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Rumen fermentation pattern of Barbari kids at different physiological stages under semi-intensive system of production

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ABSTRACT

An experiment on 24 goat kids, 8 of each stage of growth (K_1, 3–6 month; K_2, 6–9 months; K_3, 9–12 months) was conducted to study the rumen fermentation pattern of goat kids under semi-intensive system of feeding and management. The semi-intensive system of goat production involved 6 to 8 h daily grazing with feeding of concentrate at 1.5% of live weight, dry roughage (gram straw) *ad lib.* and green fodder 1,500 g/ animal/ day after grazing. The rumen fluid pH, total-N (mg/dl) and NPN (mg/dl) were similar among kid groups and mean levels were respectively 6.5, 70.81 mg/dl and 39.83 mg/dl. The TCA-ppt-N and NH_3-N concentration were lower ($p<0.05$) in K_1 (20.8 mg and 17.76 mg) kids, while K_2 and K_3 kids had the similar levels. The TVFA (mmol/dl) and fractional VFA were not different among kid groups and mean TVFA were 10.63 mmol/dl, while mean proportion (%) of acetate, propionate and butyrate were 66.29, 22.07 and 11.61 respectively. Therefore, it is concluded that kids at 3–6 months of age have low proteolytic activities while energy/fibrolytic activities not affected by age of kids.

Key words: Barbari kids, Physiological stages, Rumen fermentation

The 125.46 million goats of 23 diversified breeds (FAO 2010), having an annual population growth of 4%, rank India the second largest goat numbers in the world. Kids differ from young non-ruminants because rumen is undeveloped in newborn kids, and develop rapidly when solid feeds are fed (Heinrichs 2005). The changes in rumen papillae density on the rumen surface are important for absorptive capacity (Lesmeister *et al*. 2004). Development of rumen papillae is affected by weaning age, amount and type of ration fed and metabolizable energy content of a ration (Nockels *et al.* 1966). The chemical compositions of ration and end products from ruminal microbial fermentation have a critical influence on development of the rumen papillae (Nocek *et al*. 1984). The reticulo-rumen of ruminant livestock is the habitat of a large and diverse microbial population that converts waste resources into nutritious and valuable animal products. The rumen microbial ecosystem having anaerobic microbes mainly bacteria, protozoa, fungi, yeasts and moulds chiefly degrade plant polymers, which cannot be digested by the host enzymes. The rumen characteristics effects fermentation and end products of fermentation metabolites (Bannink *et al*. 2012) and rumen function influence by several factors such as degradation characteristics of feed, characteristics of microbial activity, rumen fermentation conditions and age of the animal. A relatively stable intra-ruminal milieu is essential for healthy ruminants. This is related to the variation of pH, short chain fatty acids (SCFA) and ammonia concentrations in rumen fluid. SCFA are mainly produced by microbial fermentation and stimulate development of the rumen epithelium resulting in improvement in structure and absorptive capability (Lesmeister and Heinrichs 2004), because they are synthesized in the rumen and then absorbed through the rumen wall (Gabel *et al*. 2002). Both butyrate and the acetate: Propionate ratios promote development of rumen epithelium and mucosa (Lane and Jesse 1997). The feed intake causes a marked increase in rumen content, in the activity and size of the microbial community in the rumen, and in the amount and type of volatile fatty acids (VFA) produced. The intraruminal fermentation conditions are regulated by feeding behavior, rumination, salivation and rumen wall function. The increase in VFA production and reduced ruminal pH impose a challenge to the regulation of intracellular pH homeostasis of rumen epithelia. The rumen fermentation characteristics relative to different physiological stages of young kids is unknown. Therefore, present experiment aim was to assess the rumen fermentation pattern of goat kids maintained under semi-intensive system of production.

MATERIALS AND METHODS

Goat kids (24), eight of each stage of growth stage (K1, 3–6 months; K2, 6–9 months; K3, 9–12 months) were maintained in 3 groups under identical feeding and

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management system. The semi-intensive system of goat production was adopted for the experiment involving 6 to 8 h daily grazing in Yamuna ravine degraded grazing land during monsoon and post monsoon, feeding of concentrate at 1.5% of live weight, dry roughage (gram straw) *ad lib.* and green fodder 1,500 g / animal / day after grazing. Drinking water was available *ad lib.* 24 h.

The rumen liquor samples were collected from all animals after grazing at 35 days of initial feeding during each physiological stage. A 50 ml rumen fluid was collected from intact animal using stomach tube. The pH was estimated within 5 min of aspiration thereafter rumen fluid was strained with 4 layers of muslin cloth and stored at –20ºC until analyzed. Chemical analysis of rumen fluid was done to determine total nitrogen and NH_3-N (Kjeldahl procedure -AOAC 1984), total volatile fatty acids (Barnett and Reid 1956) using Markham distillation apparatus (Markham 1942), and fractional VFAs of rumen fluid (Erwin 1961), cell wall components (Goering and Van Soest 1970). The observation of rumen fermentation characteristics were analysed for statistical significance using analysis of variance procedure of SPSS base 14.

RESULTS AND DISCUSSION

The chemical composition of feed resources used for kid rearing (Table 1) revealed that gram straw, anjan and dub grass were of poor quality, as these feeds have low crude protein, and high in fiber and lignin contents (Leng 1990). Dutta *et al*. (2003) reported similar chemical constituents in these feed resources. The cow pea fodder contained crude protein 13.8 and lignin 4.3% showing good nutritional quality. The kid mash feed had crude protein 18.22, fat 4.6 and lignin 3.36%. The cow pea fodder and kid mash had the nutrient density as per recommendation (Ranjhan 1998).

The rumen fermentation pattern of kids at 3 physiological stages is presented in Table 2. The rumen fluid pH ranged from 6.5 to 6.6 was similar among three kid groups, while total-N content varied from 61.7 to 77.7 mg/dl was higher ($P<0.05$) in K_3 compared to K_2 kids. The NPN content was similar among 3 kid groups, which ranged from 38.5 to 41.3 mg/dl. The TCA-ppt-N was significantly ($P<0.05$) different among kid groups, which was the lowest in K_1, while K_2 and K_3 had similar levels. Similarly, NH_3-N ranged from 17.8 to 25.6 mg/dl was significantly ($P<0.05$) different among 3 kid groups and followed the trend of TCA-ppt-N. The TVFA were similar among kid groups, which varied from 9.6 to 11.7mol/dl. Acetate, propionate and butyrate showed a normal trend of VFA in rumen fluid, which was not different among kid groups. The mean acetate, propionate, butyrate and A:p ratio were respectively 66.3, 22.1, 11.6% and 3:1 in kids.

Table 1. Chemical composition (%) of feeds fed to kids

Attributes	Feeds of kid feeding*				
	Gram straw	Kid mash	Cowpea fodder	Anjan grass	Dub grass
Organic matter	92.47	91.33	87.36	89.52	88.64
Crude protein	5.72	18.22	13.82	9.09	5.67
Fat	1.28	4.58	3.49	1.37	1.19
Total carbohydrates	85.45	68.51	70.04	79.05	81.77
Neutral detergent fiber	78.06	46.94	65.02	68.10	76.62
Acid detergent fiber	42.48	12.82	24.09	36.20	34.75
Hemi-cellulose	36.08	34.92	41.73	32.50	42.37
Cellulose	29.49	8.66	19.00	27.79	26.43
Lignin	12.49	3.36	4.29	7.81	7.82

*Cowpea fodder, *Vigna sinensis*; Anjan grass, *Cenchrus ciliaris;* Dub grass, *Cynodon dactylon;* Gram straw, *Cicer arietinum.*

Table 2. Rumen fermentation pattern of kids at different stages of growth

	Physiological stage of kids*			Mean±SE	Significance
	K_1	K_2	K_3		
pH	6.47±0.06	6.47±0.06	6.60±0.09	6.51±0.04	NS
Total-N (mg/dl)	$73.06^{ab}4.11$	$61.68^{a}\pm2.89$	$77.7^{b}\pm5.61$	70.81±2.78	$P<0.05$
NPN (mg/dl)	38.47±3.20	41.30±3.05	39.72±2.43	39.83±1.62	NS
TCA-ppt -N (mg/dl)	$20.38^{a}\pm4.59$	$34.58^{b}2.73$	$37.97^{b}\pm5.18$	30.98±2.85	$P<0.05$
NH_3-N (mg/dl)	$17.76^{a}\pm1.10$	$22.57^{b}\pm0.86$	$25.63^{b}\pm1.38$	21.99±0.92	$P<0.01$
TVFA (mmol/dl)	9.63±0.51	10.63±0.36	11.65±0.73	10.63±0.35	NS
Acetate%	66.80±1.00	65.28±1.56	66.80±1.09	66.29±0.70	NS
Propionate%	21.45±0.76	21.91±0.60	22.85±1.01	22.07±0.46	NS
Butyrate%	11.73±0.64	12.80±1.03	10.33±0.70	11.62±0.49	NS
A/P ratio	3.15±0.15	3.00±0.15	2.98±0.18	3.04±0.09	NS

*K_1 (kids 3–6 months), K_2 (kids 6–9 months), K_3 (kids 9–12 months).

The results of the present study corroborated the findings of Solaiman *et al*. (2009) who reported similar pH range (6.72) in weaned Boer kids reared under semi-intensive system of management (pasture graze + pellet supplement). Sun *et al*. (2011) also reported similar rumen fluid pH after 60 days of weaning in calves. In weaned sheep also similar type of results were observed for pH (6.6), VFA (12.9 mmol/dl) and total–nitrogen (62.8 mg/dl) when the animals were reared under semi-intensive systems of management (grazing + 250g concentrate mixture per lamb) (Raghuvansi *et al.* 2007). Galina *et al*. (2004) reported almost similar type of ammonia-nitrogen (16.3 mg/dl) concentration; and acetate (67.4), propionate (19.7) and butyrate (7.5)% in Alpin kids when they were allowed in rangeland pasture and concentrate mixture under semi intensive management system. Bhatt *et al*. (2008) also observed rumen pH (6.39), TVFA (11.91 mmol /dl), total-nitrogen (86.33 mg/dl), TCA-precipitable-N (39.53 mg/dl) and ammonia-nitrogen (12.75 mg/dl) in weaned lambs reared under grazing condition along with *ad lib.* creep mixture and tree leaves.

Generally Barbari kids are weaned at 3 months of age and the rumen starts to develop from about 60 days of age onwards. Rumen in the kids under 3–6 months age group is considered to be under developing phase and after 6 months of age the Barbari kids starts consuming more fibrous feed from grazing resources as well as from a straw based solid diet offered to them. Due to gradual development of the rumen and the ruminal ecosystem the fermentation pattern were observed more prominent at latter stages of growth in Barbari kids reared under semi-intensive system of management. The rumen microbial ecosystem of kids at different physiological stages showed that the nitrogen, TCA-ppt-N and NH_3-N levels affected by the stage of rumen development. The K_1 kids (3 to 6 months) had the low microbial population especially of proteolytic microbes as demonstrated by reduced TCA-ppt-N and NH_3-N levels in spite of similar total nitrogen levels. However, fibrolytic population did not change between 3 to 12 months of age, which is demonstrated by similar TVFA and fractional VFA levels. Therefore, it is concluded that kids at 3–6 months of age have low proteolytic activities while energy/fibrolytic activities are not affected by age of kids.

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