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Effect of Depotash Vinasse on Rumen Fermentation Kinetics *in vitro*

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ABSTRACT

Vinasse is a by-product of distilleries which may be used in animal feeding otherwise it is a pollutant of water and soil. An *in vitro* experiment was conducted to observe the effect of molasses and depotash vinasse on rumen fermentation parameters such as *in vitro* dry matter digestibility (DMD), organic matter digestibility (OMD), ammonia nitrogen (NH_3-N), partition factor (PF) and microbial biomass production (MBP). Concentrate mixture, pellet with molasses (Pellet M) and pellet with depotash vinasse (pellet DPV) were prepared with same ingredients while pellet M contained 8% molasses and pellet DPV contained 8% depotash vinasse (as at this level binding was optimum) with little change of ingredients, chemical composition was similar. The substrate for the *in vitro* experiment comprised of concentrate mixture/ pellet M/, pellet DPV individually and TMRs with concentrate/ pellets, oat green and wheat straw in different proportions (40:40:20). The results revealed no noticeable changes due to addition of depotash vinasse and molasses pellets (upto 8%) on rumen fermentation parameters. DM, OM and crude protein (CP) digestibility was similar in all the groups. MBP and NH_3-N was also similar in all the groups. It was concluded that depotash vinasse can be used in pellet making and subsequent feeding to animals without any harmful effect on rumen fermentation parameters.

Keywords: Composition and *In vitro* digestibility, Depotash vinasse, Rumen fermentation

INTRODUCTION

Vinasse is a by-product from industrial production of yeasts, alcohol, citric acid or other substances by fermentation of molasses (Fernandez *et al.,* 2009). Vinasse is produced mostly from raw materials *viz,* corn, wheat, rice, potatoes, sugar beets, sugarcane and sweet sorghum. It is also called as condensed molasses solubles (CMS). It is a light-brown to dark brown liquid which contains water (93%), organic solids and minerals (7%) that is condensed to 60% (on wet basis) and is variable depending on source, batch and location *etc.* though, for production of each liter of ethanol, 12-15 liter of water is used which cannot be recycled (Christofoletti *et al.,* 2013). The vinasse have generally been disposed directly to the flowing water that affects water quality, subsequently aquatic life, thus, a threat to ecosystem. As an alternate to control the water pollution, significant proportion of vinasse have been disposed to agriculture land (Nataraj *et al.,* 2006). Vinasse has less energy, high ash content. It is especially rich in sulphur (S) and potassium (K), than molasses. Vinasse may be used in feeding of cattle and sheep because its crude protein consists mainly of non-protein nitrogen (NPN) compounds such as free amino acids and betaine. In cattle and poultry feed, vinasse may be used as binder and dust reducer rather than as a protein replacer. Use of vinasse beyond 5% level as a replacement for molasses in ruminant diet results reduced voluntary feed intake, weight gain and feed conversion efficiency (Campos *et al.,* 2014). Possible reason for poor performance of animal on vinasse containing diet is due to its high level of S. High S content in vinasse reduces selenium (Se) and copper (Cu) absorption and responsible for excess production of hydrogen sulphide (H_2S) in rumen. High K reduced magnesium (Mg) absorption which in turn leads to hypomagnesaemia. However, depotash vinasse, (after removal of maximum potassium) kind of new product with minerals, low CP with binding properties, though not exploited yet in India or elsewhere. Moreover, number of rumen protozoa and the amount of ruminal ammonia nitrogen in dairy cattle and sheep were also reported to be increased due to vinasse in diet (Sugoro *et al.,* 2016). Under these circumstances, depotash

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vinasse have been used for preparing feed pellet and total mixed ration and tested for *in vitro* rumen fermentation and nutrient digestibility.

MATERIALS AND METHODS

Samples of molasses were collected from Sagbara, Gujarat and depotash vinasse was collected from Demo plant at Kemrej, Gujarat. Physical characteristics of depotash vinasse and molasses were observed visually and pH by digital pH meter. The cattle feed pellets were manufactured at Nand Gopala Feeds, Sagbara, Gujarat. Ingredients used for pellets preparation were maize grain, mustard cake, ground nut cake, wheat bran, mineral mixture and salt. Molasses and depotash vinasse were added at the level of 8% in each formulation by little changing the composition (Table 1). Eight percent level of molasses and depotash vinasse was selected because at this level binding and pelleting were optimum. The chemical composition *viz.*, moisture, CP, total ash, acid insoluble ash (AIA) of depotash vinasse, molasses, concentrate mix and pellets were analyzed by following protocol of AOAC (2007) and mineral composition *viz.*, calcium (Ca), Mg, K, sodium (Na), Cu, cobalt (Co), zinc (Zn) and manganese (Mn) were analyzed by using Atomic Absorption Spectrophotometer (AAS; Hitachi Z-5000, Polarized Zeeman) (Table 2).

TMR was prepared by mixing of concentrate mixture, and pellets with green oats and wheat straw in 40:40:20 ratios. A total of 6 groups were there *i.e.* concentrate mixture, pellet with molasses, pellet with depotash vinasse individually and TMR with concentrate mixture: green oats: wheat straw (40:40:20), TMR with molasses containing pellet: green oats: wheat straw (40:40:20) and TMR with depotash vinasse containing pellet: green oats: wheat straw (40:40:20). Samples of TMRs in triplicate were used to observe the gas production and nutrient digestibility (Menke and Steingass, 1988).

The generated data were analyzed by one way ANOVA using IBM SPSS version 20 to observe the treatment effect on fermentation kinetics.

RESULTS AND DISCUSSION

Colour of the molasses was light brown while that of depotash vinasse was dark brown. Odour of the molasses was sweetish while it was mild sweetish for depotash vinasse. pH of the samples varied between 4.5-5.1. These parameters indicated that depotash vinasse was visually similar to the molasses. Chemical composition of depotash vinasse and molasses is depicted in Table 2. DM of depotash vinasse was around 76.36% and in molasses it was 60.85%. The OM varied from 85-90% in both the samples. The CP content was higher in depotash vinasse than molasses (7.70 *vs.* 5.36%). Total ash content was higher in depotash vinasse than molasses due to higher mineral content. Acid insoluble ash was 1.5 to 2.01% in both the samples. Calcium level was higher in DPV and low in the molasses varied from 0.4–0.8% in DPV and 0.2–0.4% in molasses. The concentration of potassium low in depotash vinasse as well as in molasses (3.3-3.9%). The concentration of sodium was higher in DPV, varied from 0.1–0.3% and low in molasses at

Table 1. Ingredient composition of concentrate mixture and pellets (% DM basis)

Ingredient	Concentrate mix	Molasses pellets	Vinasse pellets
Maize	40	35	35
Ground nut cake	10	12	12
Mustard oil cake	20	21	21
Wheat bran	27	21	21
Molasses	-	8	-
De-potash vinasse	-	-	8
Mineral mixture	2	2	2
Common salt	1	1	1

Table 2. Chemical composition of depotash vinasse and molasses (% DM basis or as mentioned)

Parameter	Depotash vinasse	Molasses
DM	76.36	60.85
CP	7.70	5.36
Total ash	16.49	8.66
AIA	2.01	1.52
S	2.05	0.67
Ca	1.20	0.33
Mg	2.80	0.19
K	1.80	3.26
Na	0.26	0.07
Cu (ppm)	45.26	35.08
Co (ppm)	19.21	17.00
Zn (ppm)	8.62	9.16
Mn (ppm)	55.51	35.21

around 0.1%. The concentration of zinc varied from 8.2–9.6 ppm in DPV and 9.6–10.4 ppm in molasses, whereas spent wash had high zinc concentration around 112 ppm. The iron concentration was high in DPV, varied from 92–585 ppm and low in molasses around 33–154 ppm. The value of manganese was 55 and 35 ppm which was higher in DPV followed by in molasses group, respectively. The finding of present study was

Table 3. Chemical Composition of concentrate mixture and pellets samples

Parameter	Concentrate	Pellet (M)*	Pellet (V)**
Chemical composition (% DM)			
DM	90.4±0.27	89.3±0.18	88.7±0.15
OM	89.5±0.18	90.6±0.11	89.5±0.05
CP	20.6±0.15	19.3±0.12	21.7±0.17
EE	4.47±0.19	4.83±0.02	4.75±0.05
NDF	24.1±0.17	26.7±0.05	25.7±0.09
ADF	12.1±0.25	13.7±0.05	12.3±0.05
CF	6.15±0.24	5.60±0.02	4.99±0.05
AIA	2.15±0.05	2.35±0.05	1.07±0.01
	10.5±0.16	9.40±0.03	10.6±0.05
Mineral composition (% or as mentioned)			
Ca	0.61±0.01	0.71±0.01	0.67±0.04
K	2.12±0.17	2.35±0.05	2.35±0.05
Na	1.84±0.24	0.99±0.02	1.04±0.02
Mg	0.81±4.42	0.84±6.12	0.79±6.22
Cu (ppm)	29.42±2.74	28.5±3.52	27.08±2.11
Zn (ppm)	42.1±8.32	41.55±1.54	45.3±1.22
Fe (ppm)	210.1±8.41	221.5±14.5	206.2±6.58
Mn (ppm)	69.5±2.52	66.3±1.45	63.55±2.09
Durability Index (%)	-	95.71%	96.74%

Table 4. Effect of molasses and depotash vinasse on fermentation kinetics

Parameter	Group						P-Value
	Concentrate	Pellets (M)	Pellets (V)	TMR Conc	TMR (M)	TMR (V)	
Net gas(ml/24h)	35.07±6.40	34.47±1.56	36.63±1.79	33.88±1.35	35.93±1.09	32.81±0.23	0.935
Gas (ml/kg DM digested)	175.35±32	172.34±7.79	183.13±8.94	169.41±6.77	179.67±5.47	164.04±1.16	0.935
IVDMD (%)	61.52±.66	62.19±2.0	62.32±0.64	62.89±2.0	62.79±2.4	60.65±0.60	0.907
TOMD (%)	65.16±2.21	65.68±0.04	68.69±1.15	63.36±2.3	66.10±5.9	61.84±0.62	0.643
PF	3.49±0.52	3.45±0.15	3.37±0.12	3.48±0.04	3.36±0.21	3.45±0.08	0.997
MBP (mg)	39.91±10.3	40.98±3.40	40.57±2.0	41.10±0.86	39.38±8.69	38.97±1.92	1
NH_3-N mg/dl)	6.40±0.50	6.00±0.20	5.50±1.5	6.00±0.10	5.50±0.30	5.10±0.20	0.774

Pellets (M), - molasses pellets; Pellets (V), - depotash vinasse pellets; TMR Conc, total mixed ration with concentrate mixture; TMR (M), - total mixed ration with molasses pellets; TMR (V), - total mixed ration with depotash vinasse pellets.

similar to that of Khan *et al.* (2006), they found similar chemical composition of cane sugar molasses. Brito *et al.* (2015) reported that molasses had a similar DM, CP, and Ca. The present findings are in line with the findings of Maneerat *et al.* (2015) and Zali *et al.* (2017). The difference in the chemical composition of molasses and vinasse may be due to nature of raw material used for alcohol making, their inclusion level, and the type of channels they pass through, and batch to batch variation, application of fertilizer during crop production.

Chemical composition of concentrate mixture and pellets prepared from molasses (PM) and depotash vinasse (PV) have been presented in Table 3. The value of DM, OM, CP, ether extract and NDF level were alike in concentrate mixture and both the pellets. Ca level was 0.6 to 0.7% in the feeds. Mineral concentration, including the trace minerals was comparable in all the groups.

Results of the *in vitro* experiment have been shown in Table 4. The net gas production and total gas production were similar in concentrate, pellets of molasses, pellets of vinasse and TMR with concentrate, with molasses pellets and with depotash vinasse pellets. It was similar statistically, though there were little variations among the groups. The *in vitro* dry matter digestibility (IVDMD) was similar with the average value around 62%. The total OM digestibility (TOMD) was also similar in all the groups with the average value of 66%. PF and MBP were not different among the samples of different groups. NH_3-N was also similar among the samples, but higher with concentrate/ pellets individually as it was not utilized in optimum quantity by the microbes.

The results are similar with the findings of Mavimbela and Ryssen (2001) as they observed that the NH_3-N concentrations in ruminal fluid did not differ between the treatment groups. The results are conflicting with Iranmehr *et al.* (2011) who found that the ruminal NH_3-N and population of protozoa in rumen fluids were increased in all treatment groups. In the present experiment no such result observed.

CONCLUSIONS

Depotash vinasse, a by-product of distillery industry was evaluated for its chemical and mineral composition and found comparable to molasses. Its incorporation in pellet and incubation with rumen liquor individually and with TMR indicated no adverse effect on rumen fermentation characteristics and digestibility of nutrients, hence, can be used in cattle feed at 8% in concentrate mixture. Though, before incorporation in the dairy ration, it must be validated by *in vivo* experiments.

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