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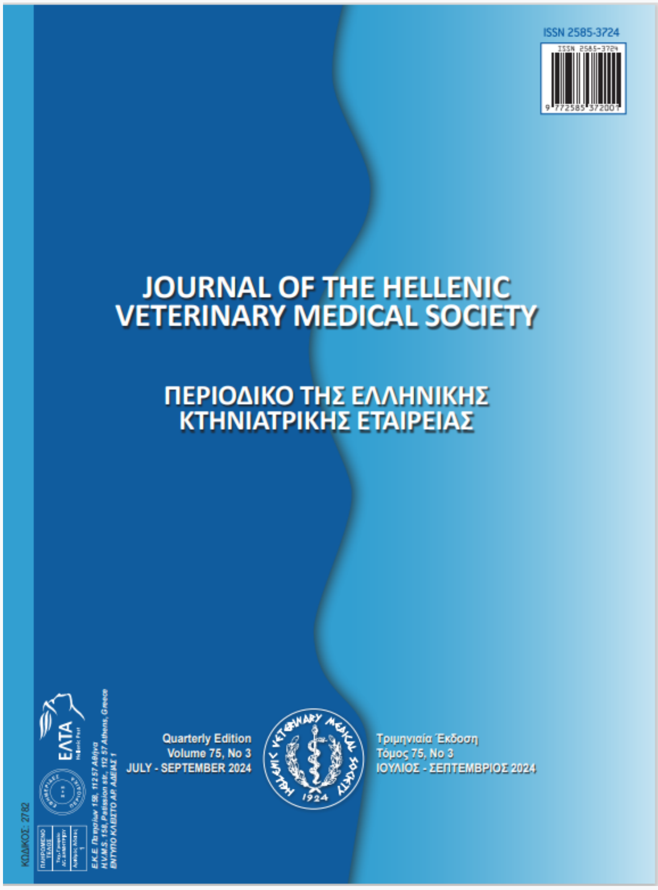

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Research article
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Addition of the By-Pass Fat into Diet of Awasi Sheep on Milk Composition

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ABSTRACT: By-pass fat is an important source of essential fatty acids for ruminants. It affects yield rather than maintenance requirements. This study was carried out to investigate the effect of adding by-pass fat into diet of dairy sheep on milk components. The study was carried out in a private dairy sheep farm in Konya. For this purpose, 99 Awassi sheep were used, starting one month after 1 month of the birth during the fresh lactation period. The sheep were randomly divided into 2 groups. The control (C) group (n=54) was fed a total mixed ration (TMR) twice a day, while the by-pass fat (BF) group (n=45) was fed with TMR twice a day, and each sheep was individually given 30 g/day of commercial calcium (Ca)-soap palm oil by-pass fat during milking. The trial lasted for 15 days with 11 days of adaptation and 4 days of sample collection. The animals in the experimental group consumed 30 g/day of Ca-soap palm oil by-pass fat individually during morning milking. The animals were milked once with an automatic milking system and the lambs were suckled once by creep. Milk yields of the animals were automatically recorded during the sample collection period. Additionally, 50 ml milk samples were taken from each animal at the milking times on the 2nd and 3rd days, and milk fat, non-fat dry matter, protein, lactose, density, freezing point, and somatic cell counts were determined. Fat, non-fat dry matter, density, protein, lactose and somatic cell counts were respectively; 4.50±0.14 and 5.65±0.17%, 10.86±0.07 and 11.16±0.12%, 34.66±0.45 and 34.33±0.64%, 5.42±0.06 and 5.70±0.10%, 4.49±0.01 and 4.47±0.01%, 121.556±16987 and 171.222±28348 in the C and BF groups, Among milk components, while fat, non-fat dry matter and protein were higher in BF group than C group ($p<0.05$), density, lactose and somatic cell were similar between groups ($p>0.05$). It can be concluded that even though the addition of 30 g of Ca soap palm oil by-pass fat significantly improved milk fat, non-fat dry matter and protein in dairy sheep fed with TMR at the level of maintenance and yield.

***Keywords*:** By-pass fat; sheep; milk; milk fat

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INTRODUCTION

Animal husbandry is generally done to obtain economic income in all countries. This situation is primarily affected by the geographical situation of the countries. It directly affects the way of breeding, such as intensive-extensive livestock, or the type of meat-milk production (Akçapınar and Özbeyaz, 2021). Sheep are bred to produce meat, milk and fleece around the world (Daş et al., 2022). Although meat production stands out in general, sheep milk production is also carried out to a considerable extent in Turkey. Sheep milk production varies from country to country. Especially in Asian and European countries, sheep and goat milk have an important position in the rural economy (Pandya and Ghodke, 2007). While the worldwide sheep milk production is approximately 10.4 million tons, it is 1.3 million tons in Turkey. Turkey is one of the largest sheep milk producers in the world (FAO, 2017).

Sheep milk is utilized in different ways depending on consumption habits in countries. Because of its high fat content, sheep milk is generally not consumed as milk or consumed very little. For this reason, sheep milk is usually consumed as yogurt or cheese. Sheep milk products reach high values in retail sales due to their unique organoleptic structure (Bencini, 2002; Pandya and Ghodke, 2007; Milani and Wendorf, 2011).

Compared to other mammalian milks, sheep milk contains significant differences. So, human milk, cow milk, goat milk and sheep milk fat, protein and non-fat dry matter content are reported as respectively; 3.75, 3.70, 4.25 and 7.90; 1.63, 3.50, 3.52 and 5.23; 8.82, 9.10, 8.75 and 11.39 (Webb and Johnson, 1965). Considering the nutritional content of sheep milk, it is seen that it is one step ahead of other milks.

Awassi sheep are bred for meat, milk, and wool yield, with milk being the most prominent feature. Daily milk yield of Awassi sheeps ranges from 0.84 kg to 1002.82 ml/day, while lactation milk yield typically are between 60 and 506 kg. The lactation period for Awassi sheep varies from 100 to 214 days, as reported in previous studies (Pollott and Gootwine, 2004; Galal et al., 2008; Haile et al., 2017; Daş et al., 2022). There are wide variations in the daily milk yield, lactation milk yield and lactation period in Awassi sheep due to factors such as breed purity, care and feding management, environmental conditions, and operating conditions. At the same time, there are many different variations according to the countries (Galal et al., 2008).

Milk fat, protein, lactose and non-fat dry matter in Awassi sheep are reported as follows (range): 5.24% - 8.3%, 4.5%-5.7%, 4.47%-4.81%, and 9.99%-17.8%, respectively (Galal et al., 2008; Haile et al., 2017; Daş et al., 2022). Milk composition also varies considerably from country to country.

Dietary fats are used to balance the energy deficit in ruminant animals producing high-yield milk. By-pass fats do not digest in the rumen because they are preserved, but digest in the abomasum and small intestines of ruminants. The use of by-pass fat in high-yielding dairy animals has not shown any negative effects on rumen fermentation, feed consumption, and blood parameters (Kumar, 2017). The addition of fats treated with protected salts to the ration improves fiber digestion, preventing the absorption of fatty acids in the rumen. In this way, unsaturated fatty acids pass through the rumen and are digested in the intestines, resulting in changes in milk composition (Baldin et al., 2017; Behan et al., 2019). One of the preferred ones is palm-based bypass oils. Palm oil is used as an essential oil source in countries, such as Malaysia, Indonesia, Papua New Guinea, and Niger. It contains high levels of palmitic acid (C16:0), oleic acid (C18:1), linoleic acid (C18:2), and linolenic acid (C18:3), which are essential fatty acids. It is an important source of by-pass oil containing palmitic acid at 44%, oleic acid at 39.2%, linoleic acid at 10.1% and linolenic acid at 0.4% (May, 1994; Azeman et al., 2015). Palm-derived by-pass oils are among the current research topic to improve milk composition in dairy cows, goats, and sheep.

Widyawati et al. (2019) investigated the effect of linseed, treated with formaldehyde and cinnamaldehyde in their study on dairy goats, and stated that there was no effect on dry matter consumption, milk production and quality. It was determined that the addition of calcium (Ca) salts of palm and safflower oil to 2.7% dry matter (DM) in Sanen goats caused an increase in milk yield without affecting digestibility and feed consumption (Vargas-Bello-Pérez et al., 2020). It was observed that the addition of 75 g/day linseed oil Ca salt did not cause any change in milk yield and composition in Sanen crossbred goats (Cenkvari et al., 2005).

In a study examining the effects of various fat sources on milk yield and components in dairy cows (Bozan, 2008), animals were given low-fat containing feeds, feeds containing their own fat, feeds containing soybean oil and palm by-pass oil. Milk yield and components were not affected as a result of the study. However, when it is necessary to add oil to the feed, it is stated that by-pass oil should be preferred instead of unsaturated fat. Dairy cows in early lactation were given 250 g and 500 g of by-pass fat daily (Durmaz, 2019). As a result of the study, cows consuming 250 g had higher milk yield (39.68 L), milk fat is higher in the groups consuming by-pass (3.52-3.60), milk protein is lower in those consuming 250 g/day, and lactose was found to be higher in those consuming 250 g. Tyagi et al. (2009) stated that adding 2.5% by-pass fat on a DM basis to the ration of dairy cows increased milk yield, composition and the amount of milk fat unsaturated fatty acids. It has been determined that the use of prill fat in dairy cows causes an increase in milk without affecting milk components and plasma metabolites (Singh et al., 2014).

In a study investigating the effects of different by-pass fat sources on body weight and dry matter consumption in Dorper sheep (Behan et al., 2019), it was determined that the addition of different types of preserved fat to the ration did not affect animal performance. Another study investigated the effects of palm and soybean fatty acid Ca soap on milk fat in Lacaune and East Friesian sheep (Baldin et al., 2017). It was stated that milk fat was better in the palm oil consuming group. There was no difference in milk yield, milk fat, and milk protein ratios in Sarda sheep fed with a linseed oil-added ration. However, it has been stated that it can be used to increase unsaturated fatty acids in milk (Contreras-Solis et al., 2023). Mierlita et al. (2010) examined the effects of sunflower oil on milk yield and composition in sheep, and 6% by-pass fat was given of concentrated-based to the animals. In the results of the study, by-pass fat addition caused a significant increase in milk yield and milk fat, although it reduced feed consumption.

In the studies, positive effects of by-pass fat were observed in dairy animals. However, its effects are still not clear. Therefore, the objective of this study was to investigate the effect of Ca-soap palm oil on milk components of Awassi sheep.

MATERIAL AND METHOD

This study was carried out in a private dairy sheep farm in Konya Ereğli Region. The trial took a total of 15 days with 11 days of adaptation and 4 days of sample collection.

Animals

The animal material for this study consisted of 99 Awassi sheep from a private farm in the Konya Ereğli Region (37°82'63.9829'', 34°24'25.0553''). Sheep were randomly divided into two groups, among those who had multiparous ewes (2-5 births) with equal milk yields at the beginning of the study. A total of 54 animals were assigned to the control group (C) and 45 animals were in the by-pass fat group (BF). The study started 1 month after the ewes gave birth, during the fresh lactation period. The ewes were milked in the morning (10:00 am), and lambs were suckled from 14:00 pm to 02:00 am, using a creep system.

Feed Material

After the animals were divided into the groups, the control group was fed with total mixed ration (TMR) consisting of a mixture of roughage and concentrated feed (52/48%). All the animals consumed a total of 2.91 kg of TMR as two meals in the morning and

Table 1: Botanical, concentrate feed and chemical compositions of TMR, %.

Botanical composition of TMR, %.			
Feeds	**Alfalfa Hay**	**Lentil Straw**	**Concentrated**
Pergentages (%)	49	3	48

Composition of concentrate feed										
Feeds	**Barley**	**Corn**	**Cotton Seed Meal**	**Sunflower Seed Meal**	**Soybean Meal**	**Salt**	**DCP**	**Yeast**	**Vit-Min**	**Ca Carbonate**
Pergentages (%)	25	33.9	17	6	10.6	0.8	1.2	1.5	1.5	2.5

Chemical composition of TMR					
	Dry Matter	**Ash**	**Crude Protein**	**Crude Oil**	**Crude Cellulose**
TMR DM(%)*	85.00	7.70	13.66	1.59	19.92
Concentrated	91.71	4.69	16.29	3.05	4.52
Alfalfa Hay	88.51	8.96	13.15	2.28	21.40
Lentil Straw	93.41	8.39	9.86	2.83	29.68

*: 13% water added to TMR.

evening. The content of TMR and concentrate feed are in the Table 1. In by-pass fat group, in addition to the same TMR, each animal consumed 30 g/day of Ca-soap palm oil individually during the morning milking.

Sample Collection

After completing the adaptation period, the animals were milked in the morning (10:00 am) by the automatic milking system, and the milk yield was recorded automatically. On the 2nd and 3rd days of sampling period, 50 ml milk samples were taken from the animals during the morning milking and analyzed for milk composition and somatic cell counts on the same day in the laboratory.

Chemical Analysis

The milk samples were quickly trasported to the laboratory and allowed to cool down to approximately 20 °C. After reaching the room temperature, milk fat, non-fat dry matter (NFDM), protein, and lactose content analyzes were performed using the MILKANA® Multi Test Air (Serial N00001148) device. Somatic cell counts were conducted in the samples collected at the same time using the MILKANA Somatic Scan (Serial 20190858) device.

All feeds consumed by the animals were analyzed in terms of dry matter (DM), crude protein (CP), ash, crude oil (CO), and crude cellulose. Dry matter, CP, CO and ash analyzes were conducted according to AOAC (1990), while crude cellulose analyzes were performed according to Van Soest et al. (1991). The composition and nutrient content of the feeds are provided in Table 1. The content of the by-pass oil is presented in Table 2.

Table 2: Chemical composition of by-pass oil

Content	Oil	Moisture
Rate (%)	99	1

Statistical Analysis

All data were analyzed by Analysis of variance (ANOVA) oneway analysis using the MINITAB (19) package program. Tukey test was applied to determine differences between groups. Significance level was set at $p<0.05$.

RESULTS

The mean and standard errors (SE) of animals for milk fat (%), non-fat dry matter (%), density (%), milk protein (%), freezing point (°C), lactose (%) and somatic cell numbers (x10^3 cell/ml) are presented in Table 3. Milk yield was 599 ± 41 ml in the BF group at the morning milking and 539 ± 46 ml was at the C group. Milk fat was significanlty higher in the by-pass fat group ($p<0.05$). The non fat dry matter was 11.16 ± 0.12 in the by-pass fat group and 10.86 ± 0.07 in the control group. By-pass fat group was significantly higher ($p<0.05$). Density was similar in the both groups ($p>0.05$). By-pass group had higher milk protein content ($p<0.05$). Freezing point and lactose content were found to be insignificant between the groups ($p>0.05$). Somatic cell count was similar in both groups ($p>0.05$).

DISCUSSION AND CONCLUSION

Milk fat content was higher in the BF group than the control group. This difference is thought to be related to the fatty acid ratio of the bypass oil. This observed value was lower than those reported by Mierlita et al. (2010) and Daş et al. (2022), and it was lower than the normal Ca-Palm value but higher than the value reported by Baldin et al. (2017) with CLA-MFD Ca-Palm supplementation. It was found to be similar to the value reported by Contreras-Solis et al. (2023). This vatiation is thought to be due to animals' consumption of the roughage at an add-libitum level and suppression of milk fat.

In the study, there was a significant difference between the groups in terms of NFDM of milk. NFDM

Table 3: Mean and standard errors of milk components.

	Fat (%)	Non fat dry matter (%)	Density (%)	Protein (%)	Freezing point (°C)	Lactose (%)	Somatic cell counts (x103 cell/ml)
By-Pass Fat (BF group)	5.65±0.17^{a}	11,16±0,12^{a}	34,33±0,64	5,70±0,10^{a}	60,57±0,62	4,47±0,01	171.22±28.35
Control (C group)	4.50±0.14^{b}	10,86±0,07^{b}	34,66±0,45	5,42±0,06^{b}	59,66±0,41	4,49±0,01	121.56±16.99
p-value	0.00	0,027	0,68	0,024	0,227	0,308	0,137

was higher in the by-pass fat group, which can be attributed to the higher milk fat content. The density of milk was similar in both groups. In the literatüre, no report about NFDM and milk density in sheepwere observed.

Milk protein was significantly higher in the BF group than the control group. Milk protein ratio was higher than those repoted by Baldin et al. (2017), Daş et al. (2022) and Contreras-Solis et al. (2023), and lower than that of Mierlita et al. (2010). The difference in milk protein may have resulted from the differences in animal genetics, lactation periods, nutrition, and climate (Önür, 2015). In addition, the percentages of undegradable protein in the rumen in the diet also affect milk protein (Widyawati et al., 2019).

Milk freezing point and lactose levels were similar between groups in the current study. The lactose value was similar to that reported by Baldin et al. (2017) and Mierlita et al. (2010). It was higher than the value reported by Contreras-Solis et al. (2023), and lower than that reported by Daş et al. (2022).

The somatic cell count is an important indicator of the animal's general health and milk quality (Albenzio et al., 2019). The somatic cell count of the milk was not significant between the groupsin this study. The number of somatic cells was 171 x10^3 cell/ml in the BF group and 121 x10^3 cell/ml l in the C group. Although it varies according to countries, the legal limit for somatic cell count is x10^6 cell/ml in the USA and the criteria are not specified in European Union countries (Albenzio et al., 2019). The somatic cell data obtained in the study are well below the specified values. The number of somatic cells observed in the current study was lower than the value reported by Daş et al. (2022).

Based on the data observed in the current study, it can be concluded that the addition of 30 g/day of Ca-soap by-pass fat into TMR of dairy sheep, significantly increased milk fat, non-fat dry matter and protein. The use of Ca-soap by-pass fat in sheep may have positive effects on the production of cheese and yoghurt. However, there is a need for studies on the use of by-pass fat at different rates in dairy sheep.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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