and organic matter digestibility (OMD) increased with the level of addition of molasses in the rations. The highest intake of dry matter (DM), organic matter (OM) and cell walls (NDF) was obtained with RS5 + M0 (375.0, 343.8, 298gDM/d) and the lowest with RS5 + M5 (322.9, 295.3, 246.1 gDM/d) (Table 2). The addition of molasses did not significantly (p>0.05) influence the DM, OM and NDF intake of different rations. The highest apparent digestibility (CUDa) of DM, OM and NDF were obtained with RS5 + M5 (55.8, 58, 4, 65.2%DM), while the lowest for dry matter was obtained with the RS5 + M0 ration (53.7%DM) (Table 3).

The addition of molasses had not significantly (P>0.05) improve the digestibility of DM, OM and NDF.

Table3. *Digestibility of DM, OM and NDF of different rations in West African dwarf goats.*

Apparent digestibility (%)	Rations				
	RS5+M0	RS5+M5	RS5+M10	SEM	p
Dry matter (DM)	53.7	55.8	54.1	1.00	0.72
Organic matter (OM)	55.7	58.4	55.3	1.12	0.53
Cellvall (NDF)	64.3	65.2	59.5	1.54	0.30

SEM: Standard error of mean, p: probability.

The amount of nitrogen ingested by animals receiving the ration RS5 + M10 (7.9g/d) was higher, although no significant difference (p>0.05) was observed (Table 4).The amount of nitrogen excreted in feces by animals receiving the ration RS5 + M5 (3.3 g/d) ration was comparable (p>0.05) to that of animals receiving the ration RS5 + M10 (3.8 g/d) and significantly lower than that of animals receiving the ration RS5 + M0 (3.9 g/d).

In addition, the faecal nitrogen of the animals receiving the ration RS5 + M0 was comparable to that of the animals receiving the ration RS5 + M10.

Table4. *Effect of molasses level onnitrogen intake, digestion and balance of the rations.*

Parameters	Rations				
	RS5+M0	RS5+M5	RS5+M10	SEM	p
Nitrogen intake (g/j)	7.7^{a}	7.5^{a}	7.9^{a}	0.12	0.48
Faecal nitrogen (g/j)	3.9^{a}	3.3^{b}	3.8^{ab}	0.11	0.04
Urinary nitrogen (g/j)	3.4^{a}	3.5^{a}	3.1^{a}	0.13	0.37
Nitrogen absorbed (g/j)	0.3^{c}	0.6^{b}	1.0^{a}	0.19	0.03
Apparent digestibility of Nitrogen (%)	48.2^{b}	54.9^{a}	51.3^{ab}	1.21	0.04

a, b: values with different letters are significantly different at 5%.

SEM: Standard error of mean, p: probability.

The urinary nitrogen of animals receiving the ration RS5 + M5 (3.5 g/d) was higher, with no significant differences observed. The amount of nitrogen retained increased significantly with the increasing level of molasses in the ration. The highest apparent digestibility of nitrogen was obtained with the ration RS5 + M5 (54.9%), while the lowest was obtained with the ration RS5 + M0 (48.2%). The apparent digestibility of nitrogen of the ration RS5 + M0 was comparable to that of the ration RS5 + M10. The same observation was made between the rations RS5 + M5 and RS5 + M10. On the other hand, the apparent digestibility ofnitrogen of the ration RS5 + M5 was significantly higher than that of the ration RS5 + M10.

Discussion

The crude protein content of the rice straw treated with 5% urea was close to those reported by Gongnet*et al.* (1997),Boka (2009),Sooden-Karamath and Youssef (1999), while the ash levels were lower than those obtained by Sooden-Karamath and Youssef (1999) (17.0%DM) and Boka (2009) (16.02% DM). These differences in the chemical composition of the rations would result from different authors' use of different varieties, soil type and harvest period, time between harvest and straw use, and fertilization (Drake *et al*., 2002, Attoh-Kotoko, 2011). NDF contents decreased with the level of addition of molasses in rations. These results are consistent with those obtained by many authors (Matumuini*et al*., 2013, Lemoufouet *et al*., 2014) and suggest that the addition of molasses would have a diluting effect on the organic composition of the plant (Matumuini*et al*., 2013). Digestible crude protein and organic matter digestibility (OMD) increased with the addition of molasses in the rations. The addition of 10% molasses improved UFL and UFV of the rations. These results are similar to those obtained by Lemoufouet*et al*. (2014) and corroborate the assertion that molasses improves the energy value of rations (Matumuini*et al*., 2013).

The addition of molasses did not significantly (p>0.05) increase the ingestion of DM, OM and cell walls (NDF) of the rations. The highest DM, OM and NDF intake was obtained with the ration RS5 + M0 and the lowest with the ration RS5 + M5. These results are consistent with those obtained by Hue *et al*. (2003) who, treating rice straw with 2.5% urea, 0.5 kg lime and 0.5 kg table salt in sheep concluded that the addition of molasses did not significantly improve ingestion of rice straw treated with urea in these animals.

The addition of molasses did not significantly (p>0.05) increase the digestibility of DM, OM and cell walls (NDF) of the rations. The highest dry matter and organic matter digestibility were obtained with the ration RS5 + M5. This inclusion level of molasses (5%) which gives the best apparent digestibility of MS, MO and NDF is within the recommended margin (4 - 6%) reported by Broderick and Radloff (2004). In fact, molasses is a byproduct of sugar cane processing rich in minerals (Ca, P, K), vitamins and sugars (sucrose, glucose and fructose) (Arzate, 2005); these nutrients have contributed to improved food utilization efficiency (Matumuini*et al*., 2013;Lemoufouet et al., 2014). The apparent digestibility of DM and OM obtained with the ration RS5+M5 are close to those reported by Sooden-Karamathand Youssef(1999) (63.2 and 58.6%) with rice straw treated with 5% urea associated to a commercial concentrate containing a growth promoter and a grass.

The low digestibility of the dry matter of the ration RS5 + M0 would be correlated with its low energy content, which leads to insufficient proliferation of the microorganisms of the rumen, the bulkiness of the latter which tends to prolong the stay of the food in the digestive tract (Lapierre and Bernier, 1996). On the other hand, the reduction of the digestibilities of the OM and the cell walls (NDF) of the ration RS5 + M10 is due to a large amount of sugars which would limit the use of these constituents of the ration by the microorganisms. In fact, a molasses intake of more than 6-8% of the ration contributes to reducing the digestive use of the ration (Broderick and Radloff, 2004, Matumuini*et al*., 2013).

The amount of nitrogen retained increased with the increasing level of molasses in the diet, with no significant difference observed. These results confirm that the addition of molasses to rations based on roughages improves the digestibility of nitrogen (Swanson *et al*., 2004). Indeed, microorganisms would use the energy provided by molasses and ammonia produced by the fermentation of rice straw to synthesize microbial proteins. This supports the assertion that molasses is an excellent source of rapidly fermentescible energy that optimizes the use of ammonia produced by urea and generates minerals, especially trace elements (Chenost and Kayouli 1997). The addition of 5% molasses significantly increased the apparent digestibility of the nitrogen in the rice straw treated with 5% urea. This is explained by the fact that molasses provides the energy and urea the carbon skeleton necessary for the microorganisms of the rumen to improve the degradation of the ration and the passage of digesta from the rumen to the abomasum, resulting in improved digestibility of nutrients (Chenost and Kayouli, 1997;Matumuini*et al*., 2013).

CONCLUSION

At the end of this study, cell wall (NDF) and total carbohydrate contents decreased with the increasing level of molasses in the rations. On the other hand, the contents of total crude protein, digestible crude protein and organic matter digestibility (OMD) increased with the level of addition of molasses in the rations.

The addition of 5% molasses to the rice straw treated with 5% urea help to obtain the best DM, OM and NDF digestibility. However, the addition of different levels of molasses to rice straw treated with 5% urea did not significantly influence (P>0.05) the intake and digestibility of DM, OM and Cell walls (NDF). The addition of molasses to rice straw treated with 5% urea significantly improved (P<0.05) the apparent digestibility of nitrogen in West African dwarf goats. Although the results of this study are satisfactory with 5% molasses, it would be desirable to evaluate the effect of adding 5% to the urea-treated rice straw on the production performance of the West African dwarf goat. A similar study could be considered in Djallonké sheep to assess its suitability for using this crop residue.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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