NUTRITIONAL VALUE OF *VINASSE* AS RUMINANT FEED

HRANJIVA VRIJEDNOST VINASSE KAO KRMIVA ZA PREŽIVAČE

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SUMMARY

The analysis of sugar beet vinasse, originating as the condensed molasses residue from yeast production, and the effect of vinasse on rumen fermentation, protozoa population and digestibility of nutrients was investigated in two experiments. In the first experiment, a ration containing vinasse and wheat straw was fed ad libitum and voluntary feed intake for each sheep was measured. In the second experiment, four rumen fistulated Zandy sheep (40±0.5 kg BW) were assigned in a change over design in order to investigate the effects of vinasse on animal performance. At 2h post-feeding the ruminal pH value was decreased ($p<0.005$) in treatment groups. The ruminal NH_3-N and protozoa population of rumen fluids were increased in all treatment groups. Compared to the control groups, voluntary feed intake and diet digestibility were higher in treatment groups. It can be concluded that the use of vinasse at the level of 100 g/kg DM of the TMR diet per sheep per day could improve the ruminal fermentation and voluntary feed intake and also diet digestibility, resulting in a relatively better performance.

Key words: Vinasse, diet digestibility, voluntary feed intake, rumen fermentation

INTRODUCTION

Vinasse is a by-product of industrial production of alcohol, or other substances by fermentation of molasses (Haanon et al., 1990; Bokori et al., 1992; Scipioni et al., 2001). Nitrogen compounds of vinasse are largely non-essential amino acids, predominantly glutamic and aspartic acids. Vinasse is a suitable feed stuff in the feeding of ruminants, since most of its crude proteins comprise to amide- substance, and are palatable to ruminants. It is easily fermented in the rumen, and then used in microbial protein synthesis (Krzeminski et al., 1984; Leontowicz et al., 1986; Wahlberg et al., 1979). It has been reported that the consumption of forage by animals has been increased due to vinasse added to the rations, and causes an increase in daily live weight gain (Stemme et al., 2004). Inconsistent results were reported with the use of vinasse as feed additives in ruminants (Kulasek et al., 1984; Krzeminski et al., 1984; Leontowicz et al., 1994; Sampaio et al., 1989). The use of vinasse as a feed additive in poultry and pigs (Vranesic et al., 1980; Waliszewski et al., 1997; Kemenade et al., 1988; Stemme et al., 2004) and the dosages used in ruminant diets (Potter et al., 1985; Troccon et al., 1989) were reported to show its influence on animal performance. Inclusion of different dosages of vinasse and protozoa in ruminant rations has been shown to affect the molar proportions of rumen volatile fatty acids (Pahlavan et al., 2007) and not only improve nutrient digestibility but also increase voluntary feed intake (Leontowicz et al., 1994). The number of rumen protozoa (Stern et al., 1992) and the amount of ruminal ammonia nitrogen in dairy cattle and sheep (Potter et al., 1985; Lewicki et al., 1978) were also reported to be increased due to vinasse in diets. In contrast, Leontowicz et al. (1988) reported that vinasse in the ration of lamb had no significant effect on their performances. Moreover, Sampaio et al. (1989) reported that the digestibility of nutrients was not affected by vinasse in beef cattle. Kulasek et al. (1988) showed

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that vinasse had no effect on protozoa population in the rumen of sheep.

Although reasonable research are effects of vinasse as a ruminant feed has been conducted worldwide, little information has been published. Based on these considerations, the present study was conducted to investigate the effects of using vinasse in diets on fermentation parameters (PH, ammonia nitrogen (N-H3-N) and microbial population (protozoa) of the rumen in Zandy sheep. The total tract digestibility of ration nutrients and the voluntary feed intake were also investigated.

MATERIALS AND METHODS

Chemical analyses

Feed dry matter (DM) was determined by oven-drying at 55°C for 48h. Ash, ether extract and crude protein (CP) were measured as described in procedures of AOAC (1995). Crude Fiber (CF), Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) were measured according to procedures described by Van Soest et al (1991).

Experiment 1

In this experiment, four Zandy male sheep of an average BW of 41±1.5 kg were assigned in a complete randomized design. Animals were housed in individual metabolic pens with free access to water. A ration containing vinasse and wheat straw was fed ad libitum for 10 days adaptation and the next 10 days voluntary feed intake for each sheep was measured. The diets offered in tow equal portion at 12:00 and 24:00 daily. The residual amounts of diet were collected and measured in the morning of the next day before feedings.

Total tract digestibility of diet:

The total tract digestibility of diet was also measured by total feces collections for 7 consecutive days. A representative sample of homogenized and weighed feces was taken each day and dried at 60 ^{0}C for 48h. The dry matter of feed and feces samples was measured and their digestibility was calculated.

Experiment 2

Four rumen fistulated Zandy sheep (40±0.5 kg BW) were assigned in a change over design in order to investigate the effects of vinasse on animal performance. Sheep were housed in individual metabolic pens with free access to water. The total mixed ration (TMR) was offered to sheep (Table 3), and vinasse was used at the level of 100 g/kg DM of the TMR diet per sheep per day. In each experiment, based on change over design, animal fed 1.2 times of the maintenance requirements. Diet was offered twice daily at 12:00 and 24:00 and samples were collected for 34 days.

Table 1. The ingredients, chemical composition and energy content of diets used in experiment 2.

Tablica 1. Sastojci, kemijski sastav i sadržaj energije obroka korištenih u pokusu 2

Items - Sadržaj	Percent - Postotak
Diet Ingredients (DM bases) Sastojci obroka (ST – baza)	
Alfalfa hey - Sijeno lucerke	26
Wheat straw – Pšenična slama	52
Barely grain – Ječam u zrnu	10
Cottonseed – Pamukova sačma	12
Chemical composition (DM) Kemijski sastav (ST)	
Crude protein – Sirove bjelančevine	90.98
ERDP[1]	58.42
DUP[2]	21.78
NDF	49.6
ADF	37
Calcium - Kalcij	4.15
Phosphorus - Fosfor	1.59
Energy content (MJ kg^{-1} DM) Sadržaj energije (MJ kg^{-1} DM)	
ME[3]	6.94
FME[4]	6.17

1-Effective rumen degradable protein

2-Digestible undegradable protein

3-Metabolizable energy

4- Fermentable metabolizable energy

Rumen fluid samples

Rumen fluid samples were collected at 11:00, 14:00, 17:00 and 20:00 daily. The pH of the samples was measured immediately after the sampling times and the NH_3-N was assayed using the standard

methods. 2 ml of ruminal fluid mixed with 2 ml of formalin and used to count microbial populations.

Statistical analysis

Data were analyzed using GLM procedure of statistical analyzer software (SAS, 1997). Results were reported based on the mean values for observation in treatment groups with their related Standard Error of Mean (SEM).

RESULTS AND DISCUSSION

Ruminal PH

Before-feeding, the ruminal pH of treatment group was higher ($p<0.05$) compared to the control group (Table 2). After wards, pH values were dropped due to the highly fermentable carbohydrate contents of rations consumed by sheep in control and treatment groups. However, sheep fed vinasse diets had lower rumen pH values showing that the use of vinasse in sheep rations resulted in too lower pH values and probably increased VFA in rumen of treatment group compared to the control group. Contrastry, to this, it was reported that ruminal pH of sheep was higher when vinasse was used in diets (Krzeminski et al., 1984, Leontowicz et al., 1994) because of high potassium content of vinasse, that is alkali mineral and can increase pH values. Leontowicz et al., (1984) noted that ruminal pH was not affected when vinasse was used in lamb diets.

Ruminal NH_3-N

The concentration of ruminal NH_3-N in treatment groups was increased ($p<0.05$) at 14 pm (2h post-feeding) but it decreased ($p<0.05$) steadily until 20 (table 2). This finding is in agreement with Van-Sost (1994) who found that the peak rumen ammonia concentration occurred two to four hours post-feeding. The addition of vinasse increased ($p<0.05$) the rumen NH3-N from 114 mg L-1 in control group to 120 mg L-1 in treatment group. Wahlberg et al. (1979) and Haanon et al. (1990) also reported that vinasse usage in diets increased the ruminal ammonia concentrations.

Rumen protozoa population

Vinasse usage in rations increased rumen protozoa population, in treatment group, but the difference was not statistically significant. This might be due to the high amount of carbohydrate and ammonia composition existing in vinasse that rumen microbial population such as protozoa uses them for growth and reproduction (Krzeminski et al., 1984). However, Kulasek et al. (1984) and Stemme et al., (2004) reported that vinasse usage in sheep ration had no significant difference.

Digestibility of diet and voluntary feed intake

The total tract digestibility of DM significantly increased by vinasse utilization in sheep (Table 2). In this regard, Leontowicz et al., 1994; Stemme et al; 2004 and Konan et al; 1987 reported that addition

Table 2. Effect of vinasse on voluntary feed intake, diet digestibility and ruminal fermentation parameters

Tablica 2. Djelovanje *vinasse* na dobrovoljni unos hrane, probavljivost obroka i parametre ruminalne fermentacije

Items - Sadržaj	Treatments - Tretmani		SEM
	Control - Kontrola	Vinasse	
Voluntary feed intake (g/day) Dobrovoljni unos hrane (g/dan)	606.15[b]	848.57[a]	9.01
Digestibility - Probavljivost	38.75 [b]	45.65[a]	0.61
Ruminal pH	6.52 [b]	6.26 [a]	0.044
Ruminal NH_3 - N (mg /L)	104.06[b]	120.01[a]	2.86
Protozoal population ($\times 10^5$/mL) Populacija protozoa ($\times 10^5$/mL)	4.88	5.09	0.015

Means with different superscripts (amebic) differ significantly ($p<0.05$).

of vinasse in beef cattle increased the digestibility of diet. Stern (1992) reported that DM digestibility decreased by utilization of vinasse in merino sheep rations. Furthermore, Sampaio et al; (1989) found that the apparent digestibility of DM, CP, NDF and ADF by cattle rations was not affected by vinasse. However, the results obtained in this study are in agreement with the findings of Leontowicz (1994) and Konan (1987) who reported that vinasse caused an increase in digestibility of nutrients in beef. The improvement of nutrients digestion might be attributed to the relative increase in the population of rumen protozoa due to vinasse (Kulasek, 1984).

Vinasse caused an increase ($p<0.05$) in the voluntary feed intake of sheep. In agreement with these results, others reported that vinasse increased feed intake of sheep (Haakasma, 1987) and beef cattle (Potter, 1985 and Sampaio, 1989). Kemenade et al., 1988 and Kirshgesner et al., 1980 reported that voluntary feed intake in pigs and broilers increased as the result of addition of vinasse in their diets.

CONCLUSIONS

The use of vinasse in the diet resulted in a low ruminal pH values in sheep due to the highly fermentable carbohydrate contents of ration. The DM digestibility of rations significantly increased following treatment with vinasse. The voluntary feed intake in control group was smaller compared to the other group. The protozoa population and the rumen NH_3-N in the treatment group were increased.

REFERENCES

1. Adams, D.C., Kartchner, R.J. (1984): Effect of level of forage intake on rumen amonia, PH, Liquid volume and liquid dilution rate in feed cattle. J. of Anim. Sci., 55:708-713.
2. AFRC, Agricultural and Food Research Council. Energy and protein requirements of ruminants (1993). An advisory manual prepared by the AFRC technical committee on responses to nutrients. CAB International, Wallingford.
3. Association of Official Analytical Chemists (1990): Official Methods of Analysis. Vol .I. The 15th ed., AOAC., Arlington, VA.
4. Campbell, L.D., Roberts, W.K. (1965): The requirements and role of potassium in ovine nutrition. Journal of Animal Science, 45:147-153.
5. Church, D.C. (1991): Livestock feeds and feeding. Prentice-hall International editions, USA.
6. Dastar, B. (1986): The investigated of effects of using of vinasse on Balouchi lamb nutrition. M.Sc. Thesis, University of Ferdosi, Mashhad, Iran.
7. Haakasma J. (1987): The influence on growth energy efficiency and dressing percentage, when in ration for beef cattle containing pressed pulg soybeen meal protein was replaced by from beet vinasse or NPN. Meadedeling – Ins. Voor- ration. Suiker produktie, 15:23-29.
8. Haanon. K., Trenkle, A. (1990): Evaluation of condensed molasses fermentation solubles (vinasse) as a non-protein nitrogen source for ruminants. Journal of Animal Science, 68: 2634-2641.
9. Hosseyni, Z. (1980): Current methods of nutrients degradability. University of Shiraz.
10. Konan, V., Antolikova, M., Husar, M. (1987): Use of distillery by-products for animal feeding. Agrochemia, 27:219-221.
11. Kemenade, P.V., Hartog, L.A, Haaskma, J., Verstegen, M., Den Hartog, L.A. (1988): Beet vinasse in pig nutrition-effect on digestibility and production. Mededeling institunt voor rationele suiker producktie, 18:52. (Ab.)
12. Kirshgesner, M., Weigand, E. (1980): Broiler feeding experiment with vinasse and molasses in the complete diet. Arch. Geflugelk., 44:119-123.
13. Kirshgesner, M., Weigand, E. (1980): Using vinasse in feeds for market pigs. Zeitschrift, (26)5:150-162.
14. Krzeminski, R., Kulasek, G., Sobczak, E., Czerski, M., Leontowicz, H., Leontowicz, M. (1984): Physiological evaluation of the utility of condensed beet molasses solubles in ruminant feeding. Comparison of the effects of feeding beet molasses solubles or molasses to fattening cattle. Prace i materialy zootechniczne, 32:39-48.
15. Kulasek, G., Leontowicz, H,. Krzeminski, R., Leontowicz, M., Sobczak, E., Motyl, T., Kowska, J., Pierzynowski, S., Bartkowiak, M. (1984): Physiological evaluation of the utility of condensed beet molasses solubles (vinasse) in ruminant feeding. Prace i materialy zootechniczne, 29:69-79.
16. Kulasek, G., Leontowicze, H., Krzeminski, R., Leontowicz, M., Sobczank, E. (1988): Physiological evaluation of condensed beet molasses solubles in ruminant feeding. Prace i materialy zootechniczne, 32:63-69.
17. Kulasek, G., Barej, W., Leontowicz, M and Krzeminski, R. (1984): Mineral metabolism in chronically po-

tassium load sheep fed ration with condensed beet molasses solubles. Heigner institute of zootechnics and veterinary medicine faculty of zootechnics, 32:228-232.

18. Leontowicz, H., Krzeminski, R., Leontowicz, M., Kulasek, G., Tropilo, J., Sobczak, E. (1994): Condensed beet molasses solubles for fattening bulls. Journal of animal and feed science, 3:23-31.
19. Leontowicz, H., Krzeminski, R., Leontowicz, M., Kulasek, G., Barej, W., Sobczak, E., Bartkowiak, M, H.Z. J. (1984): Physiological evaluation of the utility of condensed beet molasses solubles in ruminant feeding. Comparison of the effects of feeding sheep with molasses or molasses solubles. Prace i materialy zootechniczne, 30:77-86.
20. Leontowicz, H., Kulasek, G., Barej, W., Chomyszyn, M. (1986): Protein and carbohydrates digestion in sheep fed rations with condensed beet molasses solubles. Heigner institute of zootechnics and veterinary medicine faculty of zootechnics, 32: 357-360.
21. Leontowicz, H., Kulasek, G., Barej, W., Chomyszyn, M. (1986): Protein and carbohydrates digestion in sheep fed rations with condensed beet molasses solubles. Heigner institute of zootechnics and veterinary medicine faculty of zootechnics, 32: 357-360.
22. Leontowicz, M., Leontowicz, H, Krzeminski, R., Kulasek, G., Sobczak, E., H.Z, J. (1984): Physiological evaluation of condensed beet molasses solubles in ruminant feeding. IV. Apparent digestibility of the major ration components and nitrogen (vinasse). Prace i materiaty zootechniczne, 33:52-60.
23. Lewicki, W. (1978): Production and use of vinasse from molasses in feeds for ruminants. World congress on animal feeding, 8:23-27.
24. Pahlavan, M. (2007): Effects of live yeast saccharomyces cerevisiae on fermentation Parameters and microbial population of rumen , total tract digestibility of diet nutrients and on the in situ degradability of alfalfa hay in Iranian chall sheep. M.Sc. Thesis, Dept. of Anim. Sci., Abureyhan Pardis, University of Tehran. Tehran, Iran.
25. Potter, S.G., Moya, A., Henry, P.R., Palmer, A.Z., Becker, H.N., Ammerman, C.B. (1985): Sugarcane condensed molasses solubles as a feed ingredient for finishing cattle. Journal of Animal Science, 60:839-846.
26. Sampaio, A. Vieira P.D., Olivera, M.D., Kronka, S., Oliverira, D. (1989): Digestibility of rations containing different levels of dry vinasse of the nutrient digestibility in bovine feeding. Pesquisa agropecuaria Brasileira.
27. SAS Institute (1991): Statistical analysis system. Inc. Releas. 6.04. Cary, nc.
28. Stemme, K., Gerdes, B., Harms, A., Kamphnes, J. (2004): Beet- vinasse as an ingredient in diets for cattle and pigs nutritive value and limitation. Journal of animal physiology and animal nutrition.
29. Stern, M. (1992): Nutritional physiological and pelleting studies of sugar beet molasses residue from fermentative baker's yeast production after partial removal potassium compared with sugar beet and sugar cane molasses for use in ruminant feeding. Thesis, Justus leibig – Universitate Giessen. 174. (Ab).
30. Troccon, J.L., Demarquilly, C. (1989): Sugar beet molasses fermentation residues for ruminants. Production animals, 2:245-248.
31. Vansoest, P.J. (1983): Nutritional ecology of the ruminant. 0 and B Books, Inc. publishing. Cornell University.
32. Vranesic, N., Motosic, C.V., Krsmanovic, M. (1980): Condensed moloasses solubles of vinasse in the nutrition of light hybrid laying hens. Veterinaria Yugoslavia.
33. Wahlberg, M.L., Cash, E.H. (1979): Various liquid by products as a protein supplement to ruminal diets. Journal of Animal Science, 49:1431-1437.
34. Waliszewski, K.N., Romeroand, A., Pardio, V.T. (1997): Use of cane condensed molasses solubles in feeding broilers. Instituto technologico de Veracruz, Mexico. Animal feed science and technology.
35. Weigand, E., Kirshgesner, M. (1979): Mineral balances of growing pigs given vinasse as feed component. Arch. Tierenahrung, 43:121-129.
36. Yano, H., Kobayoshida, Y., Kawashinma, R. (1977): Effects of high potassium intake on mineral metabolism in sheep. Journal of Zootechnical Science, 48:319-324.

SAŽETAK

U dva su pokusa analizirani vinassa šećerne repe iz ostataka kondenzirane melase u proizvodnji kvasca i djelovanje vinasse na fermentaciju u buragu, populaciju protozoa i probavljivost hranjiva. U prvom pokusu ovce su dobivale obrok koji je sadržavao vinassu i pšeničnu slamu po volji, a dobrovoljni unos hrane mjeren je

za svaku ovcu. U drugom pokusu četiri su Zandy ovce s fistuliranim buragom izabrane za ispitivanje djelovanja vinasse na proizvodne rezultate životinja. Dva sata nakon hranjenja pH vrijednost se snizila ($p<0.005$) u pokusnim skupinama. NH_3-N i populacija protozoa u tekućini buraga porasli su u svim pokusnim skupinama. U usporedbi s kontrolnim skupinama dobrovoljni unos hrane i probavljivost obroka bili su viši u pokusnim skupinama. Može se zaključiti da primjena vinasse na razini od 100 g/kg DM TMR obroka po ovci može poboljšati fermentaciju u buragu i dobrovoljno uzimanje hrane kao i probavljivost obroka, te dati relativno bolje rezultate

Ključne riječi: Vinassa, probavljivost obroka, dobrovoljno uzimanje hrane, fermentacija u buragu