Effects of Sepiolite Usage in the Manufacturing of Pellet Concentrate Feeds for Dairy Cattle and Fattening Cattle on Some Production Parameters and Pellet Quality Characteristics

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Abstract: The aim of this experiment was to determine the effects of sepiolite usage in the manufacturing of pellet concentrate feeds for dairy cattle and fattening cattle on some production parameters and pellet quality characteristics. For this purpose commercial concentrate feeds for dairy cattle and fattening cattle were used in this experiment. One control and one treatment group feeds were manufactured in a commercial feed factory for each type of concentrate feeds. Sepiolite (Exal T, Tolsa Turkey) was added to the treatment concentrate feeds at 1% as topdressed to the mixer. Pellet concentrate feeds for each group were produced with 5 batch (each batch was 2 mt) and pellet diameter was 6 mm. Steam temperature (°C), electric current (ampere) and pellet production time (min/10mt) during pelleting processes were measured. Energy consumption (kilowatts) of pelleting machine was calculated. Feed samples were analyzed in moisture content and pellet durability index (PDI, %). Energy consumption was decreased and steam temperature was increased with the usage of sepiolite. There were no significant differences between groups in moisture level. Sepiolite improved pellet durability index. As a result sepiolite may help to improve performance of the feed mill in terms of decreasing process costs and improve pellet durability index.

Key words: Dairy cattle feed, energy consumption, fattening cattle feed, pellet durability index

Süt İneği ve Besi Sığırı Pelet Yemi Üretiminde Sepiyolit Kullanımının Bazı Üretim Parametreleri ve Pelet Kalitesi Üzerine Etkisi

Özet: Bu denemede süt ineği ve besi sığırı pelet konsantre yem üretiminde sepiyolit kullanımının bazı üretim parametreleri ve pelet kalite özellikleri üzerine etkisinin belirlenmesi amaçlanmıştır. Bu amaçla denemede ticari süt ineği ve besi sığırı konsantre yemleri kullanılmıştır. Ticari bir yem fabrikasında her bir konsantre yem çeşidi için bir kontrol ve bir deneme grup yemi üretilmiştir. Sepiyolit deneme konsantre yemleri üretiminde miksere %1 düzeyinde topdressed olarak ilave edilmiştir. Her bir grup pelet konsantre yemi 5 parti (her bir parti 2 ton yem içermekte) halinde yapılmıştır. Üretilen pelet yem çapı 6 mm'dir. Peletleme süresince buhar sıcaklığı (°C), elektrik akımı (amper) ve pelet üretim süresi (dakika/metrik ton) ölçülmüştür. Peletleme aletinin enerji tüketimi (kilowatt) hesaplandı. Yem numuneleri nem miktarı ve pelet dayanıklılık indeksi (PDI, %) bakımından analiz edilmiştir. Sepiyolit kullanımı ile buhar sıcaklığı artarken enerji tüketimi azalmıştır. Gruplar arasında nem düzeyleri bakımından farklılık gözlenmemiştir. Sepiyolit kullanımı pelet dayanıklılık indeksini artırmıştır. Sonuç olarak sepiyolit kullanımı pelet maliyetinin azaltılması açısından fabrika performansının artırılmasında ve pelet dayanıklılık indeksinin geliştirilmesinde önem taşımaktadır.

Anahtar kelimeler: Besi sığırı yemi, enerji tüketimi, pelet dayanıklılık indeksi, süt ineği yemi

Introduction

Pelleting of animal feed is important to improve efficiency in animal feeding and for convenience in feed handling [19]. Good quality pellets have better growth performance and feed efficiency than those fed with mash, reground pellet feeds and pellet feeds having more fine particles [7,14,15,16,25]. The characteristics of decreased feed wastage, reduced selective feeding, decreased ingredient segregation and increased pellet durability had shown to improve animal performance [6].

There are several factors which have effect on the pellet quality. Among these, composition of the feed is one of the most significant. Gelatinization

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of starch and crude protein in the diet have shown for their positive effect on the pellet durability and hardness [24]. Contrarily, addition of high level of fat to the diet reduces the pellet durability [2]. A certain increase in the amount of steam exerted on the mash during the conditioning process has also improved pellet durability and hardness [21].

Use of pellet binders in order to improve pellet quality has also been considered. Sepiolite, a hydrated magnesium silicate, has been shown to improve pellet quality [2]. Sepiolite, a natural feed additive, has high porosity and surface area, strong absorptive power, high structural stability and chemical inertia [23]. Sepiolite is a feed additive (E-562) used as a binder and anti-caking agent upto 2% in all feeds for all animal species [10]. Nowadays to obtain the best possible quality of pelleted feeds with minimal use of labor and energy for a given feed formulation is important. Sepiolite addition at 1% to the broiler diets [9] and micronized clinoptilolite addition at 0.4, 0.6 and 0.8% [17] reduced pellet production time and enhanced the pellet durability index. There are limited studies with supplementation of sepiolite and other clay minerals in diets about energy consumption during pelleting processes and pellet quality. Therefore the objective of this experiment was to evaluate the effects of sepiolite usage in the manufacturing of pellet concentrate feeds for dairy cattle and fattening cattle on some production parameters and pellet quality characteristics.

Materials and Methods

Commercial concentrate feeds for dairy cattle and fattening cattle were used in this experiment. Manufacturing pellet feeds were produced in a commercial feed factory. Commercial dairy cattle feed contained 130 kg corn bran, 90 kg wheat bran, 25 kg soyabean meal, 60 kg sunflower seed meal, 85 kg cottonseed meal, 100 kg peanut meal, 150 kg DDGS, 50 kg barley, 250 kg corn, 12.5 kg dried molasses condansed solubles and 20 kg molasses per metric tons (mt). Commercial fattening cattle feed contained 125 kg corn bran, 225 kg wheat bran, 71 kg sunflower seed meal, 26.5 kg cottonseed meal, 75 kg peanut meal, 30 kg barley, 30 kg wheat, 30 kg corn and 17.5 kg molasses per metric ton. One control and one treatment group feeds were manufactured for each type of concentrate feeds. Sepiolite (Exal T, Tolsa Turkey) was added to the treatment concentrate feeds at 1% as top dressed to the mixer. Sepiolite Exal T used in this experiment was produced in Türkiye-Polatlı (Tolsa Turkey company). Exal contains 74% sepiolite, 18% dolomite and 8% calcite. Moisture content was 8.20% and ash was 89.80%. Pellet concentrate feeds for each group were produced with 5 batch (each batch was 2 mt) and pellet diameter was 6 mm. Water was not used in the pellet manufacturing processes. The parameters for manufacturing processes are shown in Table 1.

In the factory the data of steam

Temperature (˚C), electric current (ampere) and pellet production time (min/10mt) were measured. Energy consumption of pelleting machine (electric power in kilowatts, kW) was calculated as multiplying electric current (in ampere) with voltage supply (volts) and then dividing by 1000. Voltage supply of feed pellet machine was 380 volts.

Five samples from the mixer, after the conditioner and pelleted feed after cooling were collected for each group each type of feed. Moisture content was analysed in all of the samples collected [4]. Crude protein, crude fibre, ether extract, ash, starch, sugar analysis of control peletted feeds were determined [4]. The levels of acid detergent fibre (ADF) and neutral detergent fibre (NDF) were analyzed by the method of Goering and Van Soest [13].

Pellet durability index (PDI) was measured with a Pfost Equipment using the sieve having the hole diameter of 4.75 mm. Quadruplicate measurements were done with each sample [5].

Table 1. Parameters for pellet manufacturing processes

	Dairy cattle concentrate feed		Beef cattle concentrate feed	
Parameter	**Control**	**Sepiolite**	**Control**	**Sepiolite**
Production rate, mt/h	10	10	10	10
Production, mt	10	10	10	10
Mixer capacity, mt	2	2	2	2
Water added in mixer	No	No	No	No
Disc hole diameter, mm	6	6	6	6
Disc hole length, mm	60	60	60	60

Statistical Analysis: Data were given as mean±standard error of mean. Comparison between groups was examined with Independent samples t test. Level of significance was taken as P<0.05 [8].

Results

The nutrient composition of concentrate feeds were shown in Table 2. Production parameters during pelleting of dairy cattle feed and fattening cattle feed were given in Table 3 and Table 4, respectively. Addition of 1% sepiolite as top dressed to the mixer increased steam temperature and reduced energy consumption significantly (P<0.01) for both of the feed type. Pellet production time is same in control and treatment groups for dairy cattle feed. In the case of fattening cattle feed, 1% sepiolite addition reduces the pellet production time by 8.47%. No differences were observed in moisture content of feed samples from mixer, after conditioner and pellet after cooling between groups (Table 5). Sepiolite addition to the both types of concentrate of feeds increased pellet durability index values (Table 6).

Table 2. Nutrient composition of concentrate feeds

	Dairy cattle concentrate feed	Fattening cattle concentrate feed
Dry matter, %	86.92	87.00
Crude protein, %	16.68	13.12
Crude fibre, %	8.24	6.19
Ether extract,%	6.22	3.45
ADF, %	13.72	9.91
NDF, %	33.09	23.97
Starch, %	18.58	28.41
Sugar, %	5.44	5.96
Ash, %	7.74	7.36

Table 3. Production parameters of pelleting of dairy cattle feed

Group	Steam temperature, °C	Electric current, Ampere	Energy consumption*, kW	Production time, min/10 mt
Control	42.61±0.22	180.94±1.61	68.76±0.61	57.5
Sepiolite	44.55±0.06	163.51±0.59	62.13±0.22	57.5
P	<0.001	<0.001	<0.001	

*: Energy consumption was calculated using 380 of voltage in pelleting machine.

Table 4. Production parameters of pelleting of fattening cattle feed

Group	Steam temperature, °C	Electric current, Ampere	Energy consumption*, kW	Production time, min/10 mt
Control	40.01±0.39	186.77±0.60	70.97±0.23	59
Sepiolite	47.45±0.19	175.98±0.46	66.87±0.18	54
P	<0.001	0.002	0.002	

*: Energy consumption was calculated using 380 of voltage in pelleting machine.

Table 5. Moisture (%) content of feeds during pellet manufacturing

	Dairy cattle feed			Fattening cattle feed		
Group	**Mixer**	**After conditioner**	**Pellet after cooling**	**Mixer**	**After conditioner**	**Pellet after cooling**
Control	10.23±0.04	12.78±0.01	11.41±0.05	11.80±0.01	14.96±0.04	13.10±0.04
Sepiolite	10.23±0.01	12.92±0.01	11.49±0.04	11.62±0.09	14.42±0.05	12.99±0.04
P	0.170	0.994	0.232	0.152	0.792	0.770

Table 6. Effects of sepiolite addition on PDI (%) value of feeds

	Dairy cattle concentrate feed	Fattening cattle concentrate feed
Control	76.04±1.23	88.06±0.31
Sepiolite	84.74±0.55	94.46±0.15
P	0.003	0.048

Discussion

In the factory feeding rate, amount of production, disc hole diameter and disc hole length were same for the manufacturing of pellet concentrate feeds, Production output, energy consumption and pellet quality are important process variables that related to each other. Many factors affect pellet durability and specific energy consumption.

In the present study steam temperature is 4.55% higher in dairy cattle feed and 18.60% higher in fattening cattle feed than those of control feed (P<0.001). Applying to much heat will impair pellet production, pellet quality and may lead to plugging of the pellet press [22]. However in the present study, steam temperature is not as high as would be detrimental to pellet quality and quantity of production. Angulo et al. [2] reported that sepiolite would increase the pelleting temperature, since increasing hardness of the pellets could cause more friction in the die. Abdollahi et al. [1] concluded that pellet durability and hardness of broiler starter feed increased (P<0.001) with increasing conditioning temperatures. Addition of 1% sepiolite as top dressed to the mixer. Energy consumption during pelleting is 9.63% lower in dairy cattle feed and 5.27% lower in fattening cattle feed than those of control feed (P<0.01). Sepiolite addition reduces the pellet production time by 8.47% in the case of fattening cattle feed production. However pellet production time was same in dairy cattle feed. This may be due to the ingredients and chemical composition of diets. Moisture content of samples from mixer, after conditioner and pellet after cooling between groups were not significantly different between groups. In the factory no moisture lost during pelleting process for both of the group feeds.

Pellet durability is an important factor affecting production parameters of pelleted feed. Adding 1% sepiolite improved pellet durability on the average by 11.44% in dairy cattle feed and 7.27% in beef cattle feed as opposed to the control feed (P<0.05). Sepiolite is a binder used in feed technology to improve physical pellet quality. It acts as a filler and thereby decreases porosity in pelleted feed. A reduction in dust is beneficial in terms of feed losses and performance perspective for the farmer and the animals. Angulo ve ark. [2] reported that sepiolite reduces the amount of broken pellets and the percentage of fines and improve the efficiency of the pelleting process. In another study [3] sepiolite improved durability, independently of particle size of feed (P<0.001). Sepiolite improved the durability of pellets of starter chicken diets (P<0.05) but not in the finisher diets [3]. Similarly Durna et al. [9] observed that the inclusion of 1% sepiolite in the broiler stater diet reduced feed pelleting time and increased the pellet durability index. Palygorskite, similar to sepiolite, in another study [26] palygorskite (a clay with similar physical properties to sepiolite) inclusion at 0.5, 1.0, 1.5, 2.0% in the broiler starter and grower diets significantly increased pellet quality (linear and quadratic, P<0.001). Pappas et al. [20] reported that pellets with 1% palygorskite showed better pellet quality than those manufactured pellets without palygorskite. Another clay mineral, bentonite works as a lubricant in the die hole and therefore it decreases pressure and subsequently energy requirements of the pellet press [11,21]. Micronized clinoptilolite as a clay-like mineral addition at the level of 0.4, 0.6 and 0.8% to the dairy concentrate feeds reduced pellet production time and increased pellet durability index [17]. This improvement in pellet quality could be attributed to the sorptive and rheological properties of clay minerals [12, 18, 26]. Sepiolite and palygorskite may absorb polar liquid and form gel and thus may improve pellet quallity due to the increase of solid-solid bonding interaction [26].

As a result 1% sepiolite addition to dairy cattle feed and fattening cattle feed decreased energy consumption during pelleting and enhanced pellet durability index. Therefore sepiolite may help to improve performance of the feed mill in terms of decreasing process costs and improve physical quality. Further studies could be made about different levels of sepiolite with different diet formulation.

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