EFFECT OF LOW DEGRADABLE DIETARY PROTEINS ON HEPATIC METABOLISM OF EARLY LACTATING BUFFALOES

P. Sikka[1], S. S. Sengar and V. D. Mudgal

Central Institute for Research on Buffaloes
Sirsa Road, HISAR 125001, India

Summary

Role of low degradable protein in milk production of early lactating Murrah buffaloes has been studied in relation to energy status of test animals. Replacement of conventional concentrate mixture with low degradable cotton seed cake resulted in appreciable changes in circulatory transaminases and phosphatase levels. The enzymes viz. glutamate oxaloacetate and glutamate pyruvate transaminase and alkaline phosphatases increased with feeding of said cake indicating stress on hepatic tissue. Animals seemed to overcome stress by feeding enhanced levels of same protein along with improved feed intake, body weight and milk production.

(**Key Words**: Low Degradable Protein, Transaminases, Phosphatase, Early Lactation, Buffalo)

Introduction

Improvement in milk production by enhanced dietary crude protein has been established in cattle (Orskov, 1977; Cressman et al., 1980; Roffler et al., 1986) and refuted as well. (Henderson et al., 1985). Reduced solubility or low degradability of dietary protein has also been found improving the animal performance (Nishimuta et al., 1974; Roffler and Thacker, 1983). But level of crude protein to be fed has to be monitored keeping in view the extent of hepatic detoxification of ammonia produced and hence the increasing demand of energy so forth (Tyrrell et al., 1980 and Visek, 1984). However the low degradability of protein might facilitate the hepatic system of early lactating buffaloes in latter respect. Present study was taken up to explore the use of high CP but low degradable proteins in diet to compensate the extra demand of energy and stress on hepatic system in early lactating buffaloes.

Materials and Methods

Twenty one milk buffaloes varying from 2nd to 5th lactation were selected from Institute herd. These animals were in early lactation stage. All the animals were fed with 4 percent urea treated wheat straw *ad lib* with supplementation of 2.5 kg concentrate mixture (CP = 22.62 & CF = 9.6%) and 20 kg green fodder. Mineral mixture and common salt were offered as per requirement. Animals were kept on this feeding for six weeks and then divided into three groups randomly. Animals were fed 1.5 kg and 3.0 kg cotton seed cake (CP = 23.62% CF = 20.50%) along with 20 kg green and *ad lib* ensiled straw, respectively, in treatment 1 and 2. Control group animals were kept on 2.5 kg concentrate mixture in place of cake.

Milk yield, milk protein and milk fat were estimated with recognized methods (AOAC, 1975). Serum aminotransferases and alkaline phosphatases were estimated, respectively, by methods of Reitman and Frankel (1957) and Kind and King (1954) on 7th and 9th weeks after experimental feeding of treatment 1, 2 and control groups animals.

For comparison of milk yield and level of different milk constituents the analysis of variance was performed (Snedecor and Cochran, 1968). Correlation coefficients were also analysed to measure the mutual relationships amongst blood parameters of hepatic stress and milk yield and its quality for elaborate studies regarding performance of animals.

[1]Address reprint requests to Dr. P. Sikka, Central Institute for Research on Buffaloes, Sirsa Road, HISAR 125001, India.

Received July 9, 1991
Accepted June 8, 1992

Results

Crude protein content of feeding material was 8.75, 23.62 and 22.62 percent, respectively, for treated wheat straw, cotton seed cake and concentrate mixture. Protein content of green fodders ranged between 13.82 to 15.24 percent. Control group animals had milk yield of 5.5 ± 1.6 L per day with fat content of 6.9 ± 0.8 and protein content of 4.7 ± 0.3 percent. Milk yield was found increased in high protein fed animals (table 1) though not significant ($p > 0.05$). Slight enhancement was also noted with advancement in feeding time. But a significant ($p < 0.05$) increase in milk fat was noted after 6 weeks feeding of high dietary proteins. Although trend was not consistent with period of feeding (Jaquette et al., 1986).

Quantity and quality of milk production in relation to energy status of animals was studied through certain circulatory enzymes after 6-8 weeks time of feeding (table 1). The levels of serum glutamate oxaloacetate transaminase (EC 2. 6. 1. 1), glutamate pyruvate transaminase (EC 2. 6. 1. 2) and alkaline phosphatase (EC 3. 1. 3. 1) were found enhanced by feeding higher levels of crude protein in treatment 1 (table 1). It tends to reach normalicy by further increasing the levels of dietary low degradable protein in treatment 2. Significant correlations were found amongst milk quality parameters, milk quantity and blood parameters (enzymes monitoring degree of stress on hepatic tissue) (table 2).

A significant negative correlation of levels −0.755, −0.75, and 0.27 were found, respectively, in control, treatment 1 and 2 groups animals between SGOT and milk yield; −0.98, −0.87 and 0.99 between SGPT and milk yield. AP had a significant positive correlation with milk fat ($r = 0.98$; $r = 0.79$), respectively, in control and treatment 2 group animals. In general, aminotransferases were found having positive correlation with AP though non-significant but significant negative correlation ($r = 0.99$, $r = 0.98$) in treatment 1.

Discussion

An improvement in milk yield has been noted by enhancing CP in diet though not significant. It may be due to less degradable dietary protein being fed to these animals. Loss in body weight in these animals upto 5-6 weeks has been noted and it was recovered later with enhanced dietary protein and period of feeding as well. It is consistent with earlier studies (Roffler and Thacker, 1983).

Transamination is key for glutamate production which leads to energy production through glutamate dehydrogenase reaction in all tissues. But excess of ammonia produced in said reaction is swept away by urea cycle only in hepatic tissue. This tissue receives different nutrients through portal blood and consequently synthesizes protein,

TABLE 1. AVERAGE MILK AND BLOOD CONSTITUENTS UNDER THE DIETARY EFFECT OF LOW DEGRADABLE PROTEIN IN EARLY LACTATING BUFFALOES*

Groups	50 Days after feeding			65 Days after feeding		
	Control	Treatment 1	Treatment 2	Control	Treatment 1	Treatment 2
1. Serum glutamate oxaloacetate Transaminase (KU)	67.0± 4.1	60.0±14.1	44.6±15.0	73.3±15.2	80.4±23.8	65.5± 9.0
2. Serum glutamate pyruvate Transaminase (KU)	29.2±10.4	27.0± 1.4	20.5± 2.5	34.6±12.8	40.8±13.1	33.3±19.7
3. Alkaline Phosphatase (kAU)	9.1± 1.8	12.0± 2.4	7.5± 2.0	10.9± 3.5	12.7± 0.6	8.6± 0.8
4. Milk yield (kg)	5.5± 1.6	6.5± 1.3	7.2± 1.3	5.9± 0.5	6.5± 1.0	8.1± 0.6
5. Milk fat (kg)	6.9± 0.8	6.6± 1.5	7.3± 0.6	6.9± 0.2	6.3± 0.2	7.7± 0.1
6. Milk protein (kg)	4.7± 0.3	4.6± 0.3	5.0± 0.3	4.4± 0.1	4.3± 0.2	4.8± 0.07

* Each value is an average of seven replicates.

TABLE 2. CORRELATION BETWEEN MILK CONSTITUENTS AND BLOOD PARAMETERS ON BASIS OF AVERAGE CONCENTRATIONS OVER REPLICATES

Groups	Blood/ milk constituents	Serum glutamate pyruvate transaminase (SGPT)	Alkaline phosphatase (AP)	Milk yield (MY)	Milk fat (MF)	Milk protein (MP)
Control	SGOT	0.833*	−0.69	−0.755*	−0.25	0.216*
	SGPT		0.916**	−0.98**	−0.97**	−0.89**
	Alkaline phosphatase			−0.83*	0.98**	−0.99**
	Milk yield				−0.90**	0.80*
	Milk fat					0.80*
Treatment 1	SGOT	0.615	−0.99**	−0.75*	−0.70	−0.35
	SGPT		−0.98**	−0.87**	0.216	−0.54
	Alkaline phosphatase			−0.80*	−0.36	0.41
	Milk yield				0.27	0.88*
	Milk fat					0.712
Treatment 2	SGOT	0.36	0.54	0.27	−0.79*	−0.96**
	SGPT		0.22	0.99**	0.30	−0.14
	Alkaline phosphatase			0.17	0.79*	−0.99**
	Milk yield				0.36	0.08
	Milk fat					0.90**

* Significant at 5% level of significance.
** Significant at 1% level of significance.

supplies amino acids to circulation as and when needed. Intestinal transaminases, however, utilize glutamate and aspartate but release alanine in portal blood. Hepatic tissue damage is well known during protein turnover process especially in milk producing animals when animals lack in energy and remain in low energy state (Maynard et al., 1985). This tissue damage results in variation in circulatory transaminases levels (Treacher and Collis, 1977).

In view of this the negative correlation between SGOT and milk yield at early lactation in present investigation suggests that performance of animal is improved only when energy status of animal is satisfactory. Lower or normal SGOT or SGPT levels in serum depict the status of less glutamate and less NADH production through glutamate dehydrogenase so forth. However in treatment 2 more dietary CP has probably influenced liver for more ammonia being produced to be converted to urea requiring more input of energy (ATP). An additional energy drain through liver detoxification of extra ammonia might divert the correlation between aminotransferases and milk yield towards positive sign when animals fed high dietary CP during early lactation (Tyrrell et al., 1980; Fotiadis, 1983 and Dvorak and Macks, 1979; Stodota and Slipka, 1983). Levels of hepatic enzymes in serum being more with increasing dietary CP in treatment 1 from control group animals obviously indicate the hepatic stress (Treacher and Collis, 1977) being more in treatment 1 than treatment 2 where level of these enzymes tend to return to lower levels (table 1). It shows that although higher dietary CP enhances the extra energy utilization through ammonia detoxification of liver in treatment 2 animals yet it has a beneficial effect overall on gain in body weight, feed intake and improvement in milk production in these animals. A portion of this response may be due to increased dietary amino acids reaching small intestine for animals' benefit due to lower degradability of cotton seed cake in rumen (Kung and Huber, 1983).

The negative correlation between aminotransferases and phosphatase in treatment 1 animals further substantiates the fact that more energy (ATP) is being utilized by animals than its production through glutamate dehydrogenase at this CP level rendering animals at low energy status. The body weight loss may be because of this reason.

A positive correlation between milk fat and alkaline phosphatase indicates that more acetate production being taken place in rumen of control and treatment 2 group animals and more phosphate is being transferred to fat synthesis during better energy status of animls (Storry and Sulton, 1969).

It is obvious from present study that increase in dietary crude protein may put animal to additional stress of hepatic detoxification but low degradability of fed protein has been found beneficial for early lactating animal in maintenance of body weight and production response as well by further increase in their dietary level. So low degradable protein replacement of concentrate mixture remained beneficial for animals.

Blood aminotransferases activity has been used earlier to predict milk production in cattle (Shibistyl and Kocherigina, 1979).

Literature Cited

AOAC. 1975. Official Methods of Analysis, 12th Ed. Association of Official Analytical Chemists, Washington D. C.

Cressman, S. G., D. G. Grieve, G. K. Macleod, E. E. Wheeler and L. G. Young. 1980. Influence of dietary protein concentration on milk production by dairy cattle in early lactation. J. Dairy Sci. 63:1839.

Dvorak, J. and J. Macka. 1979. Variability of GOT and GPT in blood serum of Bochemian Pied Cattle. Acta universitates Agricultural Facultas Agronomica 27:314-155.

Emery, R. 1973. Synthesis of milk Fat. J. Dairy Sci., 56:1187.

Fotiadis, F. 1983. Predicting milk production of heifers. Molochnoei Myasnie Skotovodstvo 11:43.

Henderson, S. J., H. E. Amos and J. J. Evans. 1985. Influence of dietary protein concentration and degradability on milk production, composition and ruminal protein metabolism. J. Dairy Sci. 68:2227.

Jaquette, R. D., A. H. Rakes and Jr. W. J. Croom. 1986. Effects of dietary protein on milk, rumen and blood parameters in dairy cattle fed low fiber diets. J. Dairy Sci. 69:1026.

Kind, P. R. N. and E. J. King. 1954. Estimation of plasma phosphatase by determination of hydrolysed phenol with amino antepyrine. J. Clin. Path. 7:322.

Kung, L., Jr. and J. T. Huber. 1983. Performance of high producing cows in early lactation fed protein of varying amounts, sources and degradability. J. Dairy Sci. 66:227.

Nishimuta, J. F., D. G. Ely and J. A. Boling. 1974. Ruminal bypass of dietary soybean protein treated with heat formalin and tannic acid. J. Anim. Sci. 39:952.

Orskov, E. R., D. A. Grubb and R. N. B. Kay. 1977. Effect of postruminal glucose or protein supplementation on milk yield and composition in Friesian cows in early lactation and negative energy balance. Br. J. Nutr. 38:397.

Reitman, S. and S. Frankel. 1957. A colorimetric method for the determination of serum glutamic oxaloacetate and glutamic pyruvic transaminase. Am. J. Clin. Pathl. 28:56.

Roffler, R. E. and D. L. Thacker. 1983. Early lactation response to supplemental protein by dairy cows fed grass legume forage. J. Dairy Sci. 66:2100.

Roffler, R. E., J. E. Wray and L. D. Satter. 1986. Production responses in early lactation to additions of soybean meal to diets containing predominantly corn silage. J. Dairy Sci. 69:1055.

Shibistyl, A. L. and T. V. Kocherigina. 1979. Blood aminotransferase activity in cows and their daughters as prediction test for milk production. Selskokhogyaist Vennaya Biologiya 14:455.

Stodola, J. and J. Slipka. 1983. Relationships between blood characteristics and milk production of dairy cows. Zivocisna Vyraba, 28:241.

Storry, J. E. and J. D. Sulton, 1969. The effect of change from low roughage to high concentrate diets of rumen fermentation, blood composition and milk fat secretion in cows. Br. J. Nutr. 23:511.

Treacher, R. J. and K. A. Collis. 1977. The effect of protein intake on the activities of liver specific enzymes in plasma of dairy cows. Res. Vety. Sci. 22:101.

Tyrrell, H. F., P. W. Moe and W. P. Flatt. 1980. Influence of excess protein intake on energy metabolism of dairy cow. Proc. 5th Sympos. Energy Metab. Farm Anim. Schurch and Wenk, ed.

Visek, W. T. 1984. Ammonia It's effects on biological systems, metabolic hormones and reproduction. J. Dairy Sci. 67:481.