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Akdeniz İklim Koşullarında Mevsimin İnek, Koyun ve Keçi Süt Kompozisyonu Üzerine Etkisi

Serap GÖNCÜ[1], Gökhan GÖKÇE[2], Muhammed İkbal YEŞİL[3]*

[1,2,3]Department of Animal Science, Çukurova University, Adana, Türkiye

[1]https://orcid.org/0000-0002-0360-2723
[2]https://orcid.org/0000-0001-6980-8989
[3]https://orcid.org/0000-0001-7143-973X
*Correspondence: muhammedikbalyesil@gmail.com

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ÖZ

Bu çalışmada, Akdeniz Bölgesi iklim koşullarında inek, koyun ve keçi sütü kompozisyonunun farklı mevsimlerde değişiminin incelenmesi amaçlanmıştır. 100 sağmal kapasiteli süt sığırcılığı işletmesinde, benzer yaş ve laktasyon dönemindeki 10 Holştayn inekten yaz ve kış aylarında sabah sağımlarından süt örnekleri alınmıştır. Çiftlik %40 yonca otu ve %60 konsantre yem içeren yem karışımı kullanmaktadır. Keçi sütü örnekleri ise Halep keçilerinden alınmıştır. Nisan - Kasım arası dönemde meraya giden keçilere 0,5 kg kuru ot ve 1 kg konsantre yem, vitamin ve mineral karışımı ve yalama için tuz blokları verilmektedir. Meranın olmadığı serin, aylarda keçilere 2-3 kg mısır silajı, 1 kg pancar silajı, 1 kg kuru ot, maksimum 1 kg konsantre yem, vitamin mineral karışımı ve tuz blokları verilmiştir. Keçiler günde iki kez sağım makinası ile sağılmaktadır. Süt numunesi alınan koyunlar kuzulama döneminde meraya gönderilmemiş, ahırda tutulmuşlardır. Süt kompozisyonunun belirlenmesi için koyun, keçi ve ineklerin sabah sağımlarından 3 hafta boyunca haftada iki kez 100 ml süt örnekleri alınmış ve asitlik, yoğunluk, yağ içeriği, yağsız kuru madde gibi değişkenler belirlenmiştir. İnek sütü içeriğinin analizinde 12 süt bileşeni karşılaştırılmış ve bunlardan 7'si anlamlı, 5'i ise istatistiksel olarak anlamsız bulunmuştur. İlkbahar ve yaz örneklerinin keçi ve koyun sütü içerikleri istatistiksel olarak önemli ölçüde farklılık göstermiştir. İnsan sütü ihtiyacını karşılayan koyun, keçi ve inek sütü üretiminin sıcak ve serin ay içerikleri karşılaştırıldığında, inek sütü içeriğinde koyun ve keçi sütüne göre değişen varyasyon olduğu görülmüştür. Süt içerikleri serin aylara göre farklılık gösterdiğinden, sıcak aylarda serinletme ve dengeli rasyon kullanımı gibi düzenlemelere ihtiyaç olduğu anlaşılmaktadır.

Effect of Season on Cow, Sheep and Goat Milk Composition in Mediterranean Climate Conditions

Research Article

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ABSTRACT

In this study, it was aimed to examine the change of cow, sheep and goat milk composition in different seasons in Mediterranean Region climatic conditions. Cow milk samples were taken from the morning milking in summer and winter months from 10 Holstein cows of similar age and lactation period in a dairy farm with a capacity of 100 milking cows. The farm is fed with a feed mixture containing 40% alfalfa hay and 60%

Goat
Milk
Composition
Season

concentrated feed. Goat milk samples were taken from Aleppo goats. Between mid-May and mid-November, the goats go to pasture and are given 0.5 kg of dry grass and 1 kg of concentrated fodder, a vitamin and mineral mixture and salt blocks for licking. In the cooler months, when there is no pasture, the goats are provided with 2-3 kg of corn silage, 1 kg of beet silage, 1 kg of dry grass, a maximum of 1 kg of concentrated feed, vitamin mineral mixture and salt blocks. The goats were milked twice a day with a milking machine. The sheep from which milk samples were taken were kept in the barn, not sent to pasture during the lambing period. For the determination of milk composition, 100 mL milk samples were taken from the morning milking of sheep, goats and cows twice a week for 3 weeks. Variables such as acidity, density, fat content, non-fat dry matter determine the type characteristics of raw milk. In the analysis of cow's milk content, 12 milk contents were compared and 7 of them were significant and 5 of them were statistically insignificant. Goat and sheep milk the contents of the spring and summer samples differed significantly from each other statistically. Comparing the hot and cool month contents of sheep, goat and cow milk production that meets human milk needs, it has been observed that there is more variation in cow milk content than sheep and goat milk. moreover, milk samples were taken from enterprises producing in intensive conditions. It is understood that there is a need for regulations such as cooling and the use of balanced rations in hot months, as milk contents show differences compared to cool months.

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Introduction

According to the animal production statistics for 2021, the Turkish Statistical Institute (TUIK, 2022) declared the number of cattle as 18 million 36 thousand and the number of ovine animals as 57 million 519 thousand in 2021. In this period, the number of cattle was recorded as 17 million 850 thousand heads and the number of buffaloes as 185 thousand 574 heads (TUIK, 2022). The number of sheep was reported as 45 million 178 thousand and the number of goats as 12 million 342 thousand. In 2021, 23 million 200 thousand 306 tons were produced. Cow milk production is reported as 21,370,116 (tons), goat milk production is 622,785 tons and sheep milk production is 1,143,762 tons (TUIK, 2022). However, it can be understood from Table 1 that the yields per animal are generally low regardless of the species. If the current rate of increase continues, the world population will reach 9 billion 800 million people in 2050, and global food production should increase by at least 70% until 2050 in order for this population to be fed adequately and balanced with healthy and high quality products. The most important agenda in the world is now the efficient sharing of food resources. Cow milk constitutes 92.1%, sheep milk 4.9%, goat milk 2.7% and buffalo milk 0.3% of raw milk production consumed in Turkey (TUIK, 2022). Milk production and milking animal presence of Turkey is shown in Table 1.

Table 1. Animal production statistics in Turkey in 2019 (Anonymous, 2022)

	Cattle	**Sheep**	**Goat**	**Buffalo**
Number of Milking animals	6,580,753	19,836,985	5,471,086	79,333
Total Milk production (Liter)	20,782,374	1,521,455	577,209	70,341
Liter/Head	3,158.05	76.70	105.52	886.65

The total amount of milk produced is far from meeting the country's needs. The main reason for this is the low yield per animal (Göncü 2021). It has been reported that milk is affected by factors such as race, physiology, nutrition and environment (Göncü, 2021). Cow, sheep, goat and buffalo milk are among the foods most commonly used by people. Protein, fat, carbohydrates, vitamins and minerals, which are biochemical substances that play an important role in human nutrition, are present in milk at significant levels (Kliem et al. 2013).

Different species milk compositions are species-specific and their contents vary depending on many factors. Also, there are also differences in the content of milk produced in different geographies (Albenzio et al., 2006; Pirisi et al., 2007; Raynal-Ljutovac et al., 2008; Önür, 2015; Göncü, 2021).

Cow's milk has been studied more than other milks due to the size of its contribution to production. However, it is not possible to meet their needs only with cow's milk production. In addition, considering the taste, content and regional conditions, it should not be ignored when it is advantageous to raise sheep and goats instead of cattle breeding. In addition, the increase in demand for dairy products produced from goat and sheep milk and the increasing added value have revealed the need for this field. Goat breeding is common in many countries. The goat's ability to adapt to particularly difficult conditions provides an advantage. In addition, it is known that the products obtained from goats meet the needs of people in many areas (Kalantzopoulos et al. 2004). Although sheep farming is an agricultural production area that can be carried out with low manpower and low cost, it is generally carried out for the evaluation of weak soils in arid climates (Raynal-Ljutovac et al. 2008). Milk production is the primary source of income for medium and small agricultural enterprises in many Mediterranean countries. In addition, in some Asian and African countries, especially in regions with arid climate and weak pastures, sheep breeding is at the forefront and has the same importance in terms of milk production. Goat breeding is mostly concentrated in forested areas, mountainous areas where plant production is limited (Albenzio et al. 2006; Pirisi et al. 2007; López-Gatius, 2013). Goats can make good use of food residues and roughage, especially in garden and field agriculture. Although sheep, goats and cattle are in the ruminant group, they are animals that have the capacity to evaluate different conditions

without competing with each other. Their eating habits are different, while the goat feeds on leaves, bushes, branches and fruits, while sheep likes to graze grass and clover. For this reason, goats are grown in mountainous areas and sheep in plain areas (Albenzio et al. 2006; Pirisi et al. 2007; Raynal-Ljutovac et al. 2008; Delgado-Pertineza et al. 2013). Because cattle like to feed on tall grass, they prefer to graze in pastures with high grass. Low maintenance costs, not requiring much care, less capital required for establishment of enterprises and supply of necessary animal materials compared to other animal species make goat breeding more attractive. In recent years, the demand for goat milk and its products has mobilized the sector. Cow's milk has been studied more than goat and sheep milk due to its production capacity. However, recently, it is not possible to meet the animal product demands of the increasing population from cattle. Meeting the country's needs as required will be possible with production planning and effective use of resources. Sustainable animal production throughout the year is possible with the measures to be taken against the seasonal effect. Since the effect of seasonal fluctuations on the low annual average yields per animal has been known for a long time, it is the simplest, easiest and most widely used way to produce in periods when feed resources are intense and cheap. However, the mode of production compressed to a certain period causes problems in the simultaneous use of infrastructure and labor and resources, as well as large fluctuations in animal product prices and thus causing losses for the breeder. Sustainable production systems provide food safety and nutrition assurance (Göncü and Gökçe, 2021a). It also preserves and enriches natural resources and promotes economic and social welfare. As a result, dairy invests in sustainability and efficient food production. However, the breeder abstains from this issue as he wants investment in the measures to be taken for the warmer months. However, if the ambient temperature increases, especially if the high temperature is accompanied by high humidity, the dairy cattle will limit the heat dissipation and the cattle will be stressed when their body temperature starts to increase (Özkütük and Göncü, 1996). In animals exposed to heat stress, not only milk yield but also reproductive efficiency decreases and additive negative effects are experienced (Özkütük and Göncü, 1996; Dash et al. 2016). This situation causes great economic losses especially in intensive enterprises that produce in a highly competitive environment. From this point of view, in this study, it was aimed to examine the change of cow, sheep and goat milk composition in two different seasons in Mediterranean Region climatic conditions.

Material and Methods

Milk samples were collected from sheep, goat and dairy cattle farms producing in Mediterranean climate conditions in Adana, Antalya, Burdur, Hatay, Isparta, Kahramanmaraş, Mersin and Osmaniye provinces (Figure 1). In the Mediterranean region, summers are hot and dry, while winters are rainy and warm. In the hottest months, the temperature averages between 28-30 degrees, while in the coldest months it averages between 8-10 degrees.

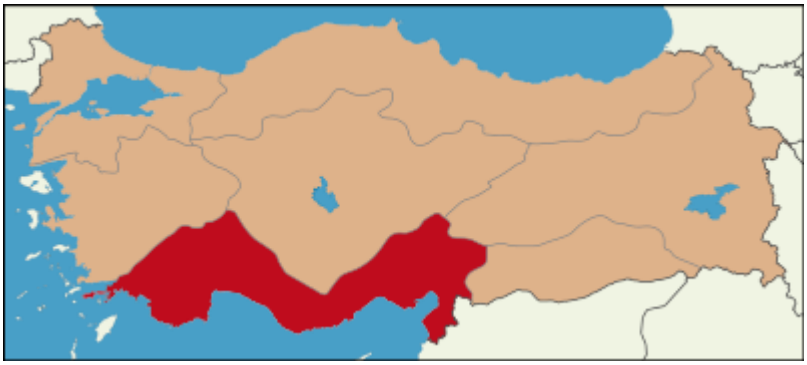

Figure 1. Mediterranean region

In this study, the long-term average climate data of the months in which the samples were taken are given in Table 2. The average annual temperature is 18 degrees. The amount of precipitation between the driest and wettest months of the year: 124 mm The average temperature varies around 19.4 °C throughout the year. Climate conditions belonging to the provinces is given in Table 2.

Table 2. Mediterranean region data from 1991 to 2021

	Apr	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**
Av. Temp. (°C)	14.1	18.2	22.2	25.2	25.6	22.7	18.4	12.7
Min Temp. (°C)	8.9	13	17	20.4	21.3	17.8	13.6	8.7
Max Temp. (°C)	18.5	22.3	26.2	29.1	29.4	27	23.1	17.4
Precipitation /Precipitation (mm)	32	24	8	6	8	14	32	69
Moisture (%)	70%	72%	72%	73%	71%	65%	60%	61%
Rainy days (d)	4	3	1	1	1	2	3	4
sunny hours (h)	10.5	11.4	11.8	11.3	10.6	10.4	9.6	8.3

Hot summers are one of the most important stressors in animal husbandry. The Mediterranean Region, which is the 4th largest region of Turkey in terms of both population and area, has 8 in total and the Mediterranean climate type is seen in all of these 8 provinces. Adana, Antalya, Burdur, Hatay, Isparta, Kahramanmaraş, Mersin and Osmaniye are the

provinces within the borders of the Mediterranean region. Milk samples were collected between May and November 2016.

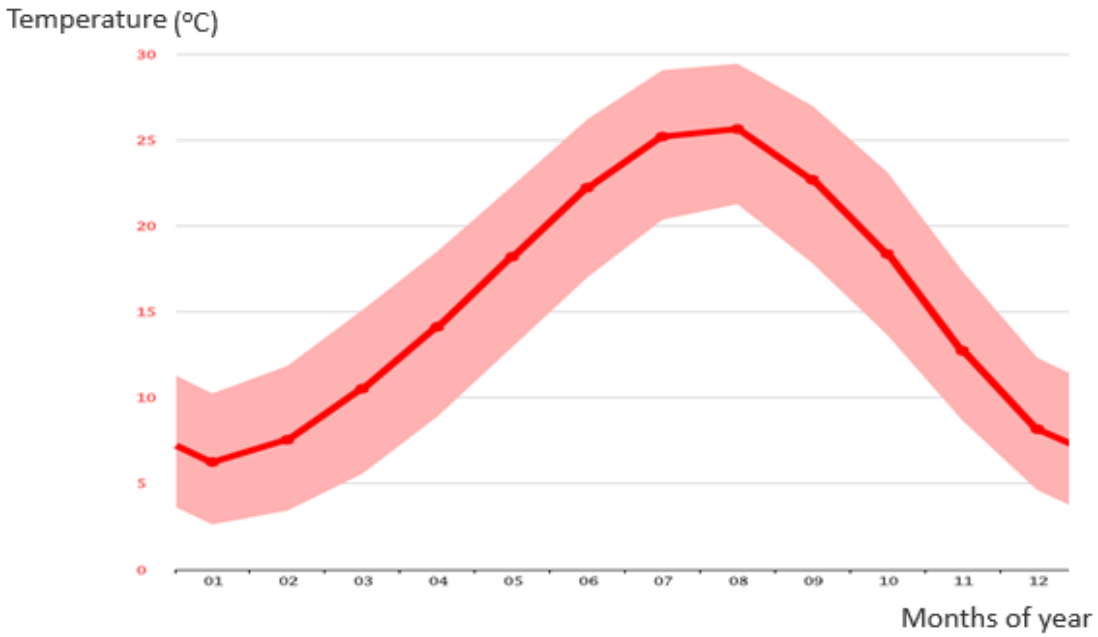

Figure 2. Mediterranean region temperature data by month from 1991 to 2021

Cow milk samples were taken from the morning milking in summer and winter months from 10 Holstein cows of similar age and lactation period in a dairy farm with a capacity of 100 milking cows. The farm is fed with a feed mixture containing 40% alfalfa hay and 60% concentrated feed. However, the same raw materials used do not have the same nutrient content. Goat milk samples were taken from the farm working with Aleppo goats and having an average milk yield of 2-3 kg per day. Between mid-May and mid-November, when the samples were taken, the goats go to the pasture and 0.5 kg of dry grass and 1 kg of concentrated fodder, vitamin and mineral mixture and salt blocks for licking are given. In the cool months when there is no pasture, the goats are provided with 2-3 kg of corn silage, 1 kg of beet silage, 1 kg of dry grass, a maximum of 1 kg of concentrated feed, a mixture of vitamins and minerals and salt blocks for licking. The goats were milked twice a day with a milking machine. The sheep from which milk samples were taken were kept in the barn, not sent to pasture during the lambing period. During the pasture period, when they return to the pasture in the evening, they are fed with concentrated feed (18% CP, 2600 kcal/kg ME) and wheat straw. During this period, mineral mixture and salt blocks are provided for licking. Goats are milked twice a day with a milking machine. For the determination of milk composition, 100 ml milk samples were taken from the morning milking of sheep, goats and

cows twice a week for 3 weeks. Samples Milk samples were determined using milk fat, protein, lactose, total solids (TS), citrate, (LactoScop MK2, Delta Instruments, The Netherlands). Milk samples were stored frozen (−27 °C) until analysis.

Milk samples analysis results were grouped using Microsoft excel program and descriptive statistics were made with SPSS package program. Independent sample t-test was used to compare the season groups of sheep, goats and cattle. SPSS package program was used for calculations (IBM SPSS 20.0 for Windows).

Results and Discussion

Cow's milk, which is 88% water on average, contains more than 100 different components. Variables such as acidity, density, fat content, non-fat dry matter determine the species characteristics of raw milk. In Table 3, 4 and 5 the compositions of dairy milk taken from cow, goats and sheep in summer and spring months in the Mediterranean region conditions are given.

Table 3. Compositions of milk samples taken from cows in the Mediterranean region conditions in Spring Summer months.

Features	**Cow**		
	Spring	**Summer**	**P<**
Dry Matter, (%)	12.32±0.07	11.89±0.05	0.486
Non-Fat Dry Matter, (%)	8.91±0.02	8.58±0.02	0.000
Fat, (%)	3.14±0.01	3.22±0.03	0.363
Protein, (%)	3.15±0.01	3.72±0.03	0.000
Lactose, (%)	4.12±0.02	4.84±0.01	0.219
Casein, (%)	2.12±0.00	2.70±0.0	0.000
Density, (g/L)	1031.723±0.08	1030.25±0.1	0.000
Acidity, (0SH)	6.74±0.07	6.84±0.08	0.126
Citric Acid, (%)	0.15±0.01	0.16±0.00	0.529
Freezing point, (°C)	0.56±0.00	0.62±0.00	0.039
Free Fatty Acids (mmol/10L)	3.33±0.07	5.52±0.02	0.000

In the analysis of cow's milk content, 12 milk contents were compared and 7 of them were significant and 5 of them were statistically insignificant. From the Table 3.' it can be understood that the differences between the values of non-fat dry matter, protein, casein, density, freezing point and free fatty acids in summer and winter months in cow milk samples were statistically significant ($P<0.05$). Differences between DM, fat, lactose, acidity and citric acid were found to be statistically insignificant.

Bertocchi et al. (2014) reported that as the temperature increases, the fat and protein concentration and milk yield also decrease. Casati et al. (1998) reported a decrease in milk fat

and protein content above 14°C and an average daily THI of 55. Bertocchi et al. (2014) reported that a negative relationship was detected between THI and fat and protein concentration. Casati et al. (1998) observed that cow milk fat and protein content decreased in the spring and increased in the autumn. Aharoni et al. (2002) report that there is a higher concentration of fat and protein in cool months than in summer months.

When Table 4, which summarizes the analysis results of goat milk samples, is examined, it was determined that the contents of the spring and summer samples differed significantly from each other statistically.

Ozkaya et al. (2017) reported the percentage levels of dry matter, fat, protein, non-fat dry matter, lactose and casein in goat milk as 11.14%, 3.60%, 3.04%, 8.06%, 4.25% and 2.58%. Cornalea et al. (2014) reported that they found goat milk fat 3.58%, protein 2.99%, non-fat dry matter 8.05%, lactose 4.41% and casein 2.45%. Delgado-Pertineza et al. (2013) reported goat milk fat 4.90%, protein 3.75%, non-fat dry matter 8.53%, lactose 4.09%. Sedighi Vesagh et al. (2015) reported goat milk as fat 3.42%, protein 2.72%, non-fat dry matter 7.88%, lactose 4.44%, dry matter 11.30%. Kesenkas et al. (2010) found goat milk fat 3.42%, protein 3.41%, lactose 4.31% and dry matter 11.74%. Güler (2007) reports goat milk dry matter at 12.32%, fat 4.37% and protein 4.15% levels.

Table 4. Compositions of milk samples taken from goats in spring and summer in Mediterranean region conditions

Features	Goat		
	Spring	**Summer**	P<
Dry Matter, (%)	13,69±0.02	13,07±0.01	0.00
Non-Fat Dry Matter, (%)	9,36±0.01	8,82±0.01	0.00
Fat, (%)	4,38±0.001	4,23±0.001	0.00
Protein, (%)	3.58±0.001	3.48±0.000	0.00
Lactose, (%)	4.45±0.000	4.17±0.000	0.00
Casein, (%)	3,13±0.000	2,95±0.000	0.00
Density, (g/L)	1031,75±0.020	1029,75±0.020	0.00
Acidity, (0SH)	7,74±0.02	7,48±0.02	0.00
Citric Acid, (%)	0,24±0.01	0,09±0.12	0.00
Freezing point, (°C)	0,56±0.00	0,53±0.00	0.00
Free Fatty Acids(mmol/10L)	1,23±0.01	1,25±0.01	0.00

When the table 5 showing the comparison results of the cold and warm months of sheep milk content is examined, it is understood that all components differ significantly except for the acidity value.

Table 5. Compositions of milk samples taken from sheep in spring and summer in Mediterranean region conditions

Features	Sheep		
	Spring	Summer	P<
Dry Matter, (%)	17,18±0.01	16,88±0.02	0.00
Non-Fat Dry Matter, (%)	11,12±0.01	10,60±0.01	0.00
Fat, (%)	6,28±0.001	6,40±0.001	0.00
Protein, (%)	4,97±0.001	4,84±0.001	0.00
Lactose, (%)	4.48±0.000	4.18±0.000	0.00
Kazein, (%)	4.30±0.000	4.14±0.001	0.00
Density, (g/L)	1035,03±0.02	1032,24±0.03	0.00
Acidity, (0SH)	11,91±0.02	11,84±0.02	0,98
Citric Acid, (%)	0,26±0.01	0,12±0.00	0.00
Freezing point, (°C)	0,66±0.00	0,65±0.00	0.00
Free Fatty Acids(mmol/10L)	1,34±0.01	1,41±0.01	0.00

Akgün and Koyuncu (2020) report the fat, protein, mineral substances and thus the dry matter composition of sheep milk as 7.9% fat, 12% non-fat dry matter, 4.9% lactose, 6.2% protein, 4.2% casein and 0.9 ash. In addition, the fat, non-fat dry matter, protein and lactose ratios in milk were found to be 7.7%, 11.2%, 5.8% and 4.5%, respectively. On the other hand, the density and pH values in milk are reported as 33.4 g/cm3 and 6.9, respectively. It is stated that the milk fat content of sheep is around 6.99% on average (Barłowskave et al. 2011; Kiper, 2016). Abd Allah et al. (2011) reported the ratio of fat in Rahmani and Chios sheep was 5.62% and 4.73%; Sezenler et al. (2016) reported 5.26% fat in Bandırma sheep, Çelik and Özdemir (2003) and Yılmaz et al. (2011) report fat ratio in Morkaraman sheep as 5.30% and 6.31%, respectively.

Milk composition is shaped under the influence of genetic structure and environmental conditions. However, the heritability of milk is 30%. This shows that the remaining 702% is due to the environment, care, feeding and managerial practices (Göncü and Gökçe, 2021b). Season affects milk content and hinders production. The quest for more efficient and sustainable processes is the cornerstone of any production system, but it is also an integral part of the economy. It is possible for the farms trying to produce under the pressure of heat stress in the Mediterranean climate to continue production with the measures to be taken (Göncü, 2021).

Milk dry matter, fat, protein content varies depending on the feeding. Roughages affect milk fat because of the cellulose they contain. During fermentation in the rumen, cellulose materials cause a fermentation in favor of acetic acid. In this way, they provide acetate, which plays an important role in the synthesis of short and medium chain fatty acids, especially in

milk. The level of forage to be used in the ration is related to its quality. The particle size of the roughage affects the chewing and rumination time in ruminants. Reducing the roughage/concentrated feed rate in the ration generally causes a decrease in milk fat. In rations with low roughage levels, an increase in milk yield, milk protein and milk lactose levels and a decrease in milk fat are observed (Görgülü, 2014). In the current study, the decrease in milk yield and the decrease in N-FDM, protein and casein content in summer can be explained by the decrease in feed consumption in hot conditions. Microbial protein synthesis efficiency in the rumen is related to the animal's energy intake (NRC, 2001). Therefore, the decrease in milk protein content in hot summer months can be considered normal. In some studies, it is reported that milk fat is affected more than other components in summer (Guo et al., 2001; Ng-Kwai-Hang et al. 1984). However, this change will not be much in intensive enterprises using standard ration regardless of the season. Görgülü (2014) reports that ruminants prefer more concentrated feed during the hot summer months, and thus the rumen pH is more acidic and thus causes a decrease in milk fat due to the decrease in acetate production. The high content of free fatty acids in the composition of milk in hot months can be attributed to the fact that lipoprotein lipase and microbial growth naturally found in milk are faster in summer months (Deeth and Fitz-Gerald, 2006). In addition, it can cause increased fat mobilization from the body in case of negative energy and an increase in the amount of free fatty acids in milk (Görgülü, 2014). Studies have reported that the values between spring and autumn show statistical significance. It has been shown that protein, lean dry matter and ash contents are higher in the autumn period, and the oil content is higher in the spring period (Çubuk, 1997). Season affects milk content (Göncü and Özkütük 1998; Metin, 2001; Altun et al. 2002).

Conclusion

In this study, it was aimed to examine the change of cow, sheep and goat milk composition in two different seasons in Mediterranean Region climatic conditions. In the analysis of cow's milk content, 12 milk contents were compared and 7 of them were significant and 5 of them were statistically insignificant. Goat and sheep milk the contents of the spring and summer samples differed significantly from each other statistically. Comparing the hot and cool month contents of sheep, goat and cow milk production that meets human milk needs, it has been observed that there is more variation in cow milk content than sheep and goat milk. moreover, milk samples were taken from enterprises producing in intensive

conditions. It is understood that there is a need for regulations such as cooling and the use of balanced rations in hot months, as milk contents show differences compared to cool months.

Statement of Conflict of Interest

Authors have no conflict of interest

Author's Contributions

The contribution of the authors is equal.

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