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Determination of Alpha S1-Casein, Beta-Lactoglobulin, Some Biochemical and Mineral Levels in Milk of Different Animals*

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Abstract: In this study, it was aimed to investigate α -S1-casein and β -lactoglobulin levels and some biochemical and mineral values in raw milk samples obtained from cows, buffaloes, sheep, and goats raised in Samsun. The study material consisted of 40 raw milk taken from goats, cows, sheep and buffaloes after milking in a farm in Samsun province Bafra district. α-S1-casein and β-lactoglobulin levels in milk serum were determined using ELISA test kits. Calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), total protein (TP), albumin (ALB), total cholesterol (TC), and triglyceride (TG) levels were measured using a spectrophotometric autoanalyzer. Sheep milk TP, ALB, GLO, TC levels were significantly higher than other milk samples. It was determined that the highest TP level was in sheep milk, followed by buffalo, goat, and cow milk, respectively. It was determined that the TG level in goat milk was significantly higher than other milk samples ($P<0.05$), followed by buffalo, sheep, and cow milk ($P>0.05$). It was determined that sheep milk contains more Ca, Mg, Fe, Zn than other milk samples, and the total mineral content is more prosperous than other milk samples. The mineral content of goat and cow milk was found similar; Zn mineral in cow milk was found slightly higher. α -S1-casein and β -lactoglobulin levels were lower in goat milk samples than other milk samples. It was concluded that α-S1-casein and β-lactoglobulin levels in goat milk were lower than in other milk samples (cow, sheep, and buffalo), and it could be recommended for those with milk allergies.
Keywords: *Alpha S1-Casein, Beta Lactoglobulins, Milk, Mineral.*

Farklı Hayvanların Sütlerinde Alfa S1-Kazein, Beta-Laktoglobulin, Bazı Biyokimyasal ve Mineral Düzeylerinin Belirlenmesi*

Özet: Bu çalışmada Samsun'da yetiştirilen inek, manda, koyun ve keçilerden elde edilen çiğ süt örneklerinde α-S1-kazein ve β-laktoglobulin düzeyleri ile bazı biyokimyasal ve mineral değerlerinin araştırılması amaçlandı. Çalışma materyalini Samsun ili Bafra ilçesindeki bir çiftlikten sağım sonrası inek, manda, koyun ve keçilerden alınan 40 adet çiğ süt oluşturdu. Süt serumundaki α -S1-kazein ve β -laktoglobulin seviyeleri ELISA test kitleri kullanılarak belirlendi. Spektrofotometrik otoanalizör kullanılarak kalsiyum (Ca), magnezyum (Mg), demir (Fe), çinko (Zn), total protein (TP), albümin (ALB), total kolesterol (TC) ve trigliserit (TG) seviyeleri ölçüldü. Koyun sütü TP, ALB, GLO, TC seviyeleri diğer süt örneklerinden anlamlı derecede yüksek bulundu. En yüksek TP düzeyinin koyun sütünde olduğu, bunu sırasıyla manda, keçi ve inek sütünde olduğu belirlendi. Keçi sütünde TG düzeyinin diğer süt örneklerine göre anlamlı derecede yüksek olduğu ($P<0.05$), bunu sırasıyla manda, koyun ve inek sütlerinin izlediği ($P>0.05$) belirlendi. Koyun sütünün diğer süt örneklerinden daha fazla Ca, Mg, Fe, Zn içerdiği ve toplam mineral içeriğinin diğer süt örneklerinden daha zengin olduğu belirlendi. Keçi ve inek sütünün mineral içeriği benzer bulundu, inek sütündeki Zn minerali biraz daha fazla bulundu. Keçi sütü örneklerinde α -S1-kazein ve β -laktoglobulin seviyeleri diğer süt örneklerine göre daha düşük bulundu. Keçi sütündeki α-S1-kazein ve β-laktoglobulin düzeylerinin diğer süt örneklerine (inek, koyun ve manda) göre daha düşük olduğu ve süt alerjisi olanlara önerilebileceği sonucuna varıldı.
Anahtar Kelimeler: *Alfa S1-Kazein, Beta Laktoglobulinler, Mineral, Süt.*

Introduction

Milk is a secretion of the mammalian gland, whose physical characteristics and composition vary between species. The use of milk from domesticated mammalian animals in the human diet has a long tradition. Today, cattle, buffaloes, sheep, goats, and camels are used in various parts of the world to produce milk and milk products for human consumption (Goff, 2016). Every mammal species has a unique milk composition in major and minor constituents such as proteins, polyunsaturated fatty acids, vitamins, and minerals (Fukuda, 2013). Approximately 98% of lipids in milk are triglycerides (Grummer, 1991). However, micronutrients such as small amounts of vitamins and minerals contribute significantly to the properties of milk. Lactose is the only carbohydrate in milk, and it is a disaccharide composed of glucose

and galactose. Lactose is essential for brain and nerve development (Varma, 1962).

Milk proteins are divided into caseins (80%) and serum proteins (20%). Caseins are composed of alpha (S1), alpha (S2) caseins, beta casein and kappa casein. Contribution of milk proteins to growth and development, besides its effectiveness in tissue differentiation; It has been reported to have positive effects on calcium absorption and immune functions, reduce blood pressure and cancer risk, be effective in the control of body weight, and protect against dental caries (Jain, 1998). Almost 20% of all milk proteins are milk serum proteins. The main milk serum proteins are lactalbumin, lactoglobulin, immunoglobin, and proteose peptones. β-lactoglobulin is more important than other fractions, and in terms of amount, it constitutes more than half of the total lactalbumin. It is rich in amino acids of leucine and lysine. It has been reported that β-lactoglobulin plays a role in carrying passive immunity in newborns and the regulation of phosphorus metabolism in the mammary gland. Since cysteine is present in the amino acid structure of this protein, it is crucial for glutathione (GSH) synthesis and muscle development. In addition to all these, it has been reported to act as a fatty acid or lipid-binding protein (De Wit, 1998; Yerlikaya, 2010).

Every infant needs to get the milk of his mother for growth and development, optimum bone health and immune system development, and increasing the quality of life (Fox and Mcsweeney, 1998). Cow's milk proteins are the first proteins babies take after breast milk usually. In the last few decades, allergic reactions to casein appear to have become more prevalent decades (Wal, 2002). The primary allergens in cow's milk, according to most research, are α-lactalbumin, β-lactoglobulin, and casein (Chen et al., 2014; Pessato et al., 2016). Among people allergic to milk, 51% are allergic to α-lactalbumin, and 82% are allergic to β-lactoglobulin (Exl, 2001).

This study aimed to investigate and comparatively evaluate alpha S1-casein, beta-lactoglobulin levels, and some biochemical and mineral values in raw milk samples obtained after milking from cows, buffalo, sheep, and goats raised in Samsun.

Materials and methods

Study area and animals: The study material consisted of 40 raw milk taken from ten goats, ten cows, ten sheep, and ten buffaloes in Bafra, Samsun. Animals were kept in traditional barns, and the feeding was traditional. Milk samples were collected in sterile containers within an hour on the same day grown in the same farm under similar soil conditions in November and brought to the laboratory in a thermos bag in ice molds. Milk serums were removed on the same day, aliquoted, and kept at -20 °C until analysis.

Preparation of Milk Serum: Milk samples obtained after milking from different animal species were centrifuged by two different methods used in ELISA and biochemical analysis.

Milk serum was obtained by centrifugation at 2000 rpm for 20 minutes as specified in the kit procedure for ELISA. The milk samples obtained were stored at -20 ^{o}C until analysis with ELISA test kits.

Milk serum was obtained by centrifuging milk samples at 15 000 rpm for 20 minutes in biochemical analysis (Charkoftaki et al., 2010). The levels of calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), total protein (TP), albumin (ALB), total cholesterol (TC), and triglycerides (TG) in the milk samples obtained were kept at -20 ^{o}C until analyzed by spectrophotometric method.

Determination of α-S1-casein and β-lactoglobulin Levels in Milk Serum: α -S1-casein and β-lactoglobulin levels in milk serum were determined using (Biont, Bovine-α-S1-casein, China, Biont, Bovine- β -lactoglobulin, China) ELISA test kits and following the kit procedure. In this study, for the determination of α-S1-casein and β-lactoglobulin levels in cow, sheep, goat, and buffalo, the amino acid composition of α-S1-casein and β-lactoglobulin and its genetic diversity were similar in buffalo, sheep, goat, and cow (85-95%) Bovine specific ELISA kit was used due to (Borkova and Snaselona, 2005; Hayam et al., 2017; Masoodi and Shafi, 2010). The ELISA's were performed according to the manufacturer's instructions, and the ELISA reader measured the absorbances (as OD values) of the ELISA plates.

Determination of Calcium, Magnesium, Iron, Zinc, Total Protein, Albumin, Total Cholesterol and Triglyceride Levels in Milk Serum: Milk serum Mg, Ca, Fe, Zn, TG, TC, TP, and ALB levels were measured spectrophotometrically method (Barbour and Davisdon, 1988; Bucola and David, 1973; Fossati and Prencipe, 1982; Grant and Kachmar, 1976; Makino et al., 1982; Michaylova and Illkova 1971; Sacks, 1999; Stookey, 1970; Weichselbaum, 1946) in an autoanalyzer (Biosistem A25, İspanya) using Biosistem kits (Mg, Ca, Fe, Zn, TG, TC, TP, ALB). The results of the analyses were calculated by optical reading at a particular time and temperature.

The serum globulin level was calculated by subtracting the albumin value from the corresponding total protein value. The concentration of serum globulin was expressed as

g/ dl. The A/G ratio was calculated based on serum albumin and globulin measurements.

Statistical Analyses: SPSS statistical software for Windows (SPSS-PC, SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. One-way analysis of variance (ANOVA), Duncan's multiple ranges, and Pearson correlation tests were used to determine the differences and relationships among the groups.

Results

Some Biochemical Parameter Levels in Milk Serum: The average and standard error values (mean± SE) of TP, ALB, GLO, ALB / GLO, TC, and TG levels in raw milk samples from goats, cows, sheep, and buffaloes raised on a farm in Samsun, are given in Table 1.

Table 1. Total protein (TP), albumin (ALB), globulin (GLO), albumin / globulin (ALB / GLO), total cholesterol (TC), triglyceride (TG) levels in cow, sheep, goat and buffalo milk.

	Cow milk	Sheep milk	Goat milk	Buffalo milk
TP (g/dl)	1,7±0,07 ^{a}	4,83±0,33 ^{c}	1,96±0,1 ^{ab}	2,32±0,15 ^{b}
ALB (g/dl)	0,86±0,07 ^{a}	1,35±0,07 ^{b}	1,13±0,09 ^{ab}	1,05±0,09 ^{a}
GLO(g/dl)	0,84±0,22 ^{a}	3,48±0,36 ^{b}	0,82±0,3 ^{a}	1,27±0,81 ^{a}
ALB/GLO	1,03±0,11 ^{b}	0,43±0,056 ^{c}	1,37±0,1 ^{a}	0,83±0,084 ^{b}
TC (mg/dl)	1,4±0,16 ^{a}	2,5±0,61 ^{b}	0,82±0,26 ^{a}	0,83±0,24 ^{a}
TG (mg/dl)	35,5±2,53 ^{b}	37,6±8,6 ^{b}	110,88±15,51 ^{a}	60,25±15,69 ^{b}

$^{a, b, c:}$ Differences between groups with different letters on the same line are important (P<0,05)

It was determined that the TP level was the highest in sheep milk, which was statistically significant (P <0.05). It was determined that the TP level decreased in buffalo, goat, and cow milk samples, respectively, but the difference between them was not statistically significant (P> 0.05). It was determined that the globulin level was the highest in sheep milk, which was statistically significant (P <0.05). Later, it was determined that the difference between the GLO levels in buffalo, cow, and goat milk samples was not statistically significant (P> 0.05). We determined that the highest ALB level was in sheep milk and goat, buffalo, and cow milk, respectively. It was determined that the difference between sheep and goat milk was not statistically significant (P> 0.05). Albumin level was slightly higher in buffalo milk than cow milk, but this was not statistically significant (P> 0.05). TG level was statistically higher in goat milk samples (P <0.05) significantly. Later, it was found in buffalo, sheep, and cow milk samples, respectively. It was determined that the TG levels of cow and sheep milk samples were very close to each other (Figure 2). It was determined that the TC level was the highest in sheep milk, which was statistically significant (P <0.05). Afterward, it was determined that TC levels came from cow, buffalo, and goat milk, respectively (P <0.05).

Some Mineral Levels in Milk Serum: Average and standard errors values (mean ± SE) of Ca, Mg, Fe, Zn levels in goat, cow, sheep, and buffalo milk serum are presented in Table 2 and Figure 1.

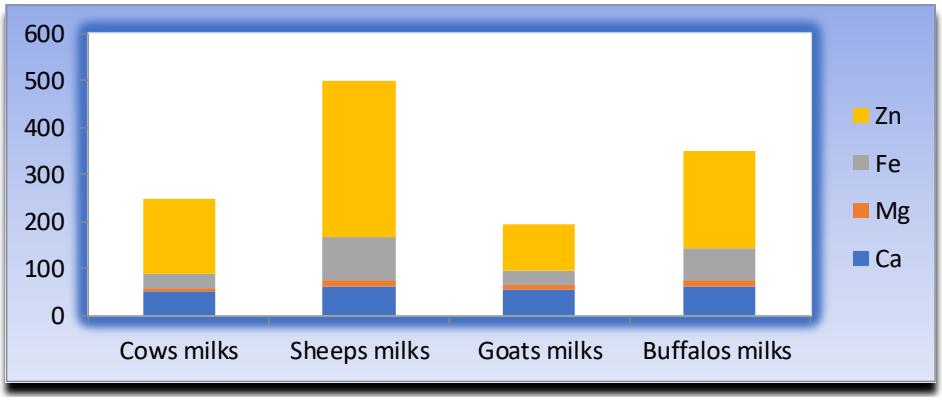

Figure 1. Mineral values of different milk samples.

Table 2. Calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn) levels in the serum of cow, sheep, goat and buffalo milk.

	Cow milk	Sheep milk	Goat milk	Buffalo milk
Ca (mg/dl)	50,81±1,26 [b]	62,72±0,29 [c]	55,48±1,04 [a]	62,45±1,32 [c]
Mg (mg/dl)	9,18±0,29 [b]	13,89±0,54 [c]	10,67±0,29 [a]	13,29±0,28 [c]
Fe (µg/dl)	29,20±7,4 [a]	90,0±9 [c]	30,29±5,17 [a]	66,58±8,77 [b]
Zn(µg/dl)	158,74±15,82 [ab]	331,62±44,87 [c]	98,53±7,19 [a]	207,65±43,47 [b]

[a, b, c :] Differences between groups with different letters on the same line are important (P<0,05)

When the Ca level was compared in different milk samples, it was determined that the highest Ca level was found in sheep and buffalo milk. However, the difference between these two species was not statistically significant (P>0.05). It was determined that Ca levels decreased in goat and cow milk, respectively, and the difference between them was statistically significant (P <0.05). It was determined that the highest amount of Mg was found in buffalo, and sheep milk and the difference between their levels was not statistically significant (P>0.05). Mg levels were found to be decreased in goat's and cow's milk, respectively (P<0.05). The Fe level was statistically significant in sheep milk (P<0.05). It was determined that the Fe level was statistically significant in sheep milk (P<0.05). It was later determined that the Fe level was high in buffalo milk (P <0.05), the Fe level was very close to each other in goat and cow milk, but the difference was not statistically significant between the two (P> 0.05). Zn level was statistically significantly higher in sheep milk (P> 0.05). It was determined that Zn level decreased in buffalo, cow and goat milk. It was determined that the difference between cow milk and goat and buffalo milk was not statistically significant (P> 0.05). In contrast the difference between goat and buffalo milk was statistically significant (P <0.05).

α-S1-casein and β-lactoglobulin Levels in Milk Serum: The average and standard error values (mean ± SE) of α-S1-casein and β-lactoglobulin levels in the serums of goat, cow, sheep, and buffalo milk are presented in Table 3.

Table 3. α-S1-casein and β-lactoglobulin levels in cow, sheep, goat and buffalo milk.

	α-S1-casein (µg/L)	β-lactoglobulin (µg/L)
Cow milk	1,40±0,089 [b]	23,19±2,84 [b]
Sheep milk	1,51±0,101 [c]	26,38±2,62 [c]
Goat milk	1,29±0,107 [a]	20,06±3,63 [a]
Buffalo milk	1,33±0,119 [ab]	22,34±3,29 [ab]

[a, b, c :] Differences between groups with different letters on the same column are important (P<0,05).

It was determined that the α-S1-casein fraction amount of casein was the highest in sheep milk (P<0.05). Later, it was determined that the level decreased in cow and buffalo milk, respectively, but the difference between them was not statistically significant (P>0.05). The lowest α-S1-casein level was found in goat's milk. It was determined that β-lactoglobulin level in different milk samples was highest in sheep milk, which was statistically significant (P<0.05). It was determined that β-lactoglobulin levels decreased in cow and buffalo milk samples, respectively, and the lowest level was in goat milk. It was determined that the difference between goat milk and buffalo milk was not significant (P>0.05), but the difference between goat and sheep and cow milk was statistically significant (P <0.05).

Discussion and Conclusion

Milk is considered one of the most important foods for humans. Consumption of dairy products containing probiotic bacteria or prebiotic components for these bacteria is common due to their delicious taste and positive physiological effects. (Yerlikaya, 2014). It has been reported that 85 % of world milk production is from cows, 11% from buffalo, 2.3% from goats, 1.4% from sheep, and 0.2% from camel milk (FAO, 2015).

The most crucial nutritional benefit of milk is its high protein content. Approximately 80% of the

protein contents of milk is casein, and 20% is serum proteins (Ambrosini et al., 1988). Serum proteins consist of the α- and β-lactoalbumin fractions. It has been reported that the amino acid sequence in all milk belonging to different species is very similar to each other (Hayam et al., 2017; Jandal, 1996) and those caseins are composed of casein proteins with slight changes in the relative proportions (Ono et al., 1989; Richardson et al., 1974). The levels of casein in milk vary between species. It has been reported that the amount of casein in milk (%, w / w) was found in the highest sheep (4.6), followed by buffalo (3.6), goat (3), and the lowest amount in cow's milk (2.6) (Walstra et al., 2006). As a result of the dendrogram made with the α -S1-casein amino acid sequence data in milk, it was reported that the mRNA gene sequence of bovine, buffalo, sheep, and goat milk were similar to each otherbut different in pigs, camels, horses and humans (Sukla et al., 2007). It has been reported that the amino acid sequence of the buffalo's cDNA is most similar to that of cattle (95.3 %), then goat (86.5 %), and sheep (84.5 %) (Sukla et al., 2007). Different milk proteins (e.g. α-lactalbumin, serum albumin, lactoferrin) may cause allergic reactions. The casein fractions and β -lactoglobulin seems to be the most common milk allergens (El-Agamy, 2007). β -lactoglobulin is absent in human milk and has not been detected in camel and lama milk. It is present at relatively high concentrations in bovine, buffalo, sheep, goat milk, and horse and donkey milk. Compared to human and equine casein, ruminant casein (except for some goat milk) is relatively abundant with α-S1-casein, which is assumed to be a predominant factor in the development of or sensitization to milk allergy (Barlowska et al., 2011; Malacarne et al., 2002; Potocnik et al., 2011). In our study, it was determined that the α-S1-casein fraction amount of casein was at the highest level in sheep milk ($P < 0.05$), then it was in cow and buffalo milk, respectively, on the other hand, the differences among them were not statistically significant ($P > 0.05$). The lowest level of α-S1-casein was found in goat milk. α-S1-casein has been reported to be an essential allergen due to its IgE and T cell recognition reactions (Ruiter et al., 2007; Spuergin et al., 1996). Studies have reported that goat milk contains less α-S1-casein than cow's milk (Clark and Shebron, 2000; Martin et al., 2002). Various studies have reported that low levels of α-S1-casein in goat's milk reduce its allergenic effects (Bevilacqua et al., 2001). It is reported in the developed countries that, in the light of current trends preferring a healthy diet, the interest in goat milk and its derivatives, which are of particular importance with their quality, is increasing (Barrionuevo et al., 2002; Sampelayo et al., 2002).

Our research discovered that the highest level of β-lactoglobulin in different milk samples was found in sheep milk, which was statistically significant ($P < 0.05$). The β-lactoglobulin level was later determined in cow and buffalo milk samples, respectively, and the lowest in goat milk. It was determined that the differences between goat and buffalo milk were not significant ($P > 0.05$), and the difference among goat, sheep, and cow milk was statistically significant ($P < 0.05$). The digestibility of individual milk proteins from different species differs as well. For example, horse β-lactoglobulin is more easy to digest than goat β-lactoglobulin (Inglingstad et al., 2010), and goat and sheep β-lactoglobulins are easier digestible than bovine β -lactoglobulin (Michaelidou, 2008; Uniacke- Lowe et al., 2010). Goat milk had the lowest level of β-lactoglobulin, followed by cow's milk, while sheep milk had the most significant level (Law, 1995; Ruprichova et al., 2014).

The TP level in sheep milk was statistically considerably higher ($P < 0.05$). Later, it was determined that the TP level was found in buffalo, goat, and cow milk samples, respectively, and the difference among them was not statistically significant ($P > 0.05$). Parallel to our study, it has been reported that the TP content is the highest in sheep milk and then found in buffalo, goat, and cow milk, respectively (Borkova and Snalova, 2005; Guetouache et al., 2014; Gürsoy, 2015; Mahmood and Usman, 2010). In comparing of mountain and upland areas (Kedzierska-Matysek et al., 2015), significantly higher protein content in the raw milk obtained from the mountains was found. The high TP level in sheep milk provides advantages in the nutritional value of milk and the production of cheese, yogurt, butter, and casein. It can be said that the nutritional value of yogurt or cheese made from sheep's milk is higher than the other animal milk. However, this high TP level causes sheep milk to be more challenging to digest.

ALB and GLO levels were substantially greater in sheep milk than in other forms of milk in our investigation. The highest level of ALB was found in goat milk, followed by sheep's milk, buffalo, and cow's milk at the lowest level. It has been reported that high levels of ALB cause low digestibility and, if consumed too much, may cause digestive system problems. The GLO level in goat milk was found to be at the lowest level in our investigation. GLO deficiency in the body causes the immune system to weaken and susceptibility to acute or chronic diseases. GLO plays a vital role in fighting antigens in the body and removing toxins. For this reason, it is essential to have an adequate level in the body. In our study, it was determined that the highest GLO level was found in sheep milk. Experts also

recommend that people with some stomach and intestinal diseases should not consume products made with sheep's milk. The A/G ratio is critical in clinical pathology for classifying electrophoretic profiles and detecting dysproteinemia (Kaneko, 1997). It was determined that the milk with the highest ALB / GLO ratio was goat milk. It was determined that the milk with the highest ALB / GLO ratio was goat milk.

The level of TG in goat milk was found to be the highest in our investigation (P< 0.05), followed by buffalo, sheep, and goat milk, respectively. In parallel with our study, it has been reported that the fatty acids in goat milk constitute 15-18% of the total fatty acids, and this ratio is approximately 5-9% in cow milk (Park et al., 2007). Compared to cow's milk, butyric, myristic, palmitic, and linoleic acid content in goat milk is higher, but stearic and oleic acid content is reported to be lower (Haenlein, 2004). On the other hand, it is reported in the literature that goat and sheep's milk oils contain low butyric acid but high levels of caproic, caprylic, and capric acid (Walstra et al., 2006).

Cholesterol is mainly linked to cardiovascular illness, but it is also found in body cell membranes and the central nervous system (Dietschy Turley, 2004; Gidding et al., 2006). Although the results are not conclusive, it has been proposed that human milk cholesterol is responsible for the long-term regulation of cholesterol metabolism and myelin formation. (Gidding et al., 2006; Schanler, 2011). The TC level in sheep milk was the highest, which was statistically significant. Following that, it was discovered that TC levels were derived from cow, buffalo, and goat milk, respectively (P <0.05). Ca levels were highest in sheep and buffalo milk, followed by goat and cow milk, respectively. Parallel to our research, it was shown that sheep milk had the highest concentration of Ca, followed by goat and cow milk. In our research, the Mg levels in sheep and buffalo milk were shown to be the highest (Balthazar et al., 2017). Hayam et al. (2017) reported that Ca was the highest in sheep milk and buffalo, cow, and goat milk, respectively. In another study conducted by Raynal-Ljutovac (2007), the calcium ratios of human, goat, and sheep milk were compared. Similar to our research, sheep milk was higher in terms of Ca ratio than other milk. The bioavailability of minerals in sheep milk ensures that sheep milk is a valuable source of these elements. It has been reported that Ca, which is bound to casein in both organic and mineral forms, has an important use in the milk digestion process (Gueguen and Pointillart, 2000). In our research, the Mg levels in sheep and buffalo milk were shown to be the highest. It was later discovered that it was found at the lowest levels in goat and cow milk, respectively. In a study conducted concurrently with ours, the highest Mg levels were discovered in sheep milk, followed by goat and cow milk, respectively (Balthazar et al., 2017). The Mg content of cow milk is determined in the range of 100 to 150 mg $dm^{-3.}$ Mg concentrations are correlated with the calcium content of milk (Micinski et al., 2013). Taking Mg into the body at regular intervals plays a vital role. Although the distributions of calcium, phosphorus, and magnesium in the soluble and colloidal phases of milk are similar for cow and goat milk, sheep milk differs from them because it has lower solubility (Hilali et al., 2011). In the study conducted by Hayam et al. (2017) in Egypt, it was reported that the highest Mg content was determined in buffalo milk, followed by sheep, cow, and goat milk.

Our research discovered that sheep milk had the highest Fe level, followed by buffalos, goat, and cow milk. It was determined that the difference between the Fe levels of sheep and buffalo milk was significant (P <0.05), but the difference in Fe levels between cow and goat milk was not statistically significant (P> 0.05). A study reported that the amount of Fe was highest in sheep and cow milk, while the lowest was found in goat milk (Balthazar et al., 2017). In another study, it was determined that the bioavailability of Fe was higher in goat's milk than cow's milk (Raynal-Ljutovac et al., 2008). This result could be related to the higher amount of nucleotides in the intestines, ensuring better absorption.

Zn level in sheep milk was statistically significantly higher in our study (P <0.05). According to the findings, this was followed by buffalos, cow, and goat milk. Sheep milk had the greatest Zn concentration in studies conducted concurrently with our investigation, and cow and goat milk had similar values (Balthazar et al., 2017; Hayam et al., 2017). Another study reported that Anglo-Nubian goat milk contains significantly higher amounts of Cu and Zn than French Alpine goat milk (Park, 2007). In zinc deficiency, symptoms such as growth retardation (dwarfism), delayed development of the sex organs, lack of resistance to diseases, delayed healing of wounds, disorders in taste and smell perception are observed (Raynal-Ljutovac, 2008).

It was concluded that α-S1-casein and β-lactoglobulin levels in goat milk are lower than in other milk samples (cow, sheep, and buffalo), and it can be recommended for those with milk allergies.

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Congress (2019) and summarized from the author's master's thesis with the same name.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Ethical Approval

This study is not subject to HADYEK's permission in accordance with Article 8 (k) of the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees".

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