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Effect of Zeolite and Initial Weight on Feedlot Performance of Brown Swiss Cattle

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Abstract: The effect of dietary zeolite and initial weight on the performance and dressing percentage was investigated on Brown Swiss cattle. Forty cattle were weighed and sorted. Twenty heavier cattle weighing average of 207 kg were placed into 2 paddocks, 10 cattle in each paddock and 20 lighter cattle weighing average of 160 kg were placed into 2 paddocks, 10 cattle in each paddock. Treatments were; 1-one paddock of cattle in heavy group and one paddock of cattle in lighter group receiving 1% zeolite (ZE), 2-one paddock of cattle in heavy group and one paddock of cattle in lighter group not receiving zeolite (Control). When groups were pooled within treatments, ZE tended to have higher ADG and feed intakes than Control group. Control group tended to have higher dressing percentage than ZE group. Heavier cattle had higher daily dry matter intake and tended to have higher daily gain, lower feed efficiency and higher dressing percentage. Even though interaction between zeolite and initial weight was not significant, in terms of ADG and FE, receiving zeolite had greater effects on lighter cattle. It is concluded that using zeolite in feedlot diets increases performance and effect of different levels of zeolite should be investigated.

Key words: Zeolite, clinoptilolite, initial weight, feedlot, performance

Introduction

Due to unique ability of rumen microbes, ruminant animals may produce protein in their rumen without getting any protein resources in their diet. Ruminal microbes have between 20 and 60% of their dry matter as crude protein and rumen bacteria have average of 50% protein. Microbial protein together with dietary protein which escape ruminal degradation is utilized in small intestine. Nitrogen source for microbes in the rumen are protein feed ingested, non-protein nitrogen and nitrogen recycled to rumen for re-utilization (Owens and Zinn, 1988).

When using protein sources in diet, cost of protein source should be considered. Generally, non-protein nitrogen sources are least, plant sources are intermediate and animal sources of protein are most expensive. Several experiments showed that urea can reduce the cost of beef cattle rations by 1% 454 g of gain or a total of $4 to $6 a steer (Sewell, 1993). However when adding urea to the diet precaution should be exercised. Urea toxicity happens when large amount of urea is added to diet and ingested and it is hydrolyzed to ammonia and CO_2 by enzymatic actions. Ammonia is toxic to animal cells at low levels (Visek, 1978). Thus using some treatments to regulate ammonia concentration in rumen could be useful in terms of ammonia toxicity and microbial growth.

Clinoptilolite (zeolite), an aluminosilicate with cation exchange property, binds ammonia to its structure when ammonia concentration in the rumen is high and releases bound ammonia to the rumen when its concentration in the rumen is low (Pond, 1993). Thus using aluminosilicate enhances microbial growth in the rumen by providing more steady ammonia concentration.

Non-protein nitrogen is useful as a protein source because rumen microbes use ammonia to grow and initial weight has an effect on non-protein nitrogen metabolism because the amount of microbial

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protein produced daily increases with age, size and energy density of the ration (Siemens *et al*., 1999). Older and larger cattle use non-protein nitrogen sources more efficiently as a protein source than younger and smaller cattle. Since young calves do not produce enough microbial protein to meet their requirements, non-protein nitrogen sources will not support maximum growth rate for them. As cattle grow, they become capable of producing more microbial protein while the amount of protein required for growth decreases (Siemens *et al*., 1999).

In order to increase profitability in feedlot one should optimize production efficiency and marketing time. One way of increasing production efficiency is to take initial weight into consideration because initial weight is one of the important factors affecting feedlot cattle performance and profitability (Koknaroglu, 2005). Younger cattle deposit less fat and more muscle tissue. Production of fat is more expensive than muscle tissue and excessive amount of fat cannot marketed profitably through normal channels (Ralston *et al*., 1970).

Thus objective of this study was to determine effect of feeding zeolite and initial weight and their interaction on performance and dressing percentage of Brown Swiss Cattle fed in feedlot.

Materials and Methods

The study was initiated with hauling 40 Brown Swiss cattle to the feedlot facility in Atabey, Isparta in February 2002. In order to alleviate the transportation stress and make calves accustomed to their environment, cattle were given hay in the feedlot. After cattle were accustomed to the feedlot they were weighed. Twenty heaviest cattle were grouped among each other and were allotted into two lots and the same way 20 lighter cattle were grouped among each other and were allotted into two lots and thus each lot consisted of 10 cattle. Average weight was 207 kg for heavier group and was 160 kg for lighter group. Treatments were; 1-one paddock of cattle in heavy group and one paddock of cattle in lighter group receiving 1% zeolite during the study (ZE), 2-one paddock of cattle in heavy group and one paddock of cattle in lighter group not receiving zeolite during the study (control). During the experiment one cattle in each control group was removed due to health concerns. The feedlot facility consisted of open lots with 2 m of apron and 5% slope to the north. Steers were fed in fence-line concrete bunks, providing 90 cm feedbunk space per animal, on the south side of the lot and one automatic waterer was shared between two pens. Cattle were fed ad libitum and feed intake levels were provided such that feed always was available in the feedbunks. The ration were formulated according to NRC recommendation (NRC, 1996) and is provided in Table 1. As for roughage, sugarbeet pulp, sugarbeet molasses, grass hay, vetch were used whereas barley, corn, cottonseed meal, urea, vitamin-mineral premix were used as concentrate.

Table 1: Feed ingredients for treatments

	Heavy cattle		Lighter cattle	
Feed stuff	Control	ZE	Control	ZE
Barley	32.52	32.21	27.65	27.39
Corn	2.44	2.42	0.51	0.51
Cottonseed meal	9.13	9.04	13.75	13.59
Sugarbeet pulp	29.12	28.79	29.26	28.96
Molasses	11.28	11.17	11.81	11.68
Sainfoin	4.07	4.03	4.53	4.49
Grass hay	4.97	4.93	5.40	5.35
Vetch	3.55	3.52	3.96	3.92
Zeolite	0.00	1.00	0.00	1.00
Limestone	1.31	1.29	1.50	1.49
Urea	1.00	1.00	1.00	1.00
Salt	0.51	0.50	0.53	0.52
Vitamin-mineral premix	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00

Cattle were weighed every two weeks individually and average daily gain for that period and throughout the experiment were calculated. Animals were fed for 292 days and average daily gain was calculated as final weight minus initial weight divided by days on feed. After animals were slaughtered hot carcass weight was obtained and thus dressing percentage was calculated. Data was analyzed using the SAS (1999) and least square means were reported.

Results and Discussion

Performance and dressing percentage of cattle by treatment groups when groups are pooled within treatments is provided in Table 2. Cattle receiving zeolite in their diet gained a little faster than those control cattle however this difference was not significant (0.90 vs 0.86 kg/day, $p>0.05$). Daily dry matter intake of control group was lower than that of those received zeolite (7.51 vs 7.59 kg/day, $p>0.05$). Since cattle receiving zeolite gained faster than control group and there was not much difference in daily dry matter intake, feed efficiency for cattle receiving zeolite was a little better than control group (8.58 vs 8.82, $p>0.05$). Similar results to this study were obtained by Eng *et al*. (2003) where they fed black English and English continental cross steers with control diet and control diet plus 1.2% clinoptilolite zeolite added in place of equivalent amount of grain. They found that in some years cattle receiving zeolite had higher daily gain, average daily dry matter intake and better feed conversion. However when average of those years were pooled there were no significant differences among performance characteristics. Colpan *et al*. (1995) found that inclusion of 1.5% zeolite on fattening cattle diet increased daily gain and daily dry matter intake and those cattle had better feed efficiency. The reason for cattle receiving zeolite to have higher daily gain is due to particular property of zeolite. Zeolite adsorbs much of the ammonia generated from the NPN and acts as a reservoir and slow mechanism for the nitrogen. This action happens when animals ruminate. When animals ruminate, the bolus is regurgitated from rumen and is rechewed in the mouth and reswallowed thus salive introduced during mastication contains sodium which replaces the ammonium. This slow release of ammonium due to replacement with sodium allows rumen micro-organisms to synthesize cellular protein that is easily digested by animals's digestive system. Studies showed that nearly 15% of the ammonia in the rumen could be taken up by the zeolite (White and Ohlroggi, 1974). Addition of 2.5% zeolite per 1 kg dry matter to the 300 kg bulls fed urea at the rate of 0.2 g per 1 kg live weight significantly decreased ammonia concentration in rumen by 20-40%, in portal vein by 60-70% and in jugular vein whereas it did not influence urea concentration in plasma (Jacobi *et al*., 1984). Filya *et al*. (2000) found that lambs receiving zeolite had higher total volatile fatty acid concentration in the rumen. In ruminants clinoptilolite alters rumen fermentation, thereby modifying volatile fatty acid production by rumen microbes and changing milk and body fat content (Armbruster, 2001). Cattle receiving zeolite had higher daily dry matter intake than control group. Increased dry matter disappearance could be a plausible reason for this because more dry matter disappearance and thus more dry matter intake (Sanders *et al*., 1997). Since using zeolite increased average daily gain more than daily dry matter intake, feed efficiency of cattle receiving zeolite was better than control group meaning that cattle receiving zeolite ate less than control group for 1 kg of gain.

Dressing percentage was not affected by treatment groups ($p>0.05$) however control group had a little higher dressing percentage (55.72 vs 54.99%). Similar results were observed by other researchers

Table 2: Least square means for variables by zeolite

Treatment	Initial weight (kg)	Final weight (kg)	Carcass (kg)	ADG (kg day^{-1})	DDMI (kg)	FE	Dressing (%)
Control	184[a]	436[a]	243[a]	0.86[a]	7.51[a]	8.82[a]	55.72[a]
Zeolite	184[a]	446[a]	246[a]	0.90[a]	7.59[a]	8.58[a]	54.99[a]

[a]Means with the same superscript in the same column are not significantly different ($p>0.05$)

(Sanders *et al*., 1997; Eng *et al*., 2003). The reason for cattle receiving zeolite to have lower dressing percentage could be weight lost during transit due to urinary and fecal losses. Because of this, cattle having more feed consumption would be expected to defecate more per day and have a larger amount of fecal loss in transit and thus shrink more.

Cattle were grouped into two subgroups depending on their initial weight thinking that differential in initial weight would have affected cattle performance when they are mixed. Performance and dressing percentage of cattle by initial weight are given in Table 3. When heavy group and lighter group were compared, heavier cattle had higher daily dry matter intake ($p<0.01$) and tended to have higher daily gain ($p>0.05$), lower feed efficiency ($p>0.05$) and higher dressing percentage ($p>0.05$). The results in terms of daily dry matter intake agrees with Ralston *et al*. (1970) and Gaili and Osman (1979) who found that heavier cattle had higher daily gain than lighter cattle. Heavier cattle's higher daily dry matter intake could be related to their body mass. NRC (1996) developed a prediction equation to predict the dry matter intake by using initial weight. The prediction equation for dry matter intake was DMI = 4.54 + 0.0125 x Initial body weight and reveals that DMI increases linearly with increase in initial weight. Thornton *et al*. (1985) also found that daily dry matter intake increased 0.68 kg per 45.4 kg increase in initial weight. Lighter group cattle tended to be more efficient and required less feed per kilogram of gain. These results agree with Ralston *et al*. (1970) and Gaili and Osman (1979) whose findings suggest that lighter cattle are more efficient than heavier cattle. Analyzing the data obtained from Iowa cattle producers using the Iowa State University Feedlot Performance and Cost Monitoring program between January 1988 and December 1997 Koknaroglu *et al*. (2005) found that steers started on feed at heavier weights had higher average daily gain, daily dry matter intake and were less efficient than those started at lighter weights.

The fact that lighter or younger animals are more efficient than heavier or older cattle can be explained by their growth potential due to growth hormone level circulating in their blood plasma. Verde and Trenkle (1987) found that the concentration of growth hormone was highest in young cattle and gradually decreased with increasing age. Lighter cattle had lower dressing percentage than heavier cattle and this would be expected since lighter cattle were slaughtered at the same time with heavier cattle and were lighter than heavier cattle. Brown Swiss cattle are large frame cattle and by the time of slaughter, lighter cattle had developed their frame and organs and were depositing protein. Thus lighter cattle had deposited less muscle than heavier cattle and had lower dressing percentage.

Interaction between initial weight and zeolite was found to be non significant (Table 4; $p>0.05$). Even though interaction between zeolite and initial weight was not significant, in terms of ADG and FE, receiving zeolite had better effects on lighter cattle ($p>0.05$). The difference between heavier and lighter cattle in terms of ADG was lower in ZE group than control group meaning that

Table 3: Least square means for variables by initial weight

Treatment	Initial weight (kg)	Final weight (kg)	Carcass (kg)	ADG (kg day^{-1})	DDMI (kg)	FE	Dressing (%)
Heavier	207^b	473^b	265^b	0.91^a	7.94^b	8.91^a	55.88^a
Lighter	160^c	410^c	225^c	0.85^a	7.16^c	8.48^a	54.80^a

^{a}Means with the same superscript in the same column are not significantly different ($p>0.05$), ^{bc}Means with the different superscript in the same column are significantly different ($p<0.01$)

Table 4: Least square means for variables by initial weight and zeolite

	ADG (kg day^{-1})		DDM (kg)		FE		Dressing (%)	
Treatment	Control	ZE	Control	ZE	Control	ZE	Control	ZE
Heavier	0.91^a	0.92^a	7.90*	7.98*	8.95^b	8.88^b	56.14^c	55.64^c
Lighter	0.82^a	0.88^a	7.12*	7.20*	8.69^b	8.29^b	55.30^c	54.36^c

^{abc}Means with the same superscript in the same column and same row are not significantly different ($p>0.05$), *Non-estimable zeolite improved ADG of lighter cattle better. Siemens *et al*. (1999) mentioned that older and larger cattle use non-protein nitrogen sources more efficiently as a protein source than younger and smaller cattle and since young calves do not produce enough microbial protein to meet their requirements, non-protein nitrogen sources will not support maximum growth rate for these cattle. Considering effect of age and size on non-protein nitrogen utilization and particular property of zeolite adsorbing ammonia generated from the NPN and releasing it later thus providing a steady ammonia concentration in the rumen (White and Ohlroggi, 1974) could be a plausible reason for lighter cattle receiving zeolite to have better ADG and FE.

Conclusions

This study indicated that cattle receiving zeolite in feedlot tended to gain faster, have more daily dry matter intake and have better feed efficiency. Since cattle receiving zeolite tended to be more efficient this could decrease feeding costs per kilogram of weight gained. Even though we did not investigate but adding zeolite to diet containing urea could also decrease ammonia toxicity. Initial weight had effect on cattle performance and since initial weight affects performance and efficiency it would have effects on profitability as well. In terms of performance, zeolite had more prominent effect on lighter cattle than heavier cattle and zeolite's adsorbing ammonia property could have had an effect on that. Thus considering initial weight and zeolite along with zeolite's property of holding ammonia nitrogen, initial weight and zeolites could be used effectively to manipulate production efficiency in the feedlot.

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