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RESEARCH ARTICLE

NUTRIENT DIGESTIBILITY, RUMEN FERMENTATION, INGESTIVE AND ELIMINATIVE BEHAVIOUR OF GOAT FED RATION SUPPLEMENTED WITH COMMERCIAL FEED ADDITIVES

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ABSTRACT

This study was conducted to evaluate the effects of new patent of some commercial feed additives on nutrient digestibility, rumen fermentation parameters and behaviour of male goat. Fifteen healthy uncastrated Baladi bucks were randomly fed one of five experimental ration; control ration without feed additives, and four experimental ration in which basal ration was supplemented with 5g/h/d from prebiotic, probiotic, fordex or their combination for ten weeks. Five digestibility trials were carried out and ruminal samples were taken to measure rumen fermentation parameters. During the experimental period, behavioural measured as duration and frequency of ingestive behaviour (eating, drinking and rumination), furthermore the frequency of eliminative behaviour (urination and defecation) were observed and recorded. Ration supplemented by fordex had significant ($P < 0.05$) higher digestion coefficients for dry matter, organic matter, crude protein, ether extract, neutral detergent fiber, total digestible nutrients and digestible crude protein as compared to other dietary supplements or the control. Rumen fermentation parameters (pH, total volatile fatty acids and ammonia-nitrogen concentration) at 0, 3 or 6 hours weren't significantly ($P > 0.05$) different for ration supplemented by all dietary supplements as compared to the control. Significant differences were observed among ration supplemented with different dietary supplement in ingestive and eliminative behaviour.

INTRODUCTION

The goat has maintained its presence in all spheres of human activity due to adaptability to abroad range of environmental conditions, ability to graze on a wide variety of poor quality forage, ability to walk long distance, high turnover rate on investment and hence low investment risk, as well as high efficiency of milk production. It's well known that rumen fermentation processes play a key role in ruminant nutrition, as it's this distinctive symbiotic feature between the host and the rumen microflora that lends the ruminant animal several advantages in digestive and metabolic processes over non-ruminants. Mannanoligosaccharides (MOS) are a low inclusion feed additive containing mannan-based oligosaccharides derived from the cell wall of yeast locally in the gut. MOS are known to improve digestion and gut health in animals by binding to and blocking glycoprotein receptors on pathogens (Refstie *et al.,* 2010). It improved digestive morphology and modulation of gut microbial populations (Daniels *et al*., 2010). There were many studies on the effects of MOS on nonruminants, few studies researched ruminants directly and most of them paied attention to small ruminants not alone the influences of MOS on ruminal fermentation in vitro. Lactic acid bacteria as a probiotic are normal residents of the GIT and they are often considered as natural substitutes for feed antibiotics (Reid and Friendship, 2002). Probiotic known to increase ruminal pH (Umberger and Notter, 1989), total volatile fatty acids (VFAs) and thus influence the cellulolytic activity, microbial protein synthesis and fiber degradation (Yoon and Stern, 1995). It's also considered that they compete with other pathogenic micro-organisms for the provision of nutrients and other growth factors (Rolfe, 2000). Essential oils are category of feed additives includes plant-derived compounds that typically exert an antimicrobial effect that leads to an alteration of the fermentation profile, inhibit feed protein degradation and increase rumen protein by-pass to further digestive tract segments (Calsamiglia *et al*., 2007). A blend of different types of essential oils would be expected to exert a synergic effect on rumen fermentation (Spanghero *et al*., 2008). Some of these oils can destroy the cell membrane of microbes, while some function through binding proteins and disturbing the metabolism of cells (Gill and Holley, 2004). Fumaric acid has been proposed as a potential feed additive in methane mitigation as it provides an alternative electron sink and is a metabolic precursor of propionate. The stoichiometry of fumarate metabolism in ruminal fermentations indicates potentially promising results (Ungerfeld *et al*., 2007). Addition of essential oils together with fumarate would exert synergic effects on inhibition of ruminal methane production and promote hydrogen flow into the pathway of volatile fatty acid (VFA) synthesis (Lin *et al*., 2012). For goats, consideration of the effects of nutrition on behavior can be categorized into goats in grazing settings and goats in confinement settings; Factors influencing the feeding behavior of goats include grazing management practices, type of vegetation and season, breed and stage of production, group size, and properties of diets fed in confinement (Goetsch *et al*., 2010). Information on goat behavior has become an important tool to evaluate animal diets and performance (Luciane *et al*., 2011). Therefore, the objective of the present study was to investigate the effects of using the different commercial feed additives for bucks, through the comparison the effects of feeding goat on ration supplemented with commercial products of prebiotic, probiotic, fordex (acidifiers with essential oils) or their combination on nutrient digestibility, rumen fermentation, feeding and eliminative behaviour of male goat.

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MATERIALS AND METHODS

1. Experimental animal

This study was conducted on the animal farm belonging, Faculty of Veterinary Medicine, Zagazig University, in 5 experimental pens

(3 m*3 m). For this experiment, fifteen healthy unsaturated baladi bucks (approximately One-year old with averaged 19.5 kg live body weight) were allocated into 5 equal pens (three animals/ each pen) and used for a 10 weeks in experiment. Bucks were randomly fed one of five experimental ration; control ration without feed additives, and four experimental ration in which basal ration was supplemented with 5g/h/d of prebiotic, 5g/h/d of probiotic, 5g/h/d of fordex or 5g/h/d of these combination. Water and feed intake were offered ad-libitum; where feedstuffs was analyzed according to standard procedures of the AOAC (2002) and formulated from 50% concentrate feed mixture and 50 % barseem hay to meet the nutrient requirements of buck as set by NRC (1981). Chemical Composition and nutritive value of diet used listed in Table 1.

4. Rumen fermentation parameters

At the end of experimental period rumen fluid sample were taken at 0, 3 and 6 hours post feeding for 2 successive days. Each sample was strained through four fold of gauze and divided in two portions: the first portion was used immediately for measurement of pH (HANNA instrument H1 8424 micro computer pH meter) and ammonia nitrogen concentration (Conway, 1957). The second portion was preserved by addition of 2 ml N/10 HCl and 1 ml orthophosphoric acid to each 2 ml of ruminal juice for determination of total volatile fatty acids by steam distillation methods as described by Warner (1964).

Table 1. Physical and chemical composition (%) of the experimental ration and concentrate mixture

Feedstuff	*Concentrate feed mixture Calaulated composition	Berseem hay
Dry matter (DM)%	88.21	**88.90**
Organic matter (OM)%	90.40	**85.90**
Digestible energy (DE), Mcal/kg	3.60	**2.87**
Crude protein (CP) %	17.43	**14.80**
Crude fiber (CF) %	5.56	**27.00**
Acid detergent fiber (ADF) %	7.14	**34.00**
Neutral detergent fiber (NDF) %	22.88	**50.00**
Ether extract (EE) %	2.95	**2.40**
Ash %	9.60	**14.10**
Nitrogen free extract (NFE) %	64.45	**41.70**

* Concentrate feed mixture (25% yellow corn, 14% wheat bran, 10% soybean meal 44%, 0.25%, dicalcium phosphate, 0.5% Nacl, 0.25% premix).

2. The feed additives used

2.1. Biosecure-MOS: used as a prebiotic, it contains mannan oligosaccharide, β-glucan and yeast cell wall extract. Produced and exported by Brook Side Agra. USA, imported by Samu median Co… Egypt.

2.2. Biogreen E: used as a probiotic, it contains a unique formula of four strains of spore former, enzyme producer microorganisms plus digestive enzymes (Bacillus subtilis, Streptococcus faecium, Asperagillus oryzae, Lactobacillus casei, cellulase, protease, ά – amylase and B–amylase). Produced and exported by Brook Side Agra. USA, imported by Samu median Co… Egypt.

2.3. Fordex: used as a natural growth promoters, it contains unique and innovative formula; 1- Organic acids (propioic, formic and sorbic) 2- Salts of organic acids (formate and propionate) 3- Blend of essential oils (cinnamadehyde, thymol, eugenol). Produced and exported by dex iberica. Spain, imported by ATCO Pharma Co… Egypt.

3. Digestibility trials

Fifteen healthy uncastrated Baladi bucks were allotted into 5 equal groups (3 animals / group); each group was housed separately in shaded pen (3 m*3 m). Five digestibility trails were carried out to determine the feeding value of experimental ration. Each digestibility trail included two sub-periods, the preliminary period (3 weeks) in which the experimental ration were offered to bucks at regular time (8 a.m. and 14 p.m.) and daily feed intake was recorded. The collections period (7 days) in which experimental ration were offered daily and also daily fecal output was recorded. The moisture content of daily fresh sample of food and feaces was determined in order to calculate the daily feed intake and fecal out put on dry matter basis. A representative sample (about 25%) of fresh feaces was taken every 24 h just after collection. The fecal sample of each animal was dried at 65^0C for 48 h in hot air oven, thoroughly mixed, weighed, ground and kept in suitable bags for subsequent chemical analysis.

5. Behavioural observation

Bucks were adapted to experimental condition for two weeks before the start of the experiment. The behavioural observation was done using focal sample technique, as recommended Altuman *et al*. (1974), at 8:00 am until 16:00 pm to avoid the effect of diurnal rhythm (El-Lethey *et al*., 2001), with 5 minuets intervals for 8 hours / group / week to calculate the duration and frequency of ingestive behaviour (eating of concentrate & roughage; drinking and rumination), furthermore the frequency of eliminative behaviour (urination and defecation) throughout the experimental time as mentioned by Marion *et al*. (2009).

6. Statistical analysis

The obtained data in this study were statistically analyzed for variance ANOVA, LSD (Least significant difference) according to Snedecor and Cochran, (1982). Differences among treatment means were compared using Duncan's multiple range tests (Duncan, 1995). Data were presented as mean ± SE and significance was declared at ($P < 0.05$).

RESULTS AND DISCUSSION

Effect of dietary supplements on nutrient digestibility and nutritive values of the ration

The digestion coefficients and nutritive values of different nutrients as affected by adding dietary supplements are shown in Table 2. Digestibility coefficient for dry matter in the ration supplemented by prebioic, probiotic and combination wasn't significantly ($P > 0.05$) different from that of the control ration, while digestibility coefficient for dry matter in the ration supplemented by fordex was significantly ($P < 0.05$) higher as compared to that of the control ration. Ration supplemented by fordex had a significant ($P < 0.05$) higher value of organic matter, crude protein, ether extract and neutral detergent fiber as compared to other dietary supplements or control. Digestion coefficients for crude fiber and acid detergent fiber weren't significantly ($P > 0.05$) different for ration supplemented by all dietary supplements as compared to the control. Data showed that TDN values and digestible crude protein for ration supplemented by fordex was

Table 2. The effect of dietary supplementation with different growth promoters on nutrient digestibility and nutritive values in goat (mean± SE)

Parameter	Dietary Treatments				
	Control	Prebiotic	Probiotic	Fordex	Mixture
DM	69.01±0.63^{bc}	68.64±0.53^{c}	71.04±1.16^{ab}	72.51±0.64^{a}	71.26±0.39^{ab}
OM	73.94±0.52^{bc}	73.63±0.41^{c}	75.64±0.96^{ab}	76.85±0.54^{a}	75.84±0.30^{ab}
CP	69.72±0.56^{bc}	69.35 ±0.40^{c}	71.66±1.06^{ab}	73.01±0.63^{a}	71.94±0.29^{b}
EE	77.29±0.41^{bc}	77.01±0.27^{c}	78.74±0.78^{ab}	79.74±0.47^{a}	78.96±0.21^{b}
CF	51.79±1.92	51.07±3.31	55.57±2.92	59.07±1.24	54.84±2.88
ADF	48.04±2.05	47.27±3.54	52.11±3.14	55.67±1.33	51.33±3.08
NDF	55.92±1.35^{b}	55.37±1.90^{b}	59.12±2.18^{ab}	61.80±0.98^{a}	58.95±1.59^{ab}
NFE	80.67±0.30	80.43±0.19	81.87±1.06	85.98±3.67	82.11±0.17
Nutritive value %					
TDN	68.14±0.42^{bc}	67.85±0.28^{c}	69.65±0.81^{ab}	70.68±0.49^{a}	69.90±0.21^{b}
DCP	11.42±0.70	11.35 ±0.05	11.71±0.14	11.90±0.10	11.78±0.06

^{abc} Mean in the same row with different superscripts are significantly different at ($P < 0.05$).

significantly ($P < 0.05$) higher than that for the other dietary supplements or the control. The results are consistent with the findings of Yang *et al*. (2007) who reported that ruminal digestibilities of DM were higher (13%) for juniper berry EO (2 g d^{-1}) than for the control diet consisting of 40% forage and 60% barley based concentrate in Holstein cows. However, total tract digestibilities of DM, OM, fiber and starch weren't affected by the experimental treatments. They suggested that increased ruminal digestibility was due to increased ruminal digestion of dietary protein by 11% as compared with the control. On the other hand by Beauchemin and McGinn (2006) stated that a commercial blend of essential oils decreasing the digestibility of all nutrients in beef. Malecky *et al*. (2009) also reported that a monoterpene blend didn't affect digestibilities of different nutrients in dairy goats. The higher concentration of EO decrease the DM as well as fiber digestibility in the rumen (Yang *et al*., 2010). Carro and Ranilla (2003) showed that fumarate in vivo may stimulate the use of hydrogen during fermentation, and decrease the negative feed-back effect of hydrogen on microbes, which in turn improves the growth of fiber-degrading (cellulolytic) microorganisms in the rumen (Forsberg *et al*., 1997), R. flavefaciens could hydrolyze cellulose and use fumarate as the main electron acceptor producing succinate (Stewart *et al*., 1988), protein-degrading microorganisms require ammonia N for optimal growth when feeding fibrous basal diets (Williams and Coleman, 1997). B. fibrisolvens is one of the protein-degrading species in rumen with abilities to digest cellulose, although not as effective as Ruminococcus or Fibrobacter species. These results are in accordance with that of probiotic reported by Galina *et al*. (2009) stated that vivo digestibility of DM and OM by adding of a lactic probiotic containing lactobacilli to the goat kid's diet didn't differ between diets while, increased microbial protein synthesis, digestibility of fibre and NDF. Treatment with probiotics (lactobacilli and yeast culture) increases the number of cellulolytic bacteria in the rumen and, in some cases, increase cellulose degradation (Newbold *et al*., 1996). These results agreed well with that of prebiotics reported by Markey and Kline (2006) implied no significant effects on DM, OM, CP and GE apparent digestibilities of horse when adding yeast culture to higher and lower fat diets. Hinman *et al*., (1998) reported there were no significant effects on the DM, CP, NDF, ADF and GE apparent digestibilities of steers when adding yeast culture to diet.

On the other hand Zheng *et al*. (2012) found that the IVDMD, the IVCPD increased with rising of MOS. Adding yeast culture (0, 2.5, 5.0 and 7.5 kg-1) on four cereal straws could increase the IVDMD and IVOMD (Tang *et al*., 2008).

Effect of dietary supplements on rumen fermentation parameters

Data in Table 3. revealed that pH values were above 6 at different sampling times. At zero time (before feeding) ruminal pH, total volatile fatty acids and ammonia-nitrogen concentration for bucks fed ration supplemented by all dietary supplements weren't significantly ($P > 0.05$) different as compared to the control. The results also showed that ruminal pH, total volatile fatty acids and ammonia-nitrogen concentration peaked at three hours post-feeding and reached a plateau at 6 hours post feeding, during both times ruminal pH, total volatile fatty acids and ammonia-nitrogen concentration weren't significantly ($P > 0.05$) different in bucks fed ration supplemented by all dietary supplements compared to those bucks fed the control ration. In conclusion, rumen fermentation parameters (pH, total volatile fatty acids and ammonia-nitrogen concentration) at 0, 3 or 6 hours weren't significantly ($P > 0.05$) different for ration supplemented by all dietary supplements as compared to the control. Although there are some observations that ration supplemented with fordex can reduce ammonia-nitrogen and increase total volatile fatty acids while, probiotic can increase ammonia-nitrogen and reduce total volatile fatty acids but these alteration weren't significant ($P > 0.05$) if compared with the control. These results agreed with Lin *et al*. (2012) who investigate that the effect of a combination of essential oils (CEO) along with fumarate on in vitro rumen fermentation. Addition of CEO decreased ammonia-N and total volatile fatty acid (VFA) production at 24 h incubation in a dose-dependent manner, while, no significant differences ($P > 0.05$) were found in pH value among different treatments, fumarate tended to increase total VFA compared with EO added alone ($P < 0.05$) so, addition of fumarate with CEO can further alleviate the VFA-decreasing effect compared with an EO mixture alone. Zhou *et al*. (2011) investigate no apparent effect of disodium

Table 3. The effect of dietary supplementation with different growth promoters on ruminal pH, ammonia nitrogen concentration and total VFA of goat (mean± SE)

Time/ hour	Dietary Treatments				
	Control	Prebiotic	Probiotic	Fordex	Mixture
	ruminal pH (mg/dl)				
0	6.43±0. 13	6.46±0.13	6.47±0.12	6.48±0.09	6.44±0.06
3	5.81±0.13	5.86±0.08	5.95±0.13	5.88±0.07	5.84±0.06
6	6.60±1.12	6.63 ±1.13	6.68±1.13	6.65±1.12	6.65±1.13s
	ruminal ammonia nitrogen concentration (mg/dl)				
0	13.63±0.18^{aC}	13.69±0.17^{aC}	13.88±0.19^{aC}	13.77±0.17^{aC}	13.74±0.13^{aC}
3	22.54±0.79^{aA}	22.60±0.77^{aA}	23.03±0.65^{aA}	22.58±0.76^{aA}	22.40±0.87^{aA}
6	16.51±0.38^{aB}	16.48±0.45^{aB}	16.99±0.55^{aB}	16.58±0.46^{aB}	16.69±0.49^{aB}
	ruminal total VFA (meq /dl)				
0	8.55±0.46^{aB}	8.45±0.47^{aB}	7.40±0.74^{aB}	8.66±0.65^{aB}	7.40±0.77^{aB}
3	11.59±0.50^{aA}	11.79±0.53^{aA}	11.11±0.46^{aA}	12.03±0.52^{aA}	11.77±0.53^{aA}
6	9.23±0.28^{aB}	9.22±0.30^{aB}	8.99±0.32^{aB}	9.47±0.32^{aB}	9.11±0.26^{aB}

^{abc} Means in the same row with different small superscripts are significantly different at ($P < 0.05$).
^{ABC} Means in the same column with different capital superscripts are significantly different at ($P < 0.05$).

Table 4. Duration and frequencies of ingestive and eliminative behaviours (mean ± SE) in between control and treated groups with different feed additives per 8 hour weekly

Behavioural Patterns	Dietary Treatments				
	Control	Prebiotic	Probiotic	Fordex	Mixture
Minutes / 8hrs					
Eating the concentrate	94.93±5.48^{b}	96.68±5.58^{b}	111.68±6.45^{b}	143.27±8.27^{a}	98.33±5.68^{b}
Eating the roughage	64.38±3.71^{b}	34.97±2.02^{c}	68.38±3.95^{b}	152.47±8.80^{a}	62.95±3.63^{b}
Drinking	1.88±0.13^{c}	2.74±0.15^{b}	2.76±0.15^{b}	3.83±0.21^{a}	1. 84±0.13^{c}
Rumination	47.57±2.74^{b}	54.90±3.17^{b}	87.97±5.08^{a}	90.47±5.22^{a}	54.95±3.17^{b}
Frequencies/8hrs					
Eating the concentrate	25.00±1.44^{c}	25.00±1.44^{c}	51.00±2.94^{b}	62.00±3.58^{a}	48.00±2.77^{b}
Eating roughage	26.00±1.50^{c}	17.00±0.98^{d}	36.00±2.08^{b}	70.00±4.04^{a}	28.00±1.61^{c}
Rumination	13.00±0.75^{c}	19.00±1.10^{b}	28.00±1.62^{a}	29.00±1.67^{a}	19.00±1.10^{b}
Drinking	7.00±0.40^{b}	7.00±0.40^{b}	8.00±0.46^{b}	11. 00±0.63^{a}	5.00±0.29^{c}
Urination	2.00±0.11^{d}	7.00±0.40^{a}	3.00±0.17^{c}	4.00±23^{b}	1.00±0.06^{e}
Defecation	1.00±0.06^{d}	5.00±0.29^{c}	7.00±0.40^{a}	6.00±0.35^{b}	5.00±0.29^{c}

^{abcde} Means in the same row with different small superscripts are significantly different at ($P < 0.05$).

fumarate (DF) was observed (P .0.05) on pH value with dynamic changes on ammonia-N concentration (P 50.0006), while, total volatile fatty acids increased (P,0.001) in the rumen of Hu sheep fed on high-forage diets. Addition of monosodium fumarate in vitro increased total VFA (Yu *et al*., 2010). Ammonia-nitrogen concentration were decreased in vitro with cinnamaldehyde at 3000 mg L^{-1} (Busquet *et al*., 2006), while limonene and thymol up to 50 mg L^{-1} didn't affect ammonia concentration in the rumen (Castillejos *et al*., 2006). Although there are some observations that essential oils can reduce ruminal ammonia through specific inhibition of Gram-positive microbes by EO because these bacteria usually belong to ruminal ammonia-producing species (Szumacher-Strabel and Cieslak, 2010). The effects of essential oils on ruminal total VFA concentration in the rumen were generally little affected (Malecky *et al*., 2009; Patra *et al*., 2010) or decreased (Kumar *et al*., 2009), especially at higher concentration of EO. Increasing concentration of total VFA in the rumen due to supplementation of cinnamaldehyde at 0.2 g kg^{-1} DM intake (Chaves *et al*., 2008), not changed (Meyer *et al*., 2009). A lack of effect of essential oils on rumen fermentation, particularly for in vivo studies may also involve adaptation of ruminal micro-organisms and the rapid metabolism of essential oils in the rumen to a less active form. These results disagreed with that of Henning *et al*. (2010a, b) who reported that drenching lactate-utilizing bacterium Megasphaera elsdenii as a probiotic intraruminally has been effective in increasing ruminal pH and decreasing lactate concentration during a rapid transition from high forage to high concentrate diet. Adding of a lactic probiotic containing lactobacilli to the goat kid's diet increased ammonia in the rumen (Galina *et al*., 2009). These results are consistent with the findings of Goiri *et al*. (2010) demonstrated pH, total VFA and ruminal NH_3-N concentration in adding chitosan 50% alfalfa hay and 50% concentrate substrate was no difference. Lattimer *et al*. (2007) reported whereas adding yeast culture didn't impact pH, NH_3-N content and propionate acid content on both high-concentrate and high-fiber diet. On the other hand, Zheng *et al*. (2012) found that the NH_3-N content increased with rising of MOS roughly while opposite to pH.

Effect of dietary supplements on ingestive and eliminative Behaviour

A complete understanding of the feeding behaviour in stalls requires a thorough study of its three main components: eating, ruminating and drinking (Abijaoude´ *et al*., 2000). As shown in Table 4, the results indicated that feeding behaviour was significantly affected by the addition of different feed additives to the diet, as mentioned by Gonzalez *et al*., (2012), who cited that diet formulation, feeding management and the social environment may affect feeding behavior and consequently, ruminal fluid pH. This may related to the direct effect of feed additive by stimulating appetite of the host and the positive effects these feed additives, have on rumen fermentation, feeding behaviour and feed efficiency (Chaucheyras-Durand *et al*., 2012). Moreover, there is correlation between three component of ingestive behaviour, where the rumination increased linearly with high roughage intake (Dias *et al*., 2011 and Zhao *et al*., 2011). The present study is consistent with results by Lu (1987); Mc Sweeney and Kennedy (1992) using goats and hay. As general, the bucks were fed by ration supplemented by fordex were significantly higher in frequency and duration of ingestive behaviour (eating, drinking and rumination) in compare to other groups, with significance differences among other dietary supplements as compared with the control. These results were as mentioned in Benchaar *et al*. (2008) and Marion *et al*. (2009), who investigated the effect of feeding additives on behaviour of animal, especially on ingestive behaviour. On the contrary, Tager and Krause (2011) found that cinnamadehyde as source of essential oil had no effect on rumen fermentation, milk production, or feeding behavior. The frequencies of eliminative behaviour (urination and defecation), as indicated in Table 4, were significantly differ among the supplemented and control groups. Where the frequency of urination was significantly higher in bucks fed ration supplemented by prebiotic, while defecation frequency was significantly higher in bucks fed ration supplemented by prebiotic. These maybe due to the differences in digestibility among previous groups (Williams and Coleman, 1997).

Conclusion

In conclusion, the data obtained in this experiment suggested that, supplementation of goat ration with commercial products of fordex (acidifier with essential oils) at level (5g/head/day) had positive and significantly additive benefit on nutrient digestibility (daily weight gain and gain: feed ratio) with no adverse effect on rumen fermentation parameters of goat if compared with the un supplemented control, prebiotc, probiotic or their combination. Whereas, the duration of feeding behavior was significantly higher in male goats which were supplemented by fordex followed by probiotic. There were significant differences in frequencies of eliminative behaviour among previous groups. In this case, it was shown that a commercial preparation of feed additives is an ideal match to improve nutrient digestibility and rumen fermentation parameters of goat.

REFERENCES

Abijaoude´, J. A., Morand-Fehr, P., Tessier, J., Schmidely, P. and Sauvant, D. 2000. Diet effect on the daily feeding behaviour, frequency and characteristics of meals in dairy goats. Livestock Production Science, 64: 29–37.

Altuman, J. 1974. Observational study of behaviour. Sampling method. Behaviour, 49: 227-267.

AOAC, 2002. Association official analytical chemists. Official Methods of Analysis. Gaithersburg, MD, U.S.A. Chapt. 4,pp 20 – 27.

Beauchemin, K.A. and McGinn, S.M. 2006. Methane emissions from beef cattle: Effects of fumaric acid, essential oil, and canola oil. J. Anim. Sci., 84: 1489-1496.

Benchaar, C., Calsamiglia, S., Chaves, A.V., Fraser, G.R., Colombatto, D., McAllister, T.A. and Beauchemin, K.A. 2008. A review of plant-derived essential oils in ruminant nutrition and production. Animal Feed Science and Technology Volume, 145(14): 209-228.

Busquet, M., Calsamiglia, S., Ferret, A. and Kamel, C. 2006. Plant extracts affect in vitro rumen microbial fermentation. J. Dairy Sci., 89: 761-771.

Calsamiglia, S., Busquet, M., Cardozo, P.W., Castillejos, L. and Ferret, A. 2007. Invited Review: Essential oils as modifiers of rumen microbial fermentation. J. Dairy Sci., 90: 2580-2595.

Carro, M.D. and Ranilla, M.J. 2003. Influence of different concentration of disodium fumarate on methane production and fermentation of concentrate feeds by rumen micro-organisms in vitro. British Journal of Nutrition, 90: 617–623.

Castillejos, L., Calsamiglia, S. and Ferret, A. 2006. Effect of essential oil active compounds on rumen microbial fermentation and nutrient flow in in vitro systems. J. Dairy Sci., 89: 2649-2658

Chaucheyras-Durand, F., Chevaux, E., Martin, C. and Forano, E. 2012. Use of Yeast Probiotics in Ruminants: Effects and Mechanisms of Action on Rumen pH, Fibre Degradation, and Microbiota According to the Diet. Book edited by Everlon Cid Rigobelo, ISBN 978-953.

Chaves, A.V., He, M.L., Yang, W.Z., Hristov, A.N., McAllister, T.A. and Benchaar, C. 2008. Effects of essential oils on proteolytic, deaminative and methanogenic activities of mixed ruminal bacteria Canadian J. of Animal Science, 88: 117–122.

Conway, E.J. 1957. Micro diffusion analysis and volumetric error. 4th Ed. Croby Lockwood and SONS. London.

Daniels, C.L., Merrifield, D.L., Boothroyd, D.P., Davies, S.J., Factor, J.R. and Arnold, K.E. 2010. Effect of dietary Bacillus spp. and Mannanoligosaccharides (MOS) on Europian lobster (Homarus gammarus L.) larvae growth performance, gut morphology and gut microbiate. Aquaculture, 304: 49-57.

Dias, R.S., Patino, H.O., López, S., Prates, E., Swanson, K.C. and France, J. 2011. Relationships between chewing behavior, digestibility, and digesta passage kinetics in steers fed oat hay at restricted and ad libitum intakes. J. Anim. Sci., 89: 1873-1880.

Duncan, D.B. 1995. Multiple range and multiple F-tests. Biometrics, 11: 1-42.

El-Lethey, H., Jungi, T.W. and Huber-Eicher, B. 2001. Effects of feeding corticosterone and housing conditions on feather pecking in laying hens (Gallus domesticus). Physiology and Behaviour, 73: 243-251.

Forsberg, C.W., Cheng, K.J. and White, B.A. 1997. Polysaccharide degradation in the rumen and large intestine. In Gastrointestinal microbiology (ed. RI Mackie and BA White). Chapman and Hall, New York, USA. pp. 319–379.

Galina, M.A., Ortiz-Rubio, M.A., Delgado-Pertinez, L.J. and Pineda, L.J. 2009. Goat kit's growth improvement with a lactic probiotic fed on a standard base diet. Options Mediterraneens, 85: 315-322.

Gill, A.O. and Holley, R.A. 2004. Mechanisms of bactericidal action of cinnamaldehyde against Listeria monocytogenes and of eugenol against L. monocytogenes and Lactobacillus sakei. Appl. Environ. Microbiol., 70: 5750-5755.

Goetsch, A.L., Gipson, T.A., Askar, A.R. and Puchala, R. 2010. Invited review: Feeding behavior of goats. J. Anim. Sci., 2010: 88:361-373.

Goiri, I., oregui, L.M. and Garcia-Rodriguez, A. 2010. Use of chitosans to modulate ruminal fermentation of a 50:50 forage-to-concentrate diet in sheep. J. Anim. Sci., 88: 749-755.

Gonzalez, L.A., Manteca, X., Calsamiglia, S., Schwartzkopf-Genswein, K.S. and Ferret, A. 2012. Interplay between feed ingredients, rumin function and feeding behaviour (a review). J. Animal Feed Science and Technology, 172: 66-79.

Henning, P.H., Horn, C.H., Steyn, D.G., Meissner, H.H. and Hagg, F.M. 2010a. The potential of Megasphaera elsdenii isolates to control ruminal acidosis. Anim. Feed Sci. Technol., 157: 13-19.

Henning, P.H., Horn, C.H., Leeuw, K.J., Meissner, H.H. and Hagg, F.M. 2010b. Effect of ruminal administration of the lactate-utilizing strain Megasphaera elsdenii (Me) NCIMB 41125 on abrupt or gradual transition from forage to concentrate diets. Anim. Feed Sci. Technol., 157: 20-29.

Hinman, D.D., Sovensen, S.J. and Momovt, P.A. 1998. Effect of yeat culture on steer performance, apparent diet digestibility and caecal measurements when used in a barley and potato finishing diet. Prof. Anim. Sci., 14: 173-177.

Kumar, R., Kamra, D.N., Agrawal, N. and Chandhary, L.C. 2009. Effects of eucalyptus (eucalyptus globules) oil on in vitro methanogenesis and fermentation of feed with buffalo rumen liquor. Anim. Nutr. Feed. Technol., 9: 237-243.

Lattimer, J.M., Cooper, S.R., Freeman, D.W. and lalman, D.L. 2007. Effect of yeat culture on in vitro fermentation of a high-concentrate or high-fiber diet using equine fecal inoculum in a Daisy II incubator. J. Anim. Sci., 85 (2): 2489-2491.

Lin, B., Lu, Y., Wang, J.H., Liang, Q. and Liu, J.X. 2012. The effects of combined essential oils along with fumarate on rumen fermentation and methane production in vitro. Journal of Animal and Feed Sciences, 21: 198–210.

Lu, C.D. 1987. Implication of forage particle length on chewing activities and milk production in dairy goats. J. Dairy Sci., 70: 1411–1416.

Luciane, R.S., Julio, V., Leandro, S.F., Ivan, L.B., Flânia, M.A. and Juliano, B. 2011. Behavior patterns of cows with Charolais or Nellore breed predominance fed diets with plant extract or monensin sodium. On-line version ISSN 1806-9290, Revista Brasileira de zootecnia, 40 (12): 2954-2962.

Malecky, M., Broudiscou, L.P. and Schmidely, P. 2009. Effects of two levels of monoterpene blend on rumen fermentation, terpene and nutrient flows in the duodenum and milk production in dairy goats. Anim. Feed Sci. Technol., 154: 24-35.

Marion, D., Giger-Reverdin, S., Daniel, S., Gérard, B. and Duvaux-Ponter, C. 2009. The influence of acidosis and live yeast (Saccharomyces cerevisiae) supplementation on time-budget and feeding behaviour of dairy goats receiving two diets of differing concentrate proportion. Applied Animal Behaviour Sci., 121(2): 108-119.

Markey, A.D. and Kline, K.H. 2006. Effects of dietary fat and yeast culture supplementation on total tract digestibility by horses. Prof. Anim. Sci., 22: 261-266.

McSweeney, C.S. and Kennedy, P.M. 1992. Influence of dietary particle size on chewing activity and reticulo-ruminal motility in goats and sheep fed wheaten (Triticum aestivum) hay. Small Rumin. Res., 9: 107–115.

Meyer, N.F., Erickson, G.E., Klopfenstein, T.J., Greenquist, M.A., Luebbe, M.K., Williams, P. and Engstrom, M.A. 2009. Effect of essential oils, tylosin, and monensin on finishing steer performance, carcass characteristics, liver abscesses, ruminal fermentation, and digestibility. J. Anim. Sci., 87: 2346-2354.

NewBold, C.J., Wallace, R.J. and Mcintosh, F.M. 1996. Mode of action of yeast Saccharomyces cerevisiae as a feed additive for ruminants. Br. J. Nut., 76: 249-261.

NRC, 1981. Nutrient requirements of goat. National Academy Press. Washington, D.C.

Patra, A.K., Kamra, D.N. and Agarwal, N. 2010. Effects of extracts of spices on rumen methanogenesis, enzyme activities and fermentation of feeds in vitro. J. Sci. food Agric., 90: 511-520.

Refstie, S., Baeverfjord, G., Seim, R.R. and Elrebo, O. 2010. Effects of dietary yeast cell wall B-glucan and Mannan-Oligosaccharide on performance, gut health and salmon lice resistance in Atlantic salmon (salmo salar) fed sunflower and soybean meal. Aquaculture, 305: 109-116.

Reid, G. and Frienship, R. 2002. Alternatives to antibiotic use: probiotic for the gut. Int. Anim. Biotechnol., 13: 97-112.

Rolfe, R.D. 2000. The role of probiotic cultures in the control of gastrointestinal health. J. Nutr., 130: 396S-402S.

Snedecor, G.W. and Cochran, W.G. 1982. Statistical methods. 8th Ed., Ames. Iowa State University.

Spanghero, M., Zanfi, C., Fabbro, E., Scicutella, N. and Camellini, C. 2008. Effects of a blend of essential oils on some end products of in vitro rumen fermentation. Anim. Feed Sci. Tech., 145: 364-374.

Stewart, C.S., Flint, H.J. and Bryant, M.P. 1988. The rumen bacteria. In The rumen microbial ecosystem, 1st edition (ed. PN Hobson) Elsevier Applied Science, New York, USA, 21–75.

Szumacher-Strabel, M. and Cieslak, A. 2010. Potential of phytofactors to mitigate rumen ammonia and methane production. J. Anim. Sci., 19: 319-337.

Tager, L.R. and Krause, K.M. 2011. Effects of essential oils on rumen fermentation, milk production, and feeding behavior in lactating dairy cows. Journal of Dairy Science, 95: 2455-2464.

Tang, S.X., Tayo, G.O., Tan, Z.H., Sun, Z.H. and Shen T. 2008. Effects of yeast culture and fibrolytic enzyme supplementation on in vitro fermentation characteristics of low quality cereal straws. J. Anim. Sci., 86: 1164-1172.

Umberger, S.H. and Notter, D.R. 1989. Evaluation of lactobacillus inoculant on feedlot lamb performance. J. Anim. Sci., 8: 40-45.

Ungerfeld, E.M., Kohn, R.A., Wallace, R.J. and Newbold, C.J. 2007. A meta-analysis of fumarate effects on methane production in ruminal batch cultures. J. Anim. Sci., 85: 2556-2563.

Warner, A.C. 1964. Production of volatile fatty acids in the rumen. Methods of measurements. Nutr. Abstr. and Rev., 34: 339.

Williams, A.G. and Coleman, G.S. 1997. The rumen protozoa. In The rumen microbial ecosystem, 2nd edition (ed. PN Hobson and CS Stewart). Blackie Academic and Professional, London, UK., 73–139.

Yang, W.Z., Ametaj, B.N., Benchaar, C. and Beauchemin, K.A. 2010. Dose response to cinnamaldehyde supplementation in growing beef heifer's ruminal and intestinal digestion. J. Anim. Sci., 88: 680-688.

Yang, W.Z., Benchaar, C., Ametaj, B.N. and McAllister, T.A. 2007. Effects of garlic and juniper berry essential oils on ruminal fermentation and on the site and extent of digestion in lactating cows. J. Dairy Sci., 90: 5671-5681.

Yoon, I.K. and Stern, M.D. 1995. Influence of direct fed microbials on ruminant microbial fermentation and performance of ruminants: A review. Asian-Australasian J. Anim. Sci., 8: 533–555.

Yu C. W., Chen, Y.S., Cheng, Y.H., Cheng, Y.S., Yang, C.M. J. and Chang, C.T. 2010. Effects of fumarate on ruminal ammonia accumulation and fiber digestion in vitro and nutrient utilization in dairy does. Journal of Dairy Science, 93: 701–710.

Zhao, X.H., Zhang, T., Xu, M. and Yao, J.H. 2011. Effects of physically effective fiber on chewing activity, ruminal fermentation and digestibility in goats. J. Anim Sci., 89: 501-509.

Zheng, C., Zhengli, H., Fadi, L., Yanli, G. and Yanmei, J. 2012. Effects of adding Mannan-Oligosaccharide to different concentrate-to-roughage diets on ruminal fermentation in vitro. J. of Animal and Vet. Advances, 11(1): 36-42.

Zhou, Y.W., McSweeney, C.S., Wang, J.K. and Liu, J.X. 2011. Effects of disodium fumarate on ruminal fermentation and microbial communities in sheep fed on high-forage diets. The Animal Consortium, 6 (5): 815–823.

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