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APPLICATION OF NATURAL ZEOLITE ON BLOOD CHARACTERISTICS, PHYSIOLOGICAL REACTIONS AND FEEDING BEHAVIOURS OF FINISHING HOLSTEIN BEEF STEERS

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ABSTRACT

In a 210-days feedlot experiment, 27 crossbred steers (250 kg body weight) were fed a diet with clinoptilolite (CLN), a natural zeolite, substituted at 0, 2.5 and 5 % of the diet dry matter. The objective of this study was to evaluate effects of natural zeolite on blood characteristics, physiological reactions and feeding behaviors in Holstein beef steers. Overall physiological reactions like body temperature and respiration rate in all the treatments were similar. Likewise on the observation of feeding behaviors lesser time was taken in rumination time in control groups than other treatments. In feeding time none of the experimental steers showed significant effect. Blood profiles were not significantly different among the groups.

Key words : Zeolites, Blood, Feeding behaviors, Beef steers.

Natural zeolite consists of symmetrically stacked alumina and silica tetrahedral in an open and stable three dimensional honeycomb structure with a negative charge (Mumpton, 1994). The negative charge within the pores is neutralized by positively cations such as sodium. These cations are exchangeable with certain solutions such as heavy metals as well as ammonium ions (Barrer, 1987). Sweeney *et al*. (1984) demonstrated improved nitrogen, organic matter, and acid detergent fiber digestibility when five clinoptilites (the most common zeolite mineral) were added to a high solubility protein diet of growing steers and heifers.

In vivo and in vitro studies have indicated that zeolites are capable of sequestering and subsequently releasing 15% of the ammonium ions present in inculum and rumen contents (White and Ohlrogge, 1974).In contrast, Sweeney *et al* (1980) observed no effect of a synthetic zeolite on rumen ammonia concentrations. Peterson (1980) stated that CLN, when introduced into an acidic environment, will exchange constituent ions for hydrogen ions that could allow CLN to act as a buffering agent. Sweeney *et al* (1980) reported higher acetate: propionate ratio and reduced dry matter (DM) digestibility and blood K levels in dairy cattle consuming zeolites.

The aim of this study was to determine the influence of CLN on physiological responses, feeding behavior and blood characteristics in steers consuming different levels of supplemental zeolite diet.

Animals, experimental design and feeding : A 210-days feedlot trial was conducted at the Tuskestan livestock dairy farm, Gorgan vicinity. This experiment was approved by directorate of research, Gorgan University of Agricultural Sciences and Natural Resources, Iran.

Twenty seven crossbred Holstein steers were blocked by weight and assigned in a randomized complete block design with 3 pens of 9 steers/pen. Treatments were compared by ANOVA. The average body weight of animals was 250 (s.d.12.50) kg body weights. The treatments combined no supplemental zeolite, as control group, 2.50 % as treatment 1 (T1) and 5 % in treatment 2 (T2) of diet dry matter (Table1), respectively.

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In the following studies, clinoptilolite was mixed with the diets prior to feeding. The material had a minimum purity of 88%, a particle size less than 300 μm and average ammonia exchange capacity of 1.8 meg/g. The commercially procured zeolites were supplied. Clinoptilolite (Anzymite®; Product Code: A713726) was supplied by Afrandtoska Co., Tehran, Iran) from Semnan zeolite mines located in Central Iran. Chemical composition based on X- ray diffraction (Rahmani *et al.*, 2004) was (per kg):695.3g Sio_2, 36.7 g CaO, 27.7 g K_2O, 77.5 g Al_2O_3, 6.3 g Na_2O, 14.1 g Fe_2O_3 , 1.9 g TiO_2 and 129.4 g LOI (loss on ignition).

All diets met or exceeded the minimum requirements for CP, Ca, and P as described for medium-framed yearling steers. The diets were isoenergetic and isonitrogenous (Table 1) (NRC, 1996).

Physiological reactions : Physiological reactions like body temperature and respiration rate (count/ min) were recorded at 9 AM and 3 PM at monthly interval in the experimental period. The rectal body temperature was recorded by clinical thermometer. Respiration rate (count/ min) was recorded from the right flank movement of steers, (Yazdani and Gupta, 1996, Soly and Singh, 2003).

Feeding behaviours : Behavioural indicator measurement was made manually and included the recording of maintenance behavior in experiment. Maintenance behavior (eating and ruminating) was recorded for 24 h (5 – min intervals) by a team of observers at the end of every month. Three observers recorded all groups at any one time (Mladenon and Tomova, 1987., Yazdani, 2007).

Table 1. Composition of diets fed to beef steers.

Ingredients	Control	T1	T2
Natural zeolite	0	2.50	5.00
Alfalfa hay	17.48	17.48	17.48
Barley	20	11	7
Wheat straw	14	17	20.5
Wheat bran	25	25	26.50
Sugar beat pulp	7.5	7.5	1.54
Canola seed meal	13.49	17.03	19
Lime stone	0.5	0.5	0.5
$CaCo_3$	0.99	0.99	0.98
Vit.premix	1	1	1
Composition, %			
CP	17.8	18.22	18.8
ME (Mcal/kg DM)	2.72	2.72	2.72
EE	3	5.70	8.50
NDF	40	41.2	41.1
ADF	22.60	24.10	24.70

Blood characteristics : Jugular blood was obtained by venipuncture from two steers per pen at weighing on day 0, 30, 60, 90,120,150 and 210 of the trail (consist of total protein (g/100ml), packed cell volume (%), hemoglobin (mg/100ml) and glucose (mg/100ml)). Blood was placed on ice immediately after sampling and then kept at 4°C for 48 h until it was centrifuged (at 2200 x g for 15 minutes). The same steers were sampled throughout (Yazdani, 2005).

Physiological reactions and blood characteristics : No differences ($P>0.05$) were observed in physiological behaviour among treatments (Table 2).The general trend was, however, for slightly higher respiration rate amongst animals on high plane of nutrition However, higher values were noted in the group with higher plane of nutrition had no significant influence on respiration rate in morning but was significantly ($P<0.05$) higher in the steers fed higher plane of nutrition in the evening. In present research the hemoglobin (Hb) and glucose of different groups of animals were not significant among themselves, ($P>0.05$) (Table 2). Also the percentages of packed cell volume and total protein (g/100) ml had no significant effect among different treatment ($P>0.05$). (Table 2).

Feeding behaviors : Data on rumination time shows that on overall feeding behaviors of beef steers that the animals in control treatment had less significant effect compare to T1 and T2 ($P<0.05$). Likewise in feeding time no significant differences were observed among all treatment due to feeding time by the beef steers. (Table 2).

Physiological reactions : The overall average for respiration rate is shown in Table 2. Analysis showed that no significant effect among all the groups were seen ($P>0.05$). In feeding at different levels causes changes in metabolic rate, which is expected to cause relevant changes in cardio-respiratory activity. In crossbred cattle, Thomas *et al.* (1978) found that physiological reactions were not

significantly different between the animals receiving two levels of feeding. The general trend was, however, for slightly higher respiration rate amongst animals on high plane of nutrition However, higher values were noted in the group with higher plane of nutrition had no significant influence on respiration rate in morning but was significantly ($P<0.05$) higher in the buffaloes fed higher plane of nutrition in the evening. Bidarkar (1985) reported that there was no significant difference in respiration of heifers between the two-managemental group (individually rearing with 125% NRC feeding and group rearing with 100%NRC feeding) at 8 A.M. recording, but there was significant difference with regards to 3-30 P.M. recording.

The overall averages of body temperature have been presented in Table 2. The analysis of data on body temperature in the morning and afternoon showed that there was no significant ($P>0.05$) difference due to the nutritional practices among all the groups. Like all other warm-blooded animals steers also attempt to maintain a uniform body temperature by continuously balancing their heat loss with heat gain. In an attempt to maintain the body temperature constant the animals try to respire at an increased rate. Pandey and Ray, (1969).

In the present investigation also, the steers under different treatments were able to maintain their body temperature within physiological limits by increasing the respiration rate. Misra *et al.* (1963) found that ambient temperature was highly correlated with the rate of respiration while relative humidity did not influence it significantly. The critical temperature in thermo-regulation of cows was found to be 97°F (25°C).

The animals reacted more vigorously in their rate of respiration and body temperature at air temperature above the mean value of 74.48°F (23.6°C). One has to consider also the normal diurnal variation in rectal temperature and other physiological reactions, due to which the afternoon observations are higher than the morning ones. Alim and Ahmad (1957) observed such a diurnal variation in rectal temperature and respiration rate of Egyptian buffaloes during summer.

Blood characteristics : To Asses the physiological status of the experimental animals as well as to see whether their nutritional status is reflected in their blood profile, a study of the levels of certain constituents of blood was carried out. In present study the Hb and Glucose of different groups of animals were not significant among themselves, ($P>0.05$) (Table 2). In our findings only T2 animals had significant difference compared to the other groups ($P<0.05$) (Table 2). Hence, the low level of PCV in blood indicates the anemic condition of the animal. Indirectly the PCV is the index of health status of the individual. The PCV content observed in the present study was similar to the results values of earlier workers (Soly and Singh, 2003).

The level of glucose in the blood is an important factor in determining the glucose concentration in the interstitial fluid, which in has an influence on the rate of transport of this sugar into individual cells .It is one of the most important energy yielding constituents. Small increase may be

Table 2. Overall feeding behaviour, blood characteristics and physiological responses of beef steers.

	Clinoptilolite			
Item	Control	T1 (2.5 %)	T2 (5.0 %)	LSD
Rumination time (min)	427.00[a]	439.00[b]	445.31[b]	1.219
Eating time (min)	137.95 [a]	138.60[a]	139.25[a]	2.161
Total protein (g/100ml)	6.31[a]	6.18[a]	6.19[a]	0.139
Packed cell volume (%)	38.17[a]	38.11[a]	38.16[a]	0.116
Hemoglobin (mg/100ml)	9.10[a]	9.18[a]	9.66[a]	0.118
Glucose (mg/100ml)	41.16[a]	41.19[a]	41.12[a]	0.167
Body temperature (C^o)	38.16[a]	38.19[a]	38.10[a]	0.294
Respiration rate (count/min)	12.56[a]	12.70[a]	12.60[a]	0.081

Means bearing different superscript differ significantly ($P< 0.05$).

found in hyperactivity of pituitary and adrenal glands. Moderate rise of glucose level is associated with the infectious diseases. Bidarkar (1985) observed that the blood glucose level decreased with increase in age of the calves. They also observed that levels of protein in that diet had significant effect on blood glucose, which was similar with the result of present investigation.

Abdolhafez *et al.* (1983) reported that the rate of glucose utilization in ruminant was positively related with digestible energy intake. One of the reasons for variation in glucose in the ruminant species was nutritional status of animal. Soni *et al.* 1982 also reported reduction in plasma glucose level due to high ambient temperature and light intensity with low relative humidity, providing comfort through showering, wallowing or even rains led to an increase in glucose level.

The chief physio-chemical functions of the plasma protein were the maintenance of normal blood volume and normal water content in the tissue fluids. They provided nutrition for the body and contribute to the solubility and transport of lipids, fat-soluble vitamins, bile salts, hormones and various drugs in the blood. The gamma globulin fraction provided antibodies for the defence against infection. It also reflects nutritional status of animals specially the nitrogen balance.

In present study only control group animals had significant effect compared to T1 and T2 ($P<0.05$) (Table 2) Payne *et al.* (1974). Katharia and Avasathi (1985) reported that a normal value of total proteins to be 7.5 to10gm/100ml. Levels of plasma protein increase with the aging in all species (Shaffer *et al* (1981). In buffalo, Bidarkar (1985) observed that the higher plane of nutrition did not have significant effect on total plasma protein.

Feeding behaviours : When livestock are introduced in a new environment, they show distinct changes in their behaviour relating to grazing, rumination and rest. In our findings overall feeding behaviors of finishing steers on rumination time in control groups had significant effect compare to T1 and T2 ($P<0.05$). Likewise in overall no significant differences were observed among all treatment due to rumination time by the finishing steers (Table 2).

Unadapted temperature livestock show short grazing and abnormally long resting period, mainly due to high ambient temperature and intense solar radiation in the tropics. This is a behavioral adjustment in livestock to the climatic condition of the tropics. Fahimuddin, (1975) Knowledge on behavior is of great importance for improving the management and production. In our studied the finishing steers spent more time on eating during day time than the night time. This is in accordance with the reports of Todekar and Tomar (1986).

CONCLUSION

Based on our results, Clinoptilolite Zeolite has the potential to increase rumination time of steers. But CLN has no beneficial effect on physiological reactions and blood characteristics.

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