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Dietary Clinoptilolite Addition as a Factor for the Improvement of Milk Yield in Dairy Cows

[1]D.A. Ural, [2]O. Cengiz, [3]K. Ural and [4]Serpil Ozaydin
[1]Bozdogan Vocational School, Adnan Menderes University, Bozdogan, Aydin, Turkey
[2]Department of Animal Nutrition and Nutritional Diseases,
[3]Department of Internal Medicine, Faculty of Veterinary, Adnan Menderes University,
09016 Isikli, Aydin, Turkey
[4]Gordes Zeolite Mining Corporation, Izmir, Turkey

Abstract: Production of cow milk is under the influence of genetically and environmental factors. Milk yield may also be affected by diet quality. Natural zeolite has been elucidated as a feed supplement in livestock production. The present study was performed in an attempt to examine the effect of addition of clinoptilolite to the diet for lactating dairy cows on milk production. A total of 52 head lactating Holstein cows were randomly enrolled according to milk production for assignment to one of two dietary treatments; control diet (n = 26), control diet+clinoptilolite (n = 26). The control diet (group C) consisted corn silage, hay, sunflower meal, soybean meal and wheat bran. Experimental group II (group P) was fed rations involving control diet supplemented with 2% clinoptilolite. The experimental period lasted 120 days. The clinoptilolite supplementation significantly and apparently affect milk yield ($p<0.01$). The results obtained from the present study suggested that clinoptilolite supplementation may have positive influence on milk yield.

Key words: Clinoptilolite, zeolite, dairy cows, Holstein cows, diet

INTRODUCTION

Total number of dairy cattle herds in the last years shows decline, albeit the milk yield is below the average in developed countries. This fact needs to be evaluated, thus the agricultural/dairy science researchers are directed to milk yield elevations. Cow milk constitutes 91.67% of total milk production in Turkey. Milk yield of dairy cows are vast majority affected by diet quality. Thus, natural clinoptilolite, a clay mineral belonging to the zeolite group (Mumpton and Fishman, 1977) has been used successfully as a feed additive in cattle breeding (Dschaak *et al*., 2010; Ilic *et al*., 2011). There is scarcity information relevant to the effect of dietary inclusion of clinoptilolite on milk production in cows. The objective of the present research was to examine in what degree clinoptilolite supplementation affects an important production trait, milk yield.

MATERIALS AND METHODS

In the present trial 52 head lactating Holstein cows were enrolled according to milk production to one of two dietary treatments: Control (group C) and control+clinoptilolite (group P). The ingredients and chemical composition of control diet (group C) is presented in Table 1. The feeding was twice a day at 09:00 and 16:00 h in barn. The clinoptilolite group was fed the same diet, besides supplemented with 2% clinoptilolite (Nat-min 9000, Gordes Zeolit Madencilik, Turkey). According to the company that provided clinoptilolite chemical formulation was as follows; $(Na_{0.5}\ K_{2.5})\ (Ca_{1.0}\ Mg_{0.5})\ (Al_6,\ Si_{30})\ O_{72}.\ 24\ H_2O$, involving 93% clinoptilolite.

Table 1: Ingredient and chemical composition of the control diet

Ingredients	DM (%)
Corn silage (35% DM)	47.79
Hay	17.80
Sunflower meal (25% CP)	4.45
Soybean meal (44% CP)	6.75
Wheat bran	22.76
Dicalcium Phosphate (DCP)	0.10
Calcium Carbonate ($CaCO_3$)	0.25
Salt	0.05
Vitamin and mineral premix	0.05
Chemical composition and nutritional facts	
Dry matter intake/day	19.77
Crude protein (DM %)	14.50
NE_l (Net energy lactation) (Mcal/kg DM)	1.45
Ca (DM %)	0.45
NDF (DM %)	45.80

Contained in kg of vitamin-mineral premix: Vitamin A 90.000 UI; Vitamin D 6000 UI; Vitamin E 60 mg; Vitamin PP 900 mg; Vitamin B1 7,50 mg; Vitamin B2 7,50 mg; Zinc 240 mg kg^{-1}; Iron 150 mg kg^{-1}; Selenium 1 mg kg^{-1}; Iodium 3 mg kg^{-1}

Corresponding Author: Deniz Alic Ural, Bozdogan Vocational School, Adnan Menderes University, Bozdogan, Aydin, Turkey

The trial was conducted on a commercial dairy farm in Bozdogan county, Aydin Province, Turkey. The experimental period lasted 120 days. Farms were visited weekly from January to May, 2012 by all of the researchers (D.A. Ural, O. Cengiz and K. Ural). The cows were milked twice a day (05:30 and 17:30). Milk yield was recorded at day 0 and twice a day during the experimental period, similar to earlier researches. All animals enrolled were selected to those of cows among II lactation.

Statistical analysis of the results was performed by use of SPSS 17.0 for Windows (SPSS, 2011). The repeated measures approach using Analysis of Variance (ANOVA) with mixed linear models was used for statistical analysis of data. The significance of the differences between groups was compared by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The results concerning milk production were given in Table 2. The lowest mean value of milk yield was observed in group C. A somewhat higher yield was produced among cows receiving clinoptilolite. Group P cow's receiving 2% clinoptilolite through mixed ration, gave an average milk yield of 24.01 kg. The mean values of milk yield of 20.1 were obtained by group C that was fed solely with control diet. There was statistically significant difference ($p<0.01$) among II groups relevant to milk yield.

Zeolites are crystalline, hydrated aluminosilicates of alkali and alkaline earth cations, involving three dimensional frameworks of SiO_4^{-4} and AlO_4^{-5} tetrahedra linked via shared oxygen atoms. Natural and synthetic zeolites are together porous materials, possessing the ability to lose and gain water reversibly, adsorption and ion-exchange property without major change of their self-structure (Tomlinson, 1998). These properties highlight the use of clinoptilolite, one of the major compound of the natural zeolites, in a wide range of agricultural applications and besides in animal nutrition (Mumpton and Fishman, 1977; Sadeghi and Shawrang, 2006; Dschaak *et al*., 2010; Ilic *et al*., 2011). Clinoptilolite is effective as anti-diarrheic drug (Rodriguez-Fluentes *et al*., 1997), antibacterial and antiviral properties (Grce and Pavelic, 2005). On 2001 European Commission Regulation has declared the use of clinoptilolite (either volcanic or sedimentary origin) as additive in feedstuffs for farm animals.

Table 2: Means and standard errors of milk production

Groups	N	$\bar{X}\pm S_{\bar{X}}$	Min.	Max.	Statistical significance
C	26	20.1±0.49[a]	10	39	**
P	26	24.0±0.40[b]	12	42	-

Group C: Control diet group; Group P: Control diet+clinoptilolite; **: $p<0.01$; NS = Non-Significant; [a,b]Means with different superscripts in each column are different

Clinoptilolite has been the subject of earlier studies in livestock. The results from other studies may help in the interpretation of the current data. According to Dyachenko and Lysenko (1988), additive type A/B zeolite to a traditional Russian diet presented and increased milk production. Moreover, supplemental sodium zeolite into corn silage with rates of 0.5% (Roussel *et al*., 1992), 2% (Garcia-Lopez *et al*., 1988, 1992) and 4% (Kirilov *et al*., 1994) resulted in increased milk yield. The results were in agreement with previous studies, suggesting that clinoptilolite supplementation significantly and apparently affect milk yield ($p<0.01$). The results obtained from current research suggested that clinoptilolite supplementation may have positive influence on milk yield.

In a prior research performed with a limited number of lactating Brown Swiss cattle (n = 16) in Turkey, 6% zeolite was added to the concentrate diet in test group. At the end of the trial, there was no significant difference between groups (milk yields for control and test groups; 15.66 and 16.37 kg day^{-1}, respectively) ($p>0.05$) (Azman *et al*., 1999). Albeit in the latter study as shown, although not significant, the milk yield was mathematically increased in zeolite test group (Azman *et al*., 1999).

However, the present results were in contrast with some other studies. In a prior study performed in Italy, no apparent effect of clinoptilolite addition on milk production was observed. Similarly Bergero reported the same results within the use of same clinoptilolite. Supplemental 2% zeolite A to diet in a normal environment resulted in decreased feed intake and milk production. On the other hand, regarding high temperature conditions, sodium-zeolite supplementation caused increased feed intake, albeit milk production was not affected.

CONCLUSION

This study has clearly shown that the lowest mean value of milk yield (20.1 kg) was observed in group C. On the other hand, group P cows receiving 2% clinoptilolite supplementation gave a mean value of milk yield of 24.01 kg. Among two groups a statistically significant difference ($p<0.01$) was evident relevant to milk yield. According to the results obtained the clinoptilolite affected milk production. Finally in case of use of clinoptilolite in dairy cattle feeding, positive effect on milk production and probably on quality are expected. The present researchers declare competing interest with the use of clinoptilolite in dairy cattle feeding for possible

efficacy of other relevant production performances and of its anti-diarrheic drug and antibacterial properties. The latter will be the subject of the future studies.

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