

Research Article

# Determination of Some Physicochemical Properties of Milk Procured from Dairy Farms and Different Milk Collectors in Susurluk Region

Ramazan Ulku Cetin<sup>1\*</sup>, Zeynep Kilci<sup>2</sup>

<sup>1</sup>Bandirma Onyedi Eylul University, Bandirma, Turkey, ORCID: 0000-0002-9968-4988, [rcetin@bandirma.edu.tr](mailto:rcetin@bandirma.edu.tr)

<sup>2</sup> Bandirma Onyedi Eylul University, Bandirma, Turkey, ORCID:0000-0003-1700-8597, [znale@bandirma.edu.tr](mailto:znale@bandirma.edu.tr)

\* Correspondence [rcetin@bandirma.edu.tr](mailto:rcetin@bandirma.edu.tr)

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## Abstract

*In this study, the physicochemical properties of 65 different milk samples produced and brought to the Vocational School laboratories for some basic analysis in Susurluk Region of Balikesir Province; in winter, spring, summer and autumn seasons were compared. In this context, 40 of the all milk samples were supplied from different milk collectors in the Susurluk region and the remaining 25 were supplied from milk production farms around Susurluk. Some analyzes were made to determine which are the pH and total acidity (%lactic acid), dry matter (%), fat (%), protein (%) and density (g ml<sup>-1</sup>) values of the milk samples obtained. The analysis results are in line with the results of studies conducted in similar scope and the values specified in the Turkish Food Codex*

**Keywords:** Raw milk, physicochemical properties, Balikesir (Susurluk)

## 1. Introduction

Cow, goat, sheep, horse, donkey and camel milk is an important food in the diet since human beings have passed from a hunter/gatherer lifestyle to a settled and agricultural lifestyle [1]. Milk is an important nutrient that is secreted in the mammary glands of mammals, one of the most complex living groups, and contains a wide variety of nutritional components. Milk's composition and nutritional concentrations are such that they fully and optimally meet the caloric and metabolic needs of offspring of related species, particularly during early postnatal life. Fat, carbohydrates (lactose), high biological value protein, calcium (directly associated to bone growth) as macro-minerals;

phosphorus, magnesium, zinc, iodine, vitamins B2, B12, D, and A as microelements are among the nutrients in consideration [2]. Milk protein is high in quality because it contains a large number of essential and semi-essential amino acids [3, 4].

Milk is a nutrient-dense food that helps people reach their required daily intake of vital nutrients [5]. Milk is an unmatched source of nutrition since it contains good quality protein, is a rich supply of healthy fat groups such as short-chain fatty acids, has a wide variety of minerals in macro and micro levels, and is a good source of bioactive peptides [6]. Milk becomes a significant raw material not only in terms of nutrition but also when examined in the dairy sector as a whole because of the substances in its formulation. Casein is a coagulating component found in milk proteins, accounting for 80 percent of the total [7]. The fundamental step in the manufacturing of fermented milk products is the instability and curdling of casein under acidic conditions and/or by proteolytic enzymes. Because some fragrant weak organic acids generated throughout the fermentation process contribute to the final product's scent development [8, 9]. Unsaturated fatty acids can be found in abundance in milk fat. Milk fat is of significant relevance due to the presence of short-chain fatty acids. These fatty acids have been shown in studies to have anti-inflammatory characteristics as well as beneficial effects on the digestive tract [10].

Unsaturated fatty acids can be found in abundance in milk fat. Milk fat seems to be of significant relevance due to the presence of short-chain fatty acids. These fatty acids have been shown in studies to have anti-inflammatory characteristics as well as beneficial effects on the digestive tract [11]. The fact that dairy animals eat silage and concentrate in the winter and fresh grass in the spring and summer produces variations in the milk composition [12].

Aside from being more aware, today's consumers seek outstanding food in terms of physical, chemical, sensory, and microbiological quality, and they tend to consume meals that meet their expectations. As a result, it is becoming increasingly necessary for firms to provide a consistent and high-quality end product to the market. Because a high-quality raw material is a prerequisite for a high-quality final product, raw milk quality is critical for enterprises that produce milk and its products. The goal of this study was to analyze the quality of milk produced by various dairy farms and milk collectors in the Susurluk district of Balikesir province over the winter, spring, summer, and autumn seasons. The study is relevant in terms of evaluating whether there has been any change in quality by analysing the collected data, as well as demonstrating compliance with the Turkish Food Codex of milk gathered from collectors and farms.

## **2. Materials and Methods**

### **2.1. Material**

The research analyzed 65 distinct milk samples from the Susurluk region that were delivered to the School laboratories for analysis during the winter (December-February), spring (March-May), summer (June-August), and autumn (September-November) seasons. The first 25 samples came from dairy farms in the Susurluk region while the remaining 40 came from different collectors in the Susurluk region. Milk samples were put in 500 mL sterile glass bottles, containing approximately 200-300 mL of milk, and kept cool using ice cassettes before being transferred to the Bandirma Onyedi Eylül University Susurluk Vocational School Food Processing Department Dairy Laboratory. On milk samples, the following tests were done.

## 2.2.Method

A digital pH meter was used to measure the pH of 25 mL of milk samples [13]. The alkali titration method was used to determine total acidity in raw milk. 4-5 drops of phenolphthalein solution were applied to 25 mL of milk sample as a result. The results are given as percent lactic acid after titration with 0.1N NaOH solution until the pH value reaches 8.1. With an 0-8 graded special milk butyrometer, the fat ratio was calculated as a percentage using the Gerber method [14]. The protein ratio was estimated by multiplying the nitrogen quantities discovered by a factor of 6.38 and estimating the nitrogen amounts of the samples subjected to wet burning using the micro Kjeldahl method [15]. Lactodensimeter was used to assess density in milk samples [13].

## 3. Results

The physicochemical parameters of milk samples collected from dairy farms and collectors were determined in the Vocational School's laboratories, and the results are listed in Table-1. To establish the quality of street milk in our country, milk samples were compared to one other on a seasonal basis, as well as to comparable studies conducted in past years. The results were also compared to the values stated in the "Declaration on Raw Milk and Heat-Treated Drinking Milk" for the relevant parameter.

Table 1 : Physicochemical Properties of Milk Samples

	pH	Total Acidity (%lactic acid)	Total Dry Matter (%)	Fat Content (%)	Protein Content (%)	Ash Content (%)	Density (g/ml)
Lowest	6.54	0.133	9.56	2.87	2.78	0.6	1.020
Highest	6.81	0.279	18.88	3.54	3.23	0.75	1.035

### 3.1.Determination of pH and Total Acidity

The most often used procedures for indirect control of microbiological quality of milk include measuring pH and total acidity values in milk [22]. The increase in the microbial flora of milk leads to an increase in acidity as a result of lactose consumption and thus a decrease in the pH value. The increase in acidity in milk is not a desirable development since it also increases the sensitivity of milk to temperature. In particular, the loss of casein stability and the occurrence of coagulation and the occurrence of the event, also known as cessation of milk, is an undesirable development that causes problems for the dairy industry [24].

The winter milk sample received from the collectors had the lowest pH value of 6.54 among the milk samples examined as part of the study. The pH value of a milk sample taken from a farm was measured at 6.62 in the winter month. While the pH value of summer milk samples was found 6.77 in the collectors' sample, it was measured at 6.81 in the farm milk sample.

According to a similar study conducted in Sanliurfa, physical and chemical qualities of 19 milk, 20 yogurt, and 8 fresh Urfa cheese samples produced and sold were analyzed, and the pH values of the milk samples were determined in the range of 6.45-6.81 [25]. Some chemical and microbiological aspects of street milk provided for sale were studied in another study conducted in Sanliurfa. It was determined to be 6.37, 6.60, and 6.46, according to the report [26]. The values reported in the studies are similar to those discovered in our research.

The lowest titration acidity value in terms of lactic acid in the milk samples examined within the scope of the study was 0.133 percent in the winter milk sample acquired from the collectors. The titration acidity value in the milk sample from the winter month was 0.143 percent in terms of lactic acid among the samples collected from farm milk. Titration acidity value of summer milk samples, again in terms of lactic acid; whereas it was measured at 0.273 percent in the collectors' sample, it was measured at 0.279 percent in the farm milk sample.

In a similar study conducted in Mardin, the physicochemical and microbiological properties of 40 raw milk samples sold throughout the province were researched, and the titration acidity values of the analyzed milk samples were determined to be between 0.133 and 0.276 percent in terms of lactic acid [27]. According to Beykaya et al. [28], the acidity levels of 50 raw milk samples were determined in the range of 0.135-0.495 percent in terms of lactic acid in a comparable study conducted in Sivas. In a study comparing the physicochemical properties of farm milk and milk sold on the street in Adiyaman province, it was stated that the average acidity value in raw milk was measured in the range of 0.161-0.170% in farm milk and between 0.182-0.220% in street milk [29]. The values found in the studies are similar to the ones we reported in our research. According to studies on titration acidity in the literature, an acidity value of milk in terms of lactic

acid greater than 0.200 percent indicates high microbial growth in milk, while a value less than 0.110 percent indicates a negative microbial development, mammary gland disease in the animal, or incorrect feeding practice [46]. At this moment in time, it is thought that microbial analyses such as somatic cell number and total living number should be performed in milk samples where titration acidity is determined particularly close to the specified limit values, and that a decision about milk quality should be made by combining physicochemical and microbial analyses.

### **3.2.Determination of Total Dry Matter Content**

Molecules other than water in milk constitute the “total dry matter of milk”. The concept of total dry matter, which we can state as consisting of fat, protein, carbohydrates, vitamins and minerals in general, allows to make comments on the quality of milk. The nutritional and economic value of milk is related to its dry matter content. The high amount of dry matter in milk means that the nutritive value and the amount of product to be obtained from the milk to be produced are high. In addition to being vital for obtaining a high-quality end product, the amount of fat and protein in raw milk are also factors that must be established precisely and properly for production in compliance with the Turkish Food Codex Communique on Raw Milk and Heat Treated Drinking Milk. Although the minimum protein value, minimum 8 percent non-fat dry matter value, and minimum 3.5 percent milk fat for full-fat drinking milk differ depending on the type of animal from which the milk is obtained, the said communiqué specifies limit values of minimum 2.9 percent protein, minimum 8 percent non-fat dry matter value, and minimum 3.5 percent milk fat for full-fat drinking milk. It is a common practice to do physicochemical analyses on raw milk and accept milk with the maximum fat and protein content feasible in order to achieve a production that complies with regulatory constraints at the lowest possible price [47].

The lowest total dry matter ratio in the milk samples analysed within the scope of this research was 9.56 percent in the summer sample taken from milk collectors, while the lowest total dry matter value in the raw milk samples taken from milk collection farms was 10.32 percent in the summer sample. The milk samples from milk collection farms had the highest total dry matter values, with 18.88 percent (milk sample from milk collection farms) and 16.81 percent (milk sample from milk collectors). Within the scope of our research, we determined that the analysis results in the milk samples we analyzed are consistent with the limit levels mentioned in the relevant proclamation.

According to a study conducted in 2017 on raw milk received to dairy firms in Sivas, the total dry matter values of milk were measured as low as 10.00 percent and as high as 15.40 percent [32]. The total dry matter value was measured at 11.51 percent in winter and 10.54 percent in summer in a study that determined the physicochemical properties

of street milk offered for sale in Sanliurfa [33]. The results found in the researches are similar to the values we reported in our research.

### **3.3.Determination of Fat Content**

Milk fat is a nutritive and technologically important component of milk. In the dairy business, milk fat is mostly processed into butter, cheese, cream, and whole milk powder. Minor components such as mono- and di-glycerides from milk fat are increasingly being used as emulsifiers in high-priced food products, replacing palm esters [34]. Milk fat is one of the most significant components of milk for nutritional and economic reasons, throughout to its technological value. Milk fat and lipids in particular offer dairy products with unique sensory and physical qualities in addition to being a rich source of energy. Milk fat also contains fat-soluble vitamins (A, D, E, and K) as well as the carotenoid pro-vitamin A ( $\beta$ -carotene) [35]. When all of these factors are taken into account, milk fat becomes one of the most important factors in milk prices.

The amount of fat that should be present in raw milk is not specified in the Turkish Food Codex Communiqué on Raw and Heat-Treated Drinking Milk. Extra milk should have at least 3.5 percent fat, 3.0 percent fat in first class milk, and 2.5 percent fat in second class milk, according to “The Raw Milk Standard (TS 1018)”. Whereas the lowest fat rate in the milk samples evaluated within the scope of this research was 2.87 percent, measured in a spring season milk sample, the 2.95 percent fat value recorded in the spring season samples was the lowest among the samples obtained from milk collecting farms. The largest level of oil; as it was being measured at 3.54 percent in milk samples taken from collectors in the winter season, it was found at 3.22 percent in farm samples collected in the autumn season.

Once compare different researches on the topic, it was revealed that the fat content levels in raw milk samples recorded in Edirne, Tekirdag, and Kirklareli were 3.70 percent, 3.60 percent, and 3.76 percent, respectively. According to Akin et al. [31], the fat percentage of milk delivered by dairy farms and collectors in Adiyaman province ranges from 2.43 to 4.02 percent. The values discovered as a result of the fat determination done on samples collected from small scale farm tank milks in Erzurum are in the range of 3.07-4.33 percent, according to the report. The values found in the researches are similar to the values we reported in our research.

### **3.4.Determination of Protein Content**

Due to the critical significance of protein in human tissues and processes, it is clear that supplying the body with adequate building blocks in the form of amino acids is critical. A particular amount of daily protein intake is required for both adults and children in order to balance daily nitrogen losses, provide care in tissues, and generate non-protein

nitrogenous molecules [38]. Proteins must be broken down into free amino acids, di- and tri-peptides, in the digestive tract before they can be utilised as efficient sources of amino acids for the body. After conducting a literature search, it was found that different protein sources had variable digestibility rates, but that animal-derived proteins had high digestibility values in general [39, 40, 41]. Milk protein is one of the sources with the highest score in the protein digestibility criteria [42, 43]. Throughout its nutritional importance, milk's low protein content is an unfavorable industry result, since it will result in a variety of quality issues in dairy products. Whereas the protein ratio in milk does not fluctuate as much as the milk fat ratio, it is claimed that factors such as malnutrition, ethnicity, and lactation time have an impact on the protein ratio [44]. The lowest protein rate, 2.78 percent, was received from the collectors and measured in the summer milk sample, while the quantity of fat was measured at 2.97 percent in the summer milk sample taken from the milk collection farms. While it was measured at 3.11 percent in milk samples taken from milk collectors during the winter season, the value was calculated at 3.23 percent in milk samples taken from milk collection farms during the autumn season.

When similar studies on the subject are evaluated; the protein value in raw milk offered for sale in Mardin varies between 2.41-3.66% [45]; it has been determined that the % protein values of street milks vary between 3.74-2.67% and the % protein values of farm milks vary between 3.48-2.65% in İzmir [46]. The protein ratio of raw milk delivered to the pilot milk factory of Atatürk University Faculty of Agriculture ranged between 3.62-3.63 percent, according to a research conducted to determine the quality of raw milk delivered to the pilot milk factory. Furthermore, the protein ratios in the summer and fall seasons are lower than the protein ratios in the spring and winter seasons, according to the results of the same study [48]. The protein ratios of raw milk collected in the summer season are lower than all those collected in other seasons, according to a research analyzing the seasonal effect on the composition of raw milk in Adiyaman [49]. The values found in the research are similar to the values we reported in our research.

### **3.5.Determination of Ash Content**

Minerals represent a small fraction of milk and depending on the molecular form, are soluble and dispersed in the colloidal phase. Milk mineral content depends on various factors such as species, breed, individual animal, diet, lactation stage, parity and udder health [50]. Ca is essential for bone and dental health, as milk and dairy products, together with P and Mg in the human diet, offer 50 to 70% of the daily consumption [51]. Ca, P, and Mg are also crucial in cheese production since they regulate micelle characteristics (structure and stability), which affect milk coagulation and curd rheology [52, 53]. Ca, P, and Mg were negatively correlated with rennet coagulation time and curd

setting time, however curd firmness and titratable acidity were positively correlated [54, 55].

Ash determination is an important analysis in terms of giving an idea about the amount of mineral substances that are important for milk, both nutritionally and technologically. In the milk samples analyzed within the scope of the research, the lowest amount of ash was taken from the collectors as 0.60% and measured in the milk sample belonging to the winter season, while the amount of ash was measured as 0.63% in the milk sample taken from the milk collection farms for the winter season. While it was determined to be 0.71 percent in milk samples taken from collectors and in samples from the summer season, it was determined to be 0.75 percent in milk samples taken from milk collecting farms and again from the summer season.

Once similar research on the subject reviewed, it was discovered that the average dry matter and ash values of traditional milk were 12.06 percent and 0.67 percent, respectively, in a study conducted by Urkek and Sengul [56]. The lowest and highest ash levels of raw milk samples were determined to be 0.61 percent and 0.83 percent, respectively, in research conducted to investigate some physicochemical and microbiological properties of raw milk sold in Mardin [57]. The average ash level of the samples was revealed to be 0.78 percent in the analysis carried out to determine the mineral substance content of the raw milk samples taken from the milk tanks of small-scale firms, according to a research commissioned in Erzurum [58]. The values found in the studies are similar to the values we reported in our research.

### **3.6.Determination of Density**

Milk composition affects physical properties such as density and thus the basis for weight-volume calculations in the dairy processing industry. The amount of non-fat dry matter and the fat content of the milk are closely related to changes in density [59]. The density value of milk rich in milk fat is relatively lower, and the opposite is generally true. The density of milk varies between 1.025 and 1.035 g/cm<sup>3</sup> [60] with seasonal changes throughout the year. The decrease in milk fat observed in summer affects the density value in milk, and the density value of summer milk is measured lower than winter milk [61]. Temperature, agitation and homogenization can all influence the density of milk [62].

Milk density is an important parameter for estimating the weight-volume relationship in the dairy industry. In milk industry milk is supplied by volume (liter), whereas the final product mix is normally measured in mass/weight (kg), resulting in measurement anomalies. Developing a coefficient to convert weight to volume at this point will simplify the procedure and eliminate confusion. Seasonal fluctuations in the composition of milk, particularly milk fat, make it impossible to use a single conversion factor all year.



As a result, identifying the differences in milk composition and how they fluctuate seasonally is essential for accurate calculation and result determination [63]. When all of these factors are taken into account, milk density determination becomes a key requirement. The lowest density was obtained from farms as 1.020 g ml<sup>-1</sup> and measured in the autumn season samples, and it was measured as 1.022 g ml<sup>-1</sup> in the winter milk samples taken from various milk collectors with in framework of our research. The greatest density values were 1.035 g ml<sup>-1</sup> in milk samples taken from farms during the spring season, and 1.033 g ml<sup>-1</sup> in milk samples taken from various milk collectors during the spring season. According to the Turkish Food Codex Declaration on the Supply of Raw Milk, raw cow's milk should have a density of at least 1.028 g ml<sup>-1</sup>. According to this, the milk samples taken from milk collectors in the winter season and the samples taken from farms in the autumn season are both outside the value provided in the relevant proclamation. When comparing studies on the subject, Sengul et al., [64] reported that the density values of raw milk samples fluctuated seasonally in the range of 1.029-1.033 g ml<sup>-1</sup> in a study conducted to analyze the quality of raw milk arriving at the Atatürk University Faculty of Agriculture pilot milk factory. The density values of raw milk were measured in the range of 1.023-1.033 g ml<sup>-1</sup> in a study conducted to determine some properties of milk supplied from dairy farms and collectors in Adiyaman province [65]. The density values of raw milk were measured in the range of 1.023-1,029 g ml<sup>-1</sup> in a study carried out to determine the physicochemical and microbiological parameters of raw milk sold in Mardin [66]. The values found in the research are similar to the values we reported in our research.

#### 4. Discussion and Conclusion

The values reported in this study, which was carried to determine the physicochemical quality of milk produced in the Susurluk region of Balikesir province, were line with the outcomes of previous comprehensive investigations conducted in plenty of other provinces accross Turkey. Despite significant advances in the drinking milk industry and increasing consumer awareness, consumption of drinking milk produced using current processes has not performed as expected. Raw milk has become a popular choice since it has not been processed and the perception that it is more natural and healthy has not been shattered. When all of these factors are considered, it is essential for public health that raw milk production and controls are carefully carried out.

#### References

- [1] Melnik, B. C., & Schmitz, G. (2017). Milk's role as an epigenetic regulator in health and disease. *Diseases*, 5(1), 12.

- [2] Miller, G. D., Jarvis, J. K., & McBean, L. D. (2006). *Handbook of dairy foods and nutrition*. CRC press.
- [3] Aslan, R. (2018). Doğal Bir Antioksidan Olarak. *Ayrıntı Dergisi*, 6(64).
- [4] Scholz-Ahrens, K. E., Ahrens, F., & Barth, C. A. (2020). Nutritional and health attributes of milk and milk imitations. *European journal of nutrition*, 59(1), 19-34.
- [5] Serrapica, F., Masucci, F., Di Francia, A., Napolitano, F., Braghieri, A., Esposito, G., & Romano, R. (2020). Seasonal variation of chemical composition, fatty acid profile, and sensory properties of a mountain Pecorino cheese. *Foods*, 9(8), 1091.
- [6] Mohapatra, A., Shinde, A. K., & Singh, R. (2019). Sheep milk: A pertinent functional food. *Small Ruminant Research*, 181, 6-11.
- [7] Bouchoux, A., Gesan-Guiziu, G., Pérez, J., & Cabane, B. (2010). How to squeeze a sponge: casein micelles under osmotic stress, a SAXS study. *Biophysical journal*, 99(11), 3754-3762.
- [8] Horne, D. S., Lucey, J.A. (2017). *Rennet-induced coagulation of milk Cheese: Chemistry, Physics and Microbiology*(4th ed.), Elsevier Inc., Amsterdam, the Netherlands (2017), pp. 115-143
- [9] Choi, J., Horne, D. S., & Lucey, J. A. (2015). Effect of insoluble calcium concentration on endogenous syneresis rate in rennet-coagulated bovine milk. *Journal of dairy science*, 98(9), 5955-5966.
- [10] Zheng, N., Gao, Y., Zhu, W., Meng, D., & Walker, W. A. (2020). Short chain fatty acids produced by colonizing intestinal commensal bacterial interaction with expressed breast milk are anti-inflammatory in human immature enterocytes. *PloS one*, 15(2), e0229283.
- [11] O'Brien, B., & Guinee, T. P. (2016). Seasonal effects on processing properties of cows' milk.
- [12] Grimley, H., Grandison, A., & Lewis, M. (2009). Changes in milk composition and processing properties during the spring flush period. *Dairy science & technology*, 89(3), 405-416.
- [13] Oysun, G. (2011). *Süt ve Ürünlerinde Analiz Yöntemleri*. Bornova, İzmir.
- [14] Anonymous. (1989). *Çiğ Süt Standardı*. TS1018. Türk Standartları Enstitüsü, Ankara.
- [15] IDF. (1982). Determination of the total solid content (cheese and processed cheese). IDF Standard: 4A Brussels. International Dairy Federation.
- [16] Acatincăi, S., Marcu, A., Czisster, L. T., Roman, M., Tripon, I., & Erina, S. (2008). Study regarding the correlation between somatic cells count and major chemical compounds in raw milk. *Scientific Papers Animal Science and Biotechnologies*, 41(2), 350-353
- [17] Pavel, E. R., & Gavan, C. (2011). Seasonal and milking-to-milking variations in cow milk fat, protein and somatic cell counts. *Notulae Scientia Biologicae*, 3(2), 20-23.
- [18] Moslehishad, M., Ezzatpanah, H., & Aminafshar, M. (2010). Chemical and electrophoretic properties of Holstein cow milk as affected by somatic cell count. *International journal of dairy technology*, 63(4), 512-515.
- [19] Ramos, T. M., Costa, F. F., Pinto, I. S. B., Pinto, S. M., & Abreu, L. R. (2015). Effect of somatic cell count on bovine milk protein fractions. *Journal of Analytical & Bioanalytical Techniques*, 6(5), 1.
- [20] Cinar, M., Serbester, U., Ceyhan, A., & Gorgulu, M. (2015). Effect of somatic cell count on milk yield and composition of first and second lactation dairy cows. *Italian Journal of Animal Science*, 14(1), 3646.

- [21] Sert, D., Mercan, E., Aydemir, S., & Civelek, M. (2016). Effects of milk somatic cell counts on some physicochemical and functional characteristics of skim and whole milk powders. *Journal of Dairy Science*, 99(7), 5254-5264.
- [22] Walstra P, Wouters J T M and Geurts T J(2006) *Dairy Science and Technology*. Boca Raton, FL: CRC Press.
- [23] Tribst, A. A. L., Falcade, L. T. P., Leite Júnior, B. R. D. C., & De Oliveira, M. M. (2020). Why are most physicochemical parameters not useful in predicting the quality of sheep milk?. *International Journal of Dairy Technology*, 73(1), 292-295.
- [24] Türkoğlu, H., Atasoy, A. F., & Özer, H. B. (2003). Şanlıurfa ilinde üretilen ve satışı sunulan süt yoğurt ve Urfa peynirlerinin bazı kimyasal özellikleri. *Harran Üniversitesi Ziraat Fakültesi Dergisi*, 7(3-4), 69-76.
- [25] Göncü, B. G., Çelikel, A., Akın, M. B., & Akın, M. S. (2017). Şanlıurfa'da satışı sunulan sokak sütlerinin bazı kimyasal ve mikrobiyolojik özelliklerinin belirlenmesi üzerine bir araştırma. *Harran Üniversitesi Mühendislik Dergisi*, 2(2), 15-23.
- [26] Güngör, A. Ç., Gürbüz, S., Akın, M. S., Akın, M. B., & Palabıçak, B. (2020). Mardin'de satılan çiğ sütlerin bazı fizikokimyasal ve mikrobiyolojik özellikleri. *Harran Üniversitesi Veteriner Fakültesi Dergisi*, 9(1), 1-5.
- [27] Beykaya, M., Özbey, A., & Yıldırım, Z. (2017). Sivas ilindeki bazı süt işletmelerine gelen sütlerin fiziksel, kimyasal ve mikrobiyolojik özelliklerinin belirlenmesi.
- [28] Kaşıkçı, M. (2012). *Sivas ili Yıldızeli ilçesinde halk elinde yetiştirilen esmer sığırların çiğ süt kompozisyonu ve somatik hücre sayısının belirlenmesi* (Master's thesis, Gaziosmanpaşa Üniversitesi, Fen Bilimleri Enstitüsü).
- [29] Baran, A., & Adıgüzel, M. C. (2020). Some physicochemical and microbiological properties of cow milks collected from local dairy delicatessens in Erzurum, Turkey. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, 23(2), 493-505.
- [30] Güngör, A. Ç., Gürbüz, S., Akın, M. S., Akın, M. B., & Palabıçak, B. (2020). Mardin'de satılan çiğ sütlerin bazı fizikokimyasal ve mikrobiyolojik özellikleri. *Harran Üniversitesi Veteriner Fakültesi Dergisi*, 9(1), 1-5.
- [31] Akın, M. S., Yapık, Ö., & Akın, M. B. (2016). Adıyaman ilinde süt üretim çiftliklerinden ve toplayıcılardan sağlanan sütlerin bazı özellikleri. *Harran Tarım ve Gıda Bilimleri Dergisi*, 20(4), 253-265.
- [32] Beykaya, M., Özbey, A., & Yıldırım, Z. (2017). Sivas ilindeki bazı süt işletmelerine gelen sütlerin fiziksel, kimyasal ve mikrobiyolojik özelliklerinin belirlenmesi.
- [33] Göncü, B. G., Çelikel, A., Akın, M. B., & Akın, M. S. (2017). Şanlıurfa'da satışı sunulan sokak sütlerinin bazı kimyasal ve mikrobiyolojik özelliklerinin belirlenmesi üzerine bir araştırma. *Harran Üniversitesi Mühendislik Dergisi*, 2(2), 15-23.
- [34] Chung, I. M., Kim, J. K., Lee, K. J., Son, N. Y., An, M. J., Lee, J. H., ... & Kim, S. H. (2018). Discrimination of organic milk by stable isotope ratio, vitamin E, and fatty acid profiling combined with multivariate analysis: A case study of monthly and seasonal variation in Korea for 2016–2017. *Food chemistry*, 261, 112-123.
- [35] Gómez-Cortés, P., Juárez, M., & de la Fuente, M. A. (2018). Milk fatty acids and potential health benefits: An updated vision. *Trends in Food Science & Technology*, 81, 1-9.

- [36] Akın MS, Yapık O, Akın MB. 2016. Adıyaman ilinde süt üretim çiftliklerinden ve toplayıcılardan sağlanan sütlerin bazı özellikleri. *Harran Tarım ve Gıda Bilimleri Dergisi*. 20: 253- 265.
- [37] Diler A, Baran A, 2014. Erzurum'un Hınıs ilçesi çevresindeki küçük ölçekli işletme tank sütlerinden alınan çiğ süt örneklerinin bazı kalite özelliklerinin belirlenmesi. *Alinteri Dergisi*. 26: 18-24.
- [38] Ghosh, S., & Uauy, R. (2016). Protein quality and amino acids in maternal and child nutrition and health.
- [39] Bailey, H. M., & Stein, H. H. (2020). Raw and roasted pistachio nuts (*Pistacia vera* L.) are 'good' sources of protein based on their digestible indispensable amino acid score as determined in pigs. *Journal of the Science of Food and Agriculture*, 100(10), 3878-3885.
- [40] Hodgkinson, S. M., Montoya, C. A., Scholten, P. T., Rutherford, S. M., & Moughan, P. J. (2018). Cooking conditions affect the true ileal digestible amino acid content and digestible indispensable amino acid score (DIAAS) of bovine meat as determined in pigs. *The Journal of nutrition*, 148(10), 1564-1569
- [41] Mathai, J. K., Liu, Y., & Stein, H. H. (2017). Values for digestible indispensable amino acid scores (DIAAS) for some dairy and plant proteins may better describe protein quality than values calculated using the concept for protein digestibility-corrected amino acid scores (PDCAAS). *British Journal of Nutrition*, 117(4), 490-499.
- [42] Calvez, J., Benoit, S., Fleury, L., Khodorova, N., Piedcoq, J., Tomé, D., ... & Gaudichon, C. (2019). True ileal protein digestibility of zein and whey protein isolate in healthy humans (OR27-06-19). *Current developments in nutrition*, 3(Supplement\_1), nzz046-OR27.
- [43] Guillin, F., Gaudichon, C., Guérin-Deremaux, L., Lefranc-Millot, C., Tomé, D., Khodorova, N., ... & Calvez, J. (2020). Real ileal digestibility of pea protein compared to casein in healthy humans. *Current Developments in Nutrition*, 4(Supplement\_2), 634-634.
- [44] Erdem, H., Atasever, S., & Ertuğrul, K. U. L. (2007). Gökhöyük Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırların Süt ve Döl Verim Özellikleri 2. Döl Verim Özellikleri. *Anadolu Tarım Bilimleri Dergisi*, 22(1), 47-54.
- [45] Güngör, A. Ç., Gürbüz, S., Akın, M. S., Akın, M. B., & Palabıçak, B. (2020). Mardin'de satılan çiğ sütlerin bazı fizikokimyasal ve mikrobiyolojik özellikleri. *Harran Üniversitesi Veteriner Fakültesi Dergisi*, 9(1), 1-5.
- [46] Kesenkaş, H., & Akbulut, N. (2010). İzmir ilinde satılan sokak sütleri ile orta ve büyük ölçekli çiftliklerde üretilen sütlerin özelliklerinin belirlenmesi. *Ege Üniversitesi Ziraat Fakültesi Dergisi*, 47(2), 161-169.
- [47] Kaşıkçı, M. (2012). Sivas ili Yıldızeli ilçesinde halk elinde yetiştirilen esmer sığırların çiğ süt kompozisyonu ve somatik hücre sayısının belirlenmesi (Master's thesis, Gaziosmanpaşa Üniversitesi, Fen Bilimleri Enstitüsü).
- [48] Şengül, M., Ürkek, B., Kaçan, Z. G. K., Kotan, T. E., & Akgül, H. İ. (2021). Atatürk Üniversitesi Ziraat Fakültesi Pilot Süt Fabrikasına Gelen Çiğ Sütlerin Kalitesinin Belirlenmesi. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi*, 52(1), 90-97.
- [49] Akın MS, Yapık O, Akın MB. 2016. Adıyaman ilinde süt üretim çiftliklerinden ve toplayıcılardan sağlanan sütlerin bazı özellikleri. *Harran Tarım ve Gıda Bilimleri Dergisi*. 20: 253- 265.

- [50] Zamberlin, Š., Antunac, N., Havranek, J., & Samaržija, D. (2012). Mineral elements in milk and dairy products. *Mljekarstvo: časopis za unaprjeđenje proizvodnje i prerade mlijeka*, 62(2), 111-125.
- [51] Bonjour, J. P., Guéguen, L., Palacios, C., Shearer, M. J., & Weaver, C. M. (2009). Minerals and vitamins in bone health: the potential value of dietary enhancement. *British journal of nutrition*, 101(11), 1581-1596.
- [52] Bijl, E., Van Valenberg, H. J. F., Huppertz, T., & Van Hooijdonk, A. C. M. (2013). Protein, casein, and micellar salts in milk: Current content and historical perspectives. *Journal of dairy science*, 96(9), 5455-5464.
- [53] Malacarne, M., Franceschi, P., Formaggioni, P., Sandri, S., Mariani, P., & Summer, A. (2014). Influence of micellar calcium and phosphorus on rennet coagulation properties of cows milk. *Journal of Dairy Research*, 81(2), 129-136.
- [54] Toffanin, V., De Marchi, M., Lopez-Villalobos, N., & Cassandro, M. (2015). Effectiveness of mid-infrared spectroscopy for prediction of the contents of calcium and phosphorus, and titratable acidity of milk and their relationship with milk quality and coagulation properties. *International Dairy Journal*, 41, 68-73.
- [55] Visentin, G., Penasa, M., Gottardo, P., Cassandro, M., & De Marchi, M. (2016). Predictive ability of mid-infrared spectroscopy for major mineral composition and coagulation traits of bovine milk by using the uninformative variable selection algorithm. *Journal of dairy science*, 99(10), 8137-8145.
- [56] Ürkek, B., & Şengül, M. (2018). Türkiye’de üretilen organik ve konvansiyonel sütlerin bazı fizikokimyasal özellikleri ile yağ asitleri kompozisyonu ve antioksidan kapasitesinin belirlenmesi. *Türk Tarım-Gıda Bilim ve Teknoloji Dergisi*.
- [57] Güngör, A. Ç., Gürbüz, S., Akın, M. S., Akın, M. B., & Palabıçak, B. (2020). Mardin’de satılan çiğ sütlerin bazı fizikokimyasal ve mikrobiyolojik özellikleri. *Harran Üniversitesi Veteriner Fakültesi Dergisi*, 9(1), 1-5.
- [58] Diler A, Baran A, 2014. Erzurum’un Hınıs ilçesi çevresindeki küçük ölçekli işletme tank sütlerinden alınan çiğ süt örneklerinin bazı kalite özelliklerinin belirlenmesi. *Alinteri Dergisi*. 26: 18-24.
- [59] Short, A. L. (1955). 573. The temperature coefficient of expansion of raw milk. *Journal of dairy Research*, 22(1), 69-73.
- [60] Scott, R., Scott, J. E., Robinson, R. K., & Wilbey, R. A. (1998). *Cheesemaking practice*. Springer Science & Business Media.
- [61] Chen, B., Lewis, M. J., & Grandison, A. S. (2014). Effect of seasonal variation on the composition and properties of raw milk destined for processing in the UK. *Food chemistry*, 158, 216-223.
- [62] Sodini, I., Remeuf, F., Haddad, S., & Corrieu, G. (2004). The relative effect of milk base, starter, and process on yogurt texture: a review. *Critical reviews in food science and nutrition*, 44(2), 113-137.
- [63] Parmar, P., Lopez-Villalobos, N., Tobin, J. T., Murphy, E., McDonagh, A., Crowley, S. V., ... & Shalloo, L. (2020). The effect of compositional changes due to seasonal variation on milk density and the determination of season-based density conversion factors for use in the dairy industry. *Foods*, 9(8), 1004.

- [64] Şengül, M., Ürkek, B., Kaçan, Z. G. K., Kotan, T. E., & Akgül, H. İ. (2021). Atatürk Üniversitesi Ziraat Fakültesi Pilot Süt Fabrikasına Gelen Çiğ Sütlerin Kalitesinin Belirlenmesi. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi*, 52(1), 90-97.
- [65] Akın, M. S., Yapık, Ö., & Akın, M. B. (2016). Adıyaman ilinde süt üretim çiftliklerinden ve toplayıcılardan sağlanan sütlerin bazı özellikleri. *Harran Tarım ve Gıda Bilimleri Dergisi*, 20(4), 253-265.
- [66] Güngör, A. Ç., Gürbüz, S., Akın, M. S., Akın, M. B., & Palabıçak, B. (2020). Mardin'de satılan çiğ sütlerin bazı fizikokimyasal ve mikrobiyolojik özellikleri. *Harran Üniversitesi Veteriner Fakültesi Dergisi*, 9(1), 1-5.