Effect of 2 Types of Yeast on Rumen Fermentation in Carpatina Crossbred Goats – Short Term Study

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Abstract

For the experiment were allotted 3 groups of Carpatina crossbred goats (18 months old) with eight animals per group. The treatment concentrate diets for each group were as follows: control diet C (without yeast), diet D-a (includes 1.5% VY - viable yeast) and diet D-i (includes 3% BSY - brewer's spent yeast). After feeding for 21-days period, we determined digestibility and nitrogen retention rate. For rumen fermentation characteristics were taken rumen samples on 2 consecutive days and analysed for volatile fatty acids, pH and ammonia. Digestibility and nitrogen balance were not affected by yeast treatment, as well the rumen pH. The rumen ammonia increased for both yeast diets. The total volatile fatty acids production was increased only for D-a diet, but the relative proportions of these acids were similar between the diets, as well the acetate:propionate ratio.

Keywords: yeast, rumen volatile fatty acids, goat.

1. Introduction

Positive effects of a yeast culture (viable yeast *Saccharomyces cerevisiae*, VY) on performances of dairy cows and rearing calves have been reported in many studies. However, a significant positive effect of yeast on animal performance was not always confirmed. It was noticed that the diet composition influenced the response of ruminants to yeast supplementation: if the ratio of concentrate to forage in the ration increased then the milk yield also increased. The presence of the yeast increased the productivity but it was often associated with an increase in feed intake. Therefore, the mode of action of a yeast culture needs to be studied to explain the variable response to yeast supplementation. The in vitro study of Oeztuerk (2009) [1] showed that live yeast culture had a positive effect on ruminal fermentation more pronounced than inactivated yeast, and it is diet-dependent, being more noticeable with a high-fibre substrate, and subtle with a high concentrate diet [2].

Beside the VY, the brewers' spent yeast (BSY) was also included in animal feeding. BSY is a brewing by-product and it can be collected from fermentation tanks, after the filter line. BSY merits considerable attention, due to the large quantity produced (is the second largest by-product from breweries) and its rich chemical composition (complex carbohydrates like beta-glucans, large amounts of B-vitamins, good amino acid profile, and minerals such as zinc and selenium). Depending on the strains used in the fermentation process and extraction techniques, dry yeast BSY can provide about 42% crude protein [3]. Therefore, this feedstuff can be a good source of protein for livestock animals. The replacement of soybean meal by dry yeast as protein source in ruminant nutrition have been studied, for example for feeding lactating dairy goats and registration of variable responses on

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intake and digestibility of dry matter and nutrients [3-5]. The use of this by-product depends on economic factors and market availability.

The purpose of this preliminary study was to evaluate - for a short time term - the effect of the above mentioned types of yeast (viable, VY and inactivated, BSY) on digestibility and rumen fermentation on goats fed 2 different concentrate diets.

2. Materials and methods

Experimental animals and feeding

24 dairy Carpatina crossbred goats, 18 months olds with initial body weight of 34.08±5.97 kg were raised in individual pens (2 x 3 m).Three dietary concentrate treatment groups were separated (8 goats each) and each diet was fed as follows: control diet C (without yeast), D-a diet (with VY-viable, commercial bakery yeast, Egypt, included level 1.5%) and D-i diet (with BSY-brewer's spent yeast, Romania, included level 3%).

All animals were fed with concentrate at 0.6 kg/head (Table 1) in two equal meals per day (07:00 and 16:00 h) and with cock's foot hay fed 0.7 kg/head. Clean water was available at all times.

The experiment was conducted for 21 days. The last 2 days were for samples collection when 4 animals of each group were moved to the metabolism crates for total collection (faeces and urine).

Data collection, sampling procedure and chemical analysis

The individual feed intake of concentrate and hay were measured daily by weighing the offered and refused feeds before the morning feeding.

Faeces and urine were collected to determine apparent nutrient digestibility and nitrogen (N) retention. Feeds and faeces were dried at 60^{O}C then were ground to pass through a 1–mm screen. Sample (feed and faeces) were chemically assessed for dry matter, ash, crude protein, ether extract and crude fibre according to standard methods [6].

After the collection period, rumen fluid samples were collected on 2 consecutive days at about 200 mL by using a flexible esophageal tube (2 mm of wall thickness and 6 mm of internal diameter) connected with vacuum pump, from all goats at 4 h after the morning feed. Each sample was filtered by cheesecloted filter. The rumen pH was immediately measured by using a pH-meter (Dostmann electronic GmbH). An aliqote of 25 mL of the rumen fluid was analyzed for the ammonia-N concentrations by an electrode with permeable ammonia membrane. Another aliqote of 10 mL of rumen fluid was preserved with 2.5 ml phosphoric acid (25%, w/v), and kept at −20°C for later analysis of VFA (volatile fatty acids) by gas chromatography (capillary column Elite-FFAP (Perkin Elmer, USA) length 30 m, inner diameter 320 μm, film thickness of 0.25 μm; hydrogen carrier gas, flow 1.5 ml/per min.; injector set at 250ºC, flame ionization detector set to 200^{O}C, column oven set to 110^{O}C and temperature was increased to 170^{O}C at a rate of 12^{O}C/min, where it was held for 9.5 min.).

Digestibility and fermentation data were presented as means, using a 2-way analysis of variance to detect differences [7].

3. Results and discussion

Feed ingredients and chemical compositions

Feed ingredients and their chemical compositions are presented in the Table 1. The energy (feed unit for lactation, UFL) and the digestible protein (PDIN, PDIE) for total diet were calculated for dairy goats as to be enough for good health status even the animals were at the end of lactation.

The both types of yeast appeared in good physical property and were readily introduced in concentrates. VY contained 468.14 crude protein (CP), 14.03 ether extract (EE), 2.70 crude fiber (CF) and 53.02 ash on g/kg DM basis, and BSY contained 531.23 CP, 54.58 EE, 121.56 CF and 30.96 ash on g/kg DM basis.

Table 1. Feed ingredients of the experiment diets concentrates and the chemical composition of the total diets

	diet C	diet D-a (with VY)	diet D-i (with BSY)
Ingredients in concentrate (as fed, %)			
maize	46.5	45	43.5
wheat	32.5	32.5	32.5
rice bran	6.0	6.0	6.0
sunflower meal	12.0	12.0	12.0
VY (viable yeast)	-	1.5	-
BSY (brewer's spent yeast)	-	-	3.0
calcium phosphate	0.5	0.5	0.5
calcium carbonate	0.5	0.5	0.5
sodium chloride	1.0	1.0	1.0
mineral-vitamin supplement	1.0	1.0	1.0
Intake (kg/day/animal)			
concentrate	0.600	0.600	0.600
cock's foot hay	0.593	0.607	0.602
Nutrients in total diet			
Dry Matter, DM, as fed (g)	1118.36	1118.98	1119.6
Crude Protein, CP (g/kg DM)	108.72	111.93	116.2
Ether Extract, EE (g/kg DM)	16.57	16.41	16.94
Crude Fiber, CF (g/kg DM)	265.06	264.78	266.49
N-free extract (g/kg DM)	637.6	635.2	629.42
Total Ash (g/kg DM)	74.38	74.64	74.53
Starch (g/kg DM)	311.84	307.21	311.23
UFL[1]	0.9079	0.9076	0.9072
PDIN[2] (g)	81.52	86.63	88.74
PDIE[3] (g)	90.57	91.05	91.52

[1]UFL=feed unit for lactation
[2]PDIN=intestinally digestible protein allowed by nitrogen supply
[3]PDIE=intestinally digestible protein allowed by energy supply

Dry matter intake and nutrients digestibility

The intake is also presented in Table 1 and it can be observed that the yeast inclusion in the diet had no effect on hay intake ($p>0.1$). Freitas et al. (2011) [4], working with goats fed BSY in substitution for soybean meal, also found no difference in DM intake; the replacement of a conventional high-cost ingredient, such as soybean meal, for a by-product, such as BSY, shows the possibility of using new ingredients in ruminant diets. Lima (2012) [3] observed that DM, CP and organic matter intakes of the BSY diet were lower than soybean+BSY diet, but these differences seem to be more related to slight variation for body weight of animals within each diet.

The apparent digestibility coefficients are shown in Table 2. The DM, OM and CP digestibilities were not altered among diets. The lack of an effect of viable yeast on digestibility is in accordance with the experiment of Arcos-Garcia (2000) [8] who fed sheep with diets based on sugar cane tops supplemented with yeast cultures. For dry inactive yeast, Lima et al. (2012) [3] observed that the total digestible nutrients, in prepartum and postpartum Saanen goats, were not affected, only a reduction of EE digestibility from the inclusion of 38.5% of dry yeast in diets was noticed. He concluded that the inclusion of dry yeast in diets provided good energetic value for goats and dry inactive yeast can replace protein source in diets for goats with no changes on nutritive value of diets.

N–balance

The results of nitrogen balance are shown in Table 3. They were not affected by yeast treatment. These results were in accordance with the results of Edwards (1990) [9], obtained with intensively fed bulls or with results of Cunha (2019) [10] for beef cattle tested for the effect of live and inactive sugarcane yeast.

Table 2. Effect of diet on nutrient digestibility (%)

	diet C	diet D-a (with VY)	diet D-i (with BSY)	SEM*	significance**
Dry matter	77.33	76.89	76.54	1.3	>0.1
Organic matter	80.12	79.06	79.01	1.2	>0.1
Crude protein	64.29	61.17	61.48	4.0	>0.1

*SEM: standard error of the mean
**>0.1 NS (not significant)

Table 3. Effect of diet on nitrogen (N) balance

	diet C	diet D-a (with VY)	diet D-i (with BSY)	SEM*	significance**
Crude protein intake (g/day)	121.6	125.2	130.0	12.2	>0.1
Fecal N (%)	35.71	38.83	38.52	4.0	>0.1
Absorbed N (%)	64.29	61.17	61.48	4.0	>0.1
Urinary N (%)	51.00	49.83	48.02	6.3	>0.1
Retained N (%)	13.29	11.35	13.46	6.2	>0.1

*SEM: standard error of the mean
**>0.1 NS (not significant)

Rumen fermentation characteristics

The rumen fermentation data are presented in Table 4. The presence of both types of yeast had no significant effect on rumen pH. The value of rumen pH (6.71 to 6.83) was in good range value which would support the optimal microbial activity. Other studies have shown that ruminal pH was not affected by the feed supplementation with viable *Saccharomyces cerevisiae* [11] or killed yeast, used for lactating dairy cows [12].

Table 4. Effect of diet on rumen fermentation characteristics

	diet C	diet D-a (with VY)	diet D-i (with BSY)	SEM*	significance**
pH	6.83	6.73	6.71	0.05	>0.1
Ammonia NH_3-N (mg/L)	155.25	187 .86	167.71	7.27	>0.1
Total Volatile Fatty Acids (VFA, mM/L)	36.81	42.31	36.63	3.07	>0.1
Acetate C2	25.51	29.21	25.60	2.07	>0.1
Propionate C3	7.58	8.62	7.44	0.81	>0.1
Isobutyrate i-C4	0.26	0.32	0.31	0.02	>0.1
Butirate C4	2.86	3.47	2.78	0.26	>0.1
Isovalerate i-C5	0.22	0.30	0.22	0.02	0.077
Valerate C5	0.30	0.32	0.22	0.03	0.1
Caproate C6	0.07	0.06	0.05	0.01	>0.1
Molar % of VFA					
Acetate C2	69.30	69.05	69.89	0.69	>0.1
Propionate C3	20.60	20.38	20.32	0.94	>0.1
Isobutyrate i-C4	0.73	0.77	0.85	0.05	>0.1
Butirate C4	7.78	8.20	7.59	0.46	>0.1
Isovalerate i-C5	0.59	0.71	0.60	0.07	>0.1
Valerate C5	0.82	0.76	0.61	0.06	0.06
Caproate C6	0.19	0.13	0.13	0.03	>0.1
Acetate-to-Propionate ratio C2/C3	3.36	3.39	3.44	0.18	>0.1

*SEM: standard error of the mean
**>0.1 NS (not significant)

In this experiment, however the rumen ammonia concentration was increased for diet D-a, the effect was not significant. We suppose that VY yeast could induce an important increasing of the ammonia if the animals feeding would have been longer, and this could not be due to diet CP (the diets were isonitrogenous). The ammonia is beneficial for increasing microbial protein synthesis and any improvement in this synthesis is closely linked to enhancing rumen feed degradation [13].The ammonia production on VY-supplemented diets may depend on substrate: it was not affected when was added to high fibre diets, but yielded less in low fibre diets [10, 14].

The findings of this experiment revealed that total volatile fatty acids (VFA) production in diet D-a were increased but not statistically significant. The same increasing but not significantly was observed for molar concentrations of C2, C3, i-C4, and C4 acids; only for i-C5 acid it was an important enhance. There were no differences in molar VFA proportions among treatment diets, especially for the important C2 and C3 acids. The C4 molar proportion tended to increase in diet D-a, and the i-C4 tended the same in diet D-i but both tendencies were not significant. We observed an exception of C5 acid of which proportion was highest in diet C. The C2:C3 ratio was similar among treatment diets.

The observations regarding VFA (the energy source for maintenance and growth especially) probably could be different in our experiment if the term for feeding would have been longer. The constant VFA production like in our study was observed by Cunha (2019) [10] for beef cattle fed total mixed ration composed by corn silage (20%) and concentrate (80%) supplemented with live and inactive sugarcane yeast. Also, non-significant increase in VFA was registered for adult male Balady goats dietary supplemented with live dried yeast by Abd-Elkader (2019) [15] or Arcos-Garcia (2000) [8] who fed sheep. In the review of Newbold (1990) [16] the inclusion of viable yeast had a significant effect on the rumen fermentation characteristics: higher pH, less C2, more C3 and less ammonia, but constant total VFA. The increasing of C3 which is a primary glycogenic precursor is efficient for microbial growth in the rumen. The same lower molar percentage of C2 and greater that of C3 when feeding nonlactating cows with active dried yeast was registered by Chung (2011) [17]. He also, observed that different strains of *S. cerevisiae* vary in their ability to modify the rumen fermentative pattern.

Concerning the effect of inactive dry yeast on rumen VFA there are few data. Dry yeast from sugar cane was studied as protein source for feeding lactating dairy goats and results showed that it provides the milk quality (protein, lactose, acidity) and milk yield similar to those observed when soybean meal was used.

4. Conclusions

The VY is acting as a probiotic and could be included in concentrate diet for goats. Its beneficial effects on rumen environment could be observed after minimum 21-days of feeding. The well-characterized strains of live yeast are commercially available and have a stabilizing effect on the rumen microbiota.

BSY, also could be included in goats diet with similar effects on rumen as a reference diet. BSY is a new ingredient which became widely used in ruminant diets as a good alternative protein source. The decision to use such ingredient will be based on cost and market availability.

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