Indian J. Anim. Res., **43** (2) : 94-98, 2009

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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EFFECT OF BYPASSING DIETARY FATS FROM BIO-HYDROGENATION ON GROWTH AND NUTRIENT UTILIZATION IN HEIFERS

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ABSTRACT

The present study was conducted to assess the capability of dietary oils with high degree of unsaturation to act as "sinks" for absorption of bio-hydrogen of the rumen. Three fat capsules of different oils [soy (T1), sunflower (T2) and mustard (T3)] were fed to treatment groups along with control (T4). The total fat concentrations (mg/ml serum) were similar in all the treatment groups throughout the experiment. Per cent FFAs was higher in T_1 than in T_2 while T_3 and T_4 were similar. The iodine number was higher in T_1 and T_2 groups while T_3 and T_4 tended to similar. DMI (kg/day) was higher in T_4 followed by T_3, T_1 and T_2. Digestibility of crude protein differed significantly (P<0.5) and had influence on fiber digestibility. Average body weight gain tended to be higher in T_2, followed by T_1, T_3 and T_4 (lowest).

Key Words: Dietary fats, Heifers.

INTRODUCTION

Feeding protected PUFAs (Kennelly and Blair 1996: Purushothaman, 2004) or by-passing (Raman Rao and Petit, 2000) against ruminal bio-hydrogenation, would be a good strategy to improve ruminant productivity. However, the most common treatments for protection of dietary fats were either chemical (e.g. formaldehyde; Ca-soaps of fatty acids) or physical (e.g. heating). The former would be difficult to be accepted by consumers who wish to buy safe and healthy products of milk and meat, while the later could increase the proportion of *trans* isomers in FAs and produce 'non-natural' milk/ meat. In fact, FAs with *trans* isomers are usually considered to be related to abnormalities (e.g. cardiovascular diseases and cancer). It was, therefore imperative to find out ways of increasing poly unsaturated fatty acids (PUFAs) in milk without increasing the proportion of their *trans* isomers.

Normal level of bio-hydrogen happened to be about 5 per cent of the total of rumen gases, a product of the binary fermentation (Van Soest, 1982; Bondi, 1987). The basic problem of anaerobic rumen metabolism happened to be the shortage of oxygen and excess of reduced enzymes, which are badly in need of 'SINKS' for utilization of bio-hydrogen. If these hydrogen sinks are provided by way of natural sources of high degree of unsaturated fatty acids, for utilization of bio-hydrogen of the rumen, the dietary fat would be bypassed without protection and therefore, this could be an economical answer to improve the ruminant products with maximum poly unsaturated fatty acids. Keeping above facts in mind the present study was planned to prepare edible oil capsules of different vegetable oils to see the effect of bypassed dietary fats in blood profile, nutrient utilization and growth in heifers.

MATERIAL AND METHODS

Sixteen (16) young growing healthy crossbred heifers ranging between 65-99 kg body weights were randomly divided into four uniform groups of four animals in each. The heifers received five ml of double refined soy oil with jaggery (T1), five ml of double refined sunflower oil (T2), five ml of double refined mustard oil (T3) and received jaggery capsules without any oil (T4). All the heifers were given green fodder and the weighted quantity of concentrate mixture to meet the requirements as per NRC (1989).

During the trial, initial, middle and last (total three), blood samples (5-7 ml) were collected and serum was analyzed for total lipids. Free fatty acids percent and iodine number was measured in isolated lipid. The total lipids isolation was done by

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chloroform-methanol (2:1, v/v) extraction and "Folch" wash method (Folch *et al.,* 1951). The free fatty acid in the total lipid extracted from serum was estimated by titrating it against KOH in the presence of phenolphatalein indicator (Cox and Pearson, 1962). Determination of iodine number was done by the method described by William, 1975.

A digestibility trial was conducted for six days during which feed offered, residue left and feaces voided were recorded and were analyzed for proximate principles (AOAC, 1990) and for fiber fractions by the method of Goering and Van Soest (1970). The data obtained by the experiment was analysed by simple R.B.D., method described by Snedecor and Cochran (1968).

RESULT AND DISCUSSION

Chemical Composition of Feed

The chemical composition of green fodder (jowar) offered was Dry Matter 31.56, Organic Matter 90.28, Crude Protein 6.62, Ether Extract 1.47, NDF 61.07, ADF 41.98, Ash 9.72, and Hemicellulose 19,09 percent while for concentrate 91.68, 84.23, 20.15, 3.74, 43.72, 10.81, 15.76 and 32.91 percent respectively. The diet for all the treatment groups including the control was isocaloric and isonutritive.

Blood Serum Profile

Total fat/total lipid

The total fat (mg/ml serum) was more or less similar during the whole experiment while treatment T_1 was lowest and T_3 was highest among the treatments (Table 1) which can be expected from such isocaloric diet for all the animals in the treatment groups.

Percentage FFAs

At the start of the experiment the per cent FFAs were higher in T_1 followed by T_2 group before feeding of fat-capsules; however, T_3 and T_4 were similar (Table 2). After the treatment at 45 day, the percentage FFAs, was high in sunflower oil treatment group, followed by soy oil treatment group; while, mustard oil group continued to be unchanged. At the 90 day all the treatment groups showed similar pattern. Esterification of FFAs during the later phase of the trial could be the possible reason for such trend in the cross-bred heifers.

The overall FFA profile during this investigation could be the result of availability of FFAs; only a small portion of FFA are free in the blood, most are bound to protein (Goodman, 1958). The mobalization of FFA depends on, lipolysis and/ or esterification. Kronfeld (1965) found that, the blood FFA level is a sensitive clinical index of fat mobilization. Researchers have suggested the use of the blood concentration of FFA instead of body weight changes as an index to estimate maintenance requirement (Doney and Russel, 1969). The rationale of such index is that, the food intake would be controlled so that the FFA of blood would be stabilized at a level indicating neither high mobilization nor storage of lipid. Doney and Russel (1969) critically examined FFAs as a maintenance index and concluded that a relationship exists.

Iodine number

The iodine value was taken as a measure of the degree of unsaturation in the serum fat. In our study in T_1 group, the iodine number decreased as the trial advanced and in T_2 group the iodine number remained the same and during the last phase, some increase was recorded Table 3). Sunflower oil (Blank, 1999) treatment group showed promising results as compared to other groups in the present investigation. The sunflower and soy oils have more polyunsaturated fatty acids as compared to others to work as good sink for hydrogen. Therefore, the sunflower and soy oil capsule appeared to have performed better as a hydrogen sink in our study. Mewara (2006) found an increase in total unsaturated fatty acids of butterfat in lactating crossbred cows, which may be due to the supplementation of concentrate diet with soy oil.

Table 1: Serum profile of blood during the experiment of total fat (mg/ml)

Days	Groups (treatment mean)				SEm±
	I	II	III	IV	
0 day	9.08	9.22	9.68	9.33	0.234
45^{th} day	8.86	9.28	9.51	6.30	0.228
90^{th} day	8.95	9.03	9.37	9.24	0.139

Table 2: Per cent FFAs during experiment at different stages

Days	Groups (treatment mean)				SEm±
	I	II	III	IV	
0 day	0.650	0.617	0.487	0.475	0.717
45th day	0.540	0.677	0.440	0.472	0.436
90th day	0.477	0.465	0.490	0.492	0.433

Table 3: Iodine number in blood serum fat during experiment

Days	Groups (treatment mean)				SEm±
	I	II	III	IV	
0 day	25.14	23.97	21.47	21.22	1.310
45th day	24.79	23.86	22.26	21.90	0.869
90th day	24.35	24.22	22.42	22.04	0.642

As our experiment advanced, the maturity of forage (jowar) was increasing with the increase in maturity, the unsaturated fatty acids in forage decreased and obviously its effect on target tissues also decreases (Kewalramani *et al.*, 2003). Quantity and frequency of fat capsule could also be a limiting factor. Additionally, others factor might have shown their effect such as individual animal variation, seasonal variation, age etc.

Voluntary Intake of Feed and Digestibility

The changes in the voluntary intake of DM (kg/day, kg/100 kg body weight, g/w$^{0.75}$ body weight) for different treatment groups are given in Table 4. The changes in the voluntary intake of DM (kg/day, kg/100 kg body weight, g/w$^{0.75}$ body weight) for different treatment groups were possibility due to energy homeostatic mechanism, gut fill, palatability, concentration of blood metabolites. Such factors could have been responsible for limiting energy intake of such farm diet. The average (%) digestibility of the dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EF), neutral detergent fibre (NDF) and acid detergent fibre (ADF) for the four different treatments are given in Table 4.

Dry matter and Organic matter digestibility

The diet in all the groups including control were isocaloric, it may be expected that the dry matter digestibility (DMD) and organic matter digestibility (OMD) in all the groups would be on a similar plate form, because oral fat capsule feeding for all the treatment groups was independent of barn feeding. In some instances rumino-reticulum motality is depressed due to increase in cholecystokinin secretion (Gagliostro and Chilliard, 1991). Enteric involvement was likely to occur as emulsified oils, changed the reticular motility in heifers, when fat capsules were fed.

Crude protein and Ether extract digestibility

The study showed significantly differ performance (P < 0.05), when paired comparison were made. The mean daily intake of nitrogen per unit metabolic size can be expected to be improved significantly, which could be attributed to its influence in inducing greater DM intake. Therefore, it is believed that certain essential amino acids in the diet might have influenced N-metabolism principally by boosting microbial protein synthesis in the rumen (McCracken *et al.*, 1993).

Increasing trend was observed among the treatment groups respectively for EE digestibility. Changes in molar percentage may be related to fat capsule feeding (Gagliostro, and Chilliard, 1991).

NDF and ADF digestibility

Among the cell wall fractions the significant changes in CP digestibility (P < 0.05) might have improved the digestibility of NDF it clearly indicates that CP digestibility had a stimulatory effect in enhancing the fiber digestibility. Significant changes in CP digestibility would have increased the microbial growth which increased the cellulolytic activity resulting in an increased fibre digestibility. It is interesting to note that ADF digestibility had shown significant results. Therefore, this parameter confirms the correlation.

Table 4: Average DMI of animals in different treatment groups

S. No.	Particulars	Treatment mean				*SEm*±
		I	II	III	IV	
1	DMI (kg/day)	3.60	3.35	3.70	3.83	0.323
2	DMI (kg/100 kg BW)	3.45	3.09	3.62	3.74	0.267
3	DMI (g/w 0.75 kg BW)	110.39	99.97	115.45	119.01	8.76
Digestibility of Nutrients (%)						
4	DM	53.47	52.86	57.69	56.19	1.23
5	CP	59.65	59.15	64.02	63.18	1.10
6	EE	67.09	68.92	71.82	71.99	2.63
7	OM	55.79	55.50	60.15	58.68	1.24
8	NDF	42.49	45.12	49.91	47.87	2.24
9	ADF	31.18	31.48	39.05	37.21	1.52
Body weight gain						
10	Average initial body weight (kg)	85.58	85.49	85.74	85.74	–
11	Average final body weight (kg) after trial	108.83	108.86	106.66	106.16	–
12	Average weight gain during trial (kg)	23.25	23.37	20.92	20.42	–
13	Average daily gain (g/day)	217.28	219.17	195.46	190.43	25.02

Average Body Weight Gain

Average body weight changes and body weight gain is shown in Table 4. Here, the values for T_2, T_1 and T_3 treatment groups were 15.09, 14.09 and 2.64 per cent higher than control value (190.43 g/day). Taking into consideration the intake of DM and mean daily intake of CP, it can be concluded that significantly improved crude protein digestibility appeared to have effect on weight gains. Overall average body weight changes are as per reflection of dry matter or nutrient digestibility and can also be linked to their genetic potential.

CONCLUSION

It can be concluded that there is a possibility of using the dietary oils having high degree of unsaturation (poly unsaturated and/or monounsaturated) to be orally fed as 'sinks' for consuming biohydrogen present in the rumen and for the oxidation of reduced enzymes as well. There could be a possibility of increasing the level of such sinks (may be feeding the fat capsules twice a day and/or with higher doses), which would pave way for better productivity. Further, more meaningful results could have been achieved by including more number of animals in such statistical groups.

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