

Determination of some heavy metal and mineral contents microbiological and chemical properties of Çökelek cheeses

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Abstract

The Çökelek samples what 30 different, were collected from randomly local bazaars to investigate heavy metal contaminant and mineral levels and some physicochemical and microbiological properties of samples. The As was detected in the 4 of 30 samples, while the Pb was determined in the 6 of 30 samples. The mean major and trace element contents of Çökelek samples were ordered as Na > P > Ca > K > Mg and Al > Zn > Ni > Cu, respectively. The physicochemical properties indicated a high deviation among samples. The mean total solids, ash, salt, fat, protein waters soluble nitrogen contents and ripening index of samples were 29.83%, 1.88%, 0.68%, 4.31%, 19.84%, 0.33%, and 1.79%, respectively. The mean TAMB count of Çökelek samples were found as 8.26 log CFU g⁻¹. The coliform bacteria and yeast-mold counts were detected in 11 and 27 of 30 samples, respectively. The mean coliform and yeast-mold counts were 1.82 log CFU g⁻¹ and 7.11 log CFU g⁻¹, respectively. There are not mentioned traditional cheeses in the legal rules such as the Turkish Food Codex. So, there is no legal limit and standard production processes. This situation is a problem in terms of traditional cheese quality. For this reason, traditional cheese should perform a further studied, and determine the legal limits.

Introduction

There are many kinds of produced traditional or industrial cheeses in Turkey. The most known cheeses types were Turkish white, Kashar, Tulum, Çökelek ,and Lor cheeses in Turkey [1]. Çökelek cheese has been known as the same as Lor. But Çökelek cheese is different from Lor in terms of production process and composition. Because Çökelek cheese is made from yoghurt and buttermilk, while Lor is produced from whey [2, 3].

The Çökelek cheese is usually manufactured as traditional in every place in Turkey. It is called many different names according to producing region such as Ekşimik, Akçakatık (Akkatık), Keş, Minci etc. [2–4]. The Çökelek cheese has a high consumption level in Turkey [5]. It has an important role in Turkish cuisine, especially breakfast [6].

The Çökelek cheese is produced from the straining of yoghurt or buttermilk which is acidified and heated. It has low fat, low calorie, and high protein content, and it is cheap [2, 7]. Additionally, an advantage is for health that it contains low fat or non-fat [8]. Especially the Çökelek cheese is one of the most important dairy products for low-income families [2, 7]. But, some component contents such as protein, fat, lactose, some vitamins (thiamin, riboflavin), and minerals could be removed due to the filtration process [1].

One of the vital nutrients in milk and dairy products is minerals [9]. Minerals are essential for humans, and they have many physiological functions in the human body such as enzymes and hormonal structure ,and regulative [10, 11]. Milk and dairy products containing major and trace elements can include contaminants such as heavy metals. Some heavy metals could be ordered as lead (Pb), mercury (Hg), arsenic (As) ,and cadmium (Cd) [12]. These heavy metals have toxic and some harmful effects on humans. Heavy metals ingested by humans may lead to serious health problems such as kidney failure,

genetic mutations, nervous system disorders, cardiovascular problems, many types of cancers, respiratory disorders, a weak immune system, and infertility [9, 11]. The heavy metals entranceways to humans can be via the consumption of dairy products and meat. Because the plant absorbs heavy metals from polluted water or soil and storage. The contaminated plants are eaten by animals and accumulate heavy metals in their tissue or are passed to milk. So, milk and dairy products have risks in terms of heavy metals contamination [9, 12].

The microbiological properties of products such as especially pathogenic and spoilage bacteria are affected in the determination of the shelf-life of foods [13]. The high protein, moisture, lactose level, high pH, low salt content, and non-hygienic production process in cheese are eased microbial contamination from the environmental [14–16]. The microorganisms can affect the sensory properties of cheese due to decomposing protein and fat and can lead to health problems and toxic compounds [17].

There is not a standard production process for the Çökelek cheese, and it is produced under poor hygienic conditions and in small firms [1]. So, its microbiological quality is very low. Milk and dairy products are a wonderful medium for pathogenic bacteria and other microorganisms [1, 18]. Yeast and molds are an important problem for Çökelek in its spoilage and shelf life [6].

Some researchers investigate some properties of Çökelek cheese [1, 2, 18]. But the studies are not sufficient of Çökelek cheeses for the exhibition of their properties. This research aimed that Çökelek cheese of heavy, mineral contents, microbiological and physicochemical properties determined.

Materials And Methods

Çökelek cheeses (30 different samples) were collected from different districts bazaars of Trabzon province, Turkey. The samples were conveyed with a sterile cup and under a cold chain (+4 °C) to the Şiran Mustafa Beyaz Vocational School Food Laboratory. And samples were kept in the refrigerator (+4 °C) until analysis.

Heavy metal and mineral content

To determine heavy metals levels and the mineral composition of the Çökelek cheeses were used Inductively Coupled Plasma–Mass Spectrometer (ICP-MS). The samples were prepared with a wet-burning method using a microwave oven. The defined by Güler [19] method was used. The mineral content of one sample could not be detected.

Chemical analysis

Total solids (%), total nitrogen (TN) (%), titratable acidity (% LA), and salt (%) contents of the Çökelek cheese samples were determined according to AOAC methods [20]. To determine the protein contents of samples multiplied the total nitrogen amount by 6.38. The fat ratio was determined by the Gerber method [21]. A pH meter was used for pH measurements. The water-soluble nitrogen (WSN) of samples

was determined with the method described by Bütikofer et al. [22]. The Khejdahl method was used to determine the WSN ratio [20]. The Ripening Index was calculated using equation (WSN/TN) x100.

Microbiological analysis

Weighted as 10 g from Çökelek cheese samples were placed into 90 mL sterile sodium chloride (NaCl) solutions (0.85% w/v). Then, other dilutions were prepared as decimals. *Lactobacillus* bacteria counts were determined using De Man, Rogosa, Sharpe Agar (MRS agar; Merck, Darmstadt, Germany). The medium was incubated at 30 °C for 72 h, anaerobically [23]. M17 agar (modified Rogosa; Merck, Darmstadt, Germany) was incubated at 37 °C for 3 d in aerobic conditions for the determination of *Streptococcus* bacteria count [24]. Total aerobic mesophilic bacteria (TAMB) number was determined in Plate Count Agar (PCA; Merck, Darmstadt, Germany) after incubating at 30 °C for 72 h [25]. Coliform bacteria colonies were counted on the Violet Red Bile Agar (VRBA; Merck, Darmstadt, Germany) after incubated at 37 °C for 48 h [26]. Potato Dextrose Agar (PDA; Merck, Darmstadt, Germany) was used to count yeast and mold colonies. For this, PDA was incubated at 25 °C for 5 d [27].

Statistical analysis

All obtained data were evaluated using SPSS 17 statistical program. Max, min values, and standard deviations of all data were indicated.

Results And Discussion

Heavy metal and mineral contents

Heavy metal contents

Heavy metals are toxic to humans, and they can be caused serious health problems [12, 28]. Milk and dairy products have risks in terms of some heavy metals such as Pb, Cd, As, Hg, Mg, and Sn [29].

The maximum level of Pb must be 0.02 mg kg⁻¹ in milk and dairy products according to Alimentarius Commission Codex [30] and Turkish Food Codex [31]. In the present study, the Pb was determined on 5 of 30 samples. The levels of samples containing lead changed from 0.00 mg kg⁻¹ and 0.26 mg kg⁻¹, and the Pb levels of these samples did not comply with Alimentarius Commission Codex [30] and Turkish Food Codex [31] except for one sample (Table 1).

Sidawi et al. [9] determined the mean Pb levels of Imeruli and Sulguni cheeses as 0.121 mg kg⁻¹ and 0.258 mg kg⁻¹, respectively. Öksüztepe et al. [32] found that none of the samples have Pb contaminant sold in Elazığ. Dağcılar and Gezer [12] investigated heavy metal concentrations of Halloumi, Kashar, White, and Lor cheese samples in Northern Cyprus. They were not detected Pb content in Kashar, White, and Lor cheese samples, but the mean Pb content of Halloumi samples was found as 0.035 mg kg⁻¹.

¹. Meshref et al. [28] found that the Pb level of Kareish cheese samples which is one traditional cheese of Egypt was a minimum of 0.194 mg kg⁻¹, a maximum of 0.6495 mg kg⁻¹, and a mean of 0.43 mg kg⁻¹.

Pb is among the most dangerous toxic elements for human health [12]. The water, soil, and air could be polluted by industrial actions, fertilizers, motor vehicles, and pesticides. Pb passes into indirectly plants and animals [33]. Pb contamination in cheese samples might be caused directly or indirectly by water, air, and soil, in addition to equipment used in transporting and producing milk [12, 33].

As is a toxic heavy metal that widely exists in the environment, particularly in water, air, soil, and rocks, causing contamination of plants, animals, and consequently edible food [33]. There is no information about the maximum level of As in milk and dairy products in legislation rules [30, 31]. But according to World Health Organization [34] intake allowable weekly level for As must not be in excess of 0.015 mg kg⁻¹. As contamination was determined in 4 of 30 cheese samples. The levels of samples detected As changed between 0.01 mg kg⁻¹ and 0.08 0.015 mg kg⁻¹ (Table 1). Öksüztepe et al. [32] reported that arsenic detected none of Çökelek and Kurut samples. Özlü et al. [35] did not determine As contamination in fresh and ripened Kashar samples. As levels of samples in some researches were determined as 0.11 mg kg⁻¹ (Kashar cheese, Turkey) [36], 0.00066 mg kg⁻¹ (Ior, Northern Cyprus) [12], 0.002-0.020 mg kg⁻¹ (Kashk, Iran) [11].

It has been stated As the level could have been increased depending on the high use of pesticides, herbicides, and insecticides in agriculture [12]. Additionally, groundwater and drinking water may include high-level As. And their use in livestock has led to an increase in As level in dairy products [33]. In general, heavy metal levels of milk and dairy products could be affected by many factors from the milk production conditions to cheese production equipment.

Mineral contents

Milk and dairy products contain some major trace elements [37]. Although the trace elements need which present at low levels, in vital functions of humans, their high doses are harmful and cause health problems [9, 11]. Especially milk and dairy products have potentially more at risk than other foods due to consumption by infants and the elderly [9]. In the presented study, major elements such as Ca, Na, Mg, K, P, and trace elements such as S, Al, Ni, Cu, and Zn were determined in Çökelek samples (Table 1).

The Ca, Na, Mg, K, P values of samples were between sequentially 19.25-713 mg kg⁻¹, 22.75-9035 mg kg⁻¹, 14.86-246.85 mg kg⁻¹, 52.21-298.59 mg kg⁻¹, 718.64-5735.22 mg kg⁻¹ (Table 1). Öksüztepe et al. [32] determined that Ca, Na, Mg, K, P mean contents of Çökelek cheeses were 327.76, 620.40, 136.11, 1142.24 and 67.46 mg kg⁻¹ sold in Elazığ, respectively. The mineral contents of milk have been affected by the feeding, age, and lactation stage of animals [35].

Al is one of the most plentiful minerals the substantial in the world, and it uses in many different industries such as food (packing, additives), painting, and the cosmetic industry. There is no evidence of

its toxic effects on humans [34]. Al contents of samples were between 0.00 and 134.35 mg kg⁻¹ (Table 1). Öksüztepe et al. [32] who study heavy metal and mineral contents of Çökelek and Kurut samples (n=25) sold in Elazığ markets, Turkey, found the mean Al content as 3.05 mg kg⁻¹.

The high Ni concentration might cause neurotoxicity, oxidative stress, and breakdown of the male reproductive system [9]. The limit level for nickel was reported that it should be less than 0.027 mg L⁻¹ in milk and cheese [9]. But, there is no information in legal rules about the Ni level. The Ni content of the samples changed between 0.02 mg kg⁻¹ and 0.85 mg kg⁻¹, and the mean value in the samples was 0.31 mg kg⁻¹ (Table 1). Öksüztepe et al. [32] did not detect Ni content in any Çökelek and Kurut samples sold in Elazığ. The Ni level of traditional cheese samples produced in Georgia was determined as 0.011 mg kg⁻¹ (Imeruli cheese) and 0.026 mg kg⁻¹ (Sulguni) by Sidawi et al. (2021). In the presented study, Ni levels were higher than those reported as allowable levels, as reported by Öksüztepe et al. [32], and reported by Sidawi et al. (2021).

Cu is one of the important elements for many human physiological events such as sufficient growth, cardiovascular system, the elasticity of the lungs, neuroendocrine function, and iron metabolism [9, 28, 34]. Despite, excessive Cu intake may lead to some health problems (gastrointestinal disorders, immunity problems, liver cirrhosis, neurological disorders, and dermatitis) [28]. The permissible level of Cu has been mentioned in the legal rules in milk and dairy products. The highest and the lowest Cu concentration in Çökelek samples were determined as 2.40 mg kg⁻¹ and 0.09 mg kg⁻¹, respectively (Table 1). Öksüztepe et al. [32] found the lowest Cu level as 0.41 mg kg⁻¹, the highest at 1.81 mg kg⁻¹, and the mean Cu level as 1.13 mg kg⁻¹ in Çökelek samples. Dağcılar and Gezer [12] reported that the mean Cu content of Halloumi, Kashar, White, and Lor cheese samples sold in Northern Cyprus was 0.591 mg kg⁻¹, 0.270 mg kg⁻¹, 0.300 mg kg⁻¹, and 0.246 mg kg⁻¹, respectively. Meshref et al. [28] determined that the Cu of traditional Kareish cheese sold in Egypt was between 0.002 mg kg⁻¹ and 0.53 mg kg⁻¹. The obtained the highest Cu content was higher than those reported by Öksüztepe et al. [32], Meshref et al. [28], and Dağcılar and Gezer [12].

Zn is one of the essential minerals for vital. Zn has important effects on many physiological functions such as sexual maturation, the immune system, and insulin secretion. Additionally, it contributes metabolism of protein, carbohydrates, lipid, and nucleic acid. All these functions of Zn are caused by the contribution to the many enzymes structure [9, 28, 33]. Excessive Zn intake may lead to anemia, gastrointestinal diseases, vomiting, fever, and lethargy [9, 34]. Zn values of the Çökelek samples were between 0.93 mg kg⁻¹ and 11.94 mg kg⁻¹, respectively (Table 1). The mean Zn level of Çökelek and Kurut samples were found as 4.19 mg kg⁻¹ and 9.66 mg kg⁻¹, respectively by Öksüztepe et al. [32]. The researchers determined the Zn levels of some traditional cheese as 8.59 mg kg⁻¹ (Kareish cheese, Egypt) [28], 0.07586-0.1248 mg kg⁻¹ (Imeruli and Sulguni, Georgia) [9]. It is thought the mineral content of Çökelek samples may change depending on factors of the animal reasons, used equipment in all processes, and packing material.

Chemical properties

There is no information or legal rules about the chemical and microbiological properties of Çökelek cheese in the Turkish Food Codex [38]. But, some properties of Lor cheese are determined in the Turkish Food Codex [38]. The Çökelek and Lor cheese are similar, but not the same [2, 3].

The physicochemical properties of Çökelek cheese were shown in Table 2. The total solids values of samples changed between 18.32% and 45.88%, and the mean value of 30 cheese samples was 29.83%. Kavaz et al. [2] found the total solids levels of the Çökelek and Lor samples as 47.85% and 36.60, respectively. Çardak [1] investigated some microbiological and chemical properties of 25 Çökelek samples. He found the total solids content of samples between 45.64% and 83.55%. The obtained results in the study were lower than those reported by Kavaz et al. [2] and by Çardak [1]. According to the Turkish Food Codex, Lor cheese must contain 25% at the least total solid [38]. The total solids content of the 6 of 30 samples (Fig. 1) did not comply with the Turkish Food Codex [38].

The minimum, maximum, and mean values of belongings to ash were 0.61%, 8.46%, and 1.88%, respectively. The researches were determined the mean ash content of Çökelek samples as 2.60% [39], 2.14% [18], 4.04% [2], 1. % [7]. The reported results by other researchers were higher than those of the present study except for that reported by Celem et al. [7].

The lowest and highest salt values of samples were 0.61% and 6.67% (Table 2). The Turkish Food Codex reported that the highest salt content of Lor cheese must be 6.00%. Only the salt level of one sample was not in harmony with the Turkish Food Codex [38]. Celem et al. [7] examined some properties of 20 Çökelek samples collected from markets in Malatya, Turkey. They found the minimum, maximum, and mean salt values of samples as 0.1%, 1.8%, and 0.3%, respectively. Öksüztepe et al. [18] determined the salt between 0.21% and 0.76% level of Çökelek samples.

The fat values of Çökelek samples were indicated in Table 2. The mean fat value of samples was determined as 4.31%, while fat values were between 0.25% and 13.50%. In the performed studies regarding Çökelek, the mean fat levels of samples were 1.2% [39], 1.38 [18], 15.43 [1], 1.6% [7]. The fat values reported by Ağaoğlu et al. (1996), Öksüztepe et al. [18], and Celem et al. [7] were lower than the herein results, whereas the determined values by Çardak [1] were higher.

The protein and WSN values of the samples changed between 11.32-27.45% and 0.09-1.18%, respectively. Sagdic et al. [40] found protein and WSN values between 11.36% and 14.99%, 0.15% and 0.21%, respectively when studying some properties of surk cheese (a traditional Turkish cheese) samples containing thyme and pepper. Çardak [1] found min, max, and mean protein values of Çökelek samples as 16.59%, 42.75%, and 25.95%, respectively.

The RI of the samples was between 0.61% and 5.57% (Table 2). The RI values of Çökelek and Lor cheese samples were determined as 2.11% and 2.63%, respectively by Kavaz et al. [2]. Sagdic et al. [40] determined that surk samples changed from 6.45% to 9.48%. Dervisoglu et al. [4] found the RI values of Kes cheese samples between 1.79-28.53%. It has been stated that the proteolysis level of the Çökelek

cheese could be low. Because the production has been not used any enzymes or is low enzymatic activity of natural microbiota and enzymes in the product due to heat in the production process [7].

As seen in Table 2, the acidity values of samples changed from 0.19% and 1.34%. Celem et al. [7] determined the lowest and highest acidity values in fresh Çökelek samples as 0.4-0.8%, in skin-ripened Çökelek as 0.4-0.9%. Kavaz et al. [2] found that the mean acidity level of the Çökelek sample was 0.28%.

The pH values of Çökelek samples were determined as the lowest at 3.43, the highest at 6.49, and the mean at 4.40. The mean pH values of Çökelek samples were found by Ağaoğlu et al. (1996) as 4.87, by Çardak [1] as 3.79, by Kavaz et al. [2] as 4.51, by Celem et al. [7] as 3.8 in fresh Çökelek and 4.6 in skin-ripened Çökelek.

The physicochemical properties of samples demonstrated high changes in the present study. The changes might have been caused by the absence of a standard production process and legal rules about Çökelek cheese.

Microbiological properties

TAMB counts in dairy products demonstrate low hygienic quality in milk, insufficient pasteurization, and cross-contamination. The TAMB counts are a serious problem for food safety [15, 17]. TAMB counts of samples were a minimum of $6.74 \log \text{CFU g}^{-1}$, a maximum of $8.99 \log \text{CFU g}^{-1}$ and a mean of $8.26 \log \text{CFU g}^{-1}$ (Table 3). Öksüztepe et al. [18] investigated the microbiological properties of Çökelek cheese sold in Elazığ at markets. They found that the TAMB mean count was $8.46 \log \text{CFU g}^{-1}$. Çardak [1] determined that the TAMB count of Çökelek samples collected from Aydın province was between 4.49 and $6.89 \log \text{CFU g}^{-1}$. Şanlı and Anlı (2020) reported that TAMB count of Çökelek samples changed from $3.31 \log \text{CFU g}^{-1}$ to $3.58 \log \text{CFU g}^{-1}$ during 28 days of storage. The obtained results in the study are similar to those determined by Öksüztepe et al. [18] but were higher compared to those found by Çardak [1] and Şanlı and Anlı (2020).

The coliforms are one of the important indicator microorganisms the during cheese production process and then after [17]. As seen in Table 3, coliform bacteria counts were between <2 and $5.92 \log \text{CFU g}^{-1}$. The Coliform bacteria mean count ($1.82 \log \text{CFU g}^{-1}$) of samples was higher than those reported by Öksüztepe et al. [18], Kavaz et al. [2], and Celem et al. [7], but it was lower than those of found by Çardak [1], Önganer and Kırbağ (2009).

The yeast and molds are important microorganisms species in dairy technology as contaminated [14, 42]. The yeast and mold counts were demonstrated in Table 3. Yeast and mold counts of samples ranged from <2 to $8.57 \log \text{CFU g}^{-1}$, and the mean count was $7.11 \log \text{CFU g}^{-1}$. The yeast and mold mean counts were determined by Celem et al. [7] (fresh Çökelek $7.26 \log \text{CFU g}^{-1}$ and ripened Çökelek $8.13 \log \text{CFU g}^{-1}$) and by Çardak [1] ($7.49 \log \text{CFU g}^{-1}$) are similar to the mean yeast and mold counts of the samples analyzed in the presented study, while the mean yeast and mold counts in the studies by Ağaoğlu et al.

(1996) ($5.11 \log \text{CFU g}^{-1}$) Öksüztepe et al. [18] ($3.10 \log \text{CFU g}^{-1}$), Kavaz et al. [2] ($5.62 \log \text{CFU g}^{-1}$), were higher.

The microbiological properties of cheese could have been changed depending on the cheese production process, storage conditions, kind of cheese, and physicochemical characteristics [43]. There is no legal standard in the Turkish Food Codex about the quality criteria of Çökelek cheese. Additionally, Çökelek cheese has been generally produced traditionally and sold in local bazaars. So, Çökelek has not the standard production process. This situation could be caused problems with hygienic conditions, and microbial contaminations. The differences in the microbiological properties might have been caused by mentioned above conditions.

Conclusion

Some samples determined heavy metal contaminants that have harmful effects on human health. The mineral composition of samples indicated a certain change depending on many factors. The physicochemical properties of Çökelek samples showed high differences. The samples had low WSN and RI values due to limited proteolysis. The coliform and yeast-mold counts of samples were determined as $< 2 \log \text{CFU g}^{-1}$ in 19 and 2 of 30 samples, respectively. The TAMB counts of most of the samples were $> 8 \log \text{CFU g}^{-1}$. Çökelek cheese is a variety of traditional cheese. And, there are no legal rules regarding the chemical and microbiological properties of Çökelek cheese. So, there is not a standard production process and composition. As a result, if legal rules regarding traditional cheese are made, the chemical and microbiological properties of traditional cheese such as Çökelek will be improved.

Declarations

Author Contribution Nagihan Kalaycı: Formal analysis, Investigation, Methodology; Bayram Ürkek: Corresponding Author, Conceptualization; Data curation, Software, Writing – original draft, Writing – review & editing; Feyza Öztürk: Formal analysis, Data curation; Mustafa Şengül: Conceptualization; Writing – original draft, Writing – review & editing; Esengül Çiftçi: Formal analysis, Data curation.

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Ethical Approval Ethics approval is not required for this research that not use any human or animal.

Data Availability Statement Research data are not shared

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Tables

Table 1. Statistical analysis belongings to heavy metal and mineral content of Çökelek samples (mg kg⁻¹)

Parameters	n	Min	Max	Mean	SD (±)
As	29	-	0.08	0.04	0.03
Pb	29	-	0.26	0.14	0.11
Ca	29	19.25	713.93	156.58	190.71
Na	29	22.75	9035.33	941.11	1727.80
Mg	29	14.86	246.85	72.60	65.58
K	29	52.21	298.59	139.81	61.09
P	29	718.64	5735.22	2137.15	1141.38
Al	29	0.00	134.35	12.91	25.86
Ni	29	0.02	0.85	0.31	0.23
Cu	29	0.09	2.40	0.28	0.42
Zn	29	0.93	11.94	3.18	2.32

SD: Standard deviation

Table 2. Statistical analysis belongings to physicochemical values of Çökelek samples

Parameters	n	Min	Max	Mean	SD (±)
Total solids (%)	30	18.32	45.88	29.83	6.09
Ash (%)	30	0.61	8.46	1.88	1.75
Salt (%)	30	0.11	6.67	0.68	1.19
Fat (%)	30	0.25	13.50	4.31	3.66
Protein (%)	30	11.32	27.45	19.84	11.32
WSN	30	0.09	1.18	0.33	0.09
RI	30	0.61	5.57	1.79	0.61
Titretable acidity (% lactic acid)	30	11.32	27.45	19.84	11.32
pH	30	3.43	6.49	4.40	0.77

WSN: water soluble nitrogen; RI: ripening index; SD: standard deviation

Table 3. Statistical analysis belongings to microbiological counts of Çökelek samples (log CFU g⁻¹)

Parameters	n	Min	Max	Mean	SD (±)
TAMB	30	6.74	8.99	8.26	0.53
Coliforms	30	<2	5.92	1.82	2.38
Yeast and mould	30	<2	8.57	7.11	2.43

SD: Standard deviation

Figures

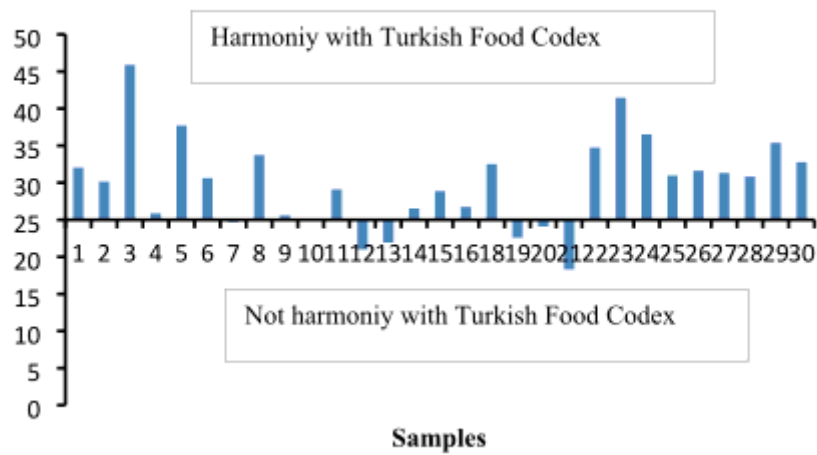


Figure 1

The total solids contents of Çökelek samples

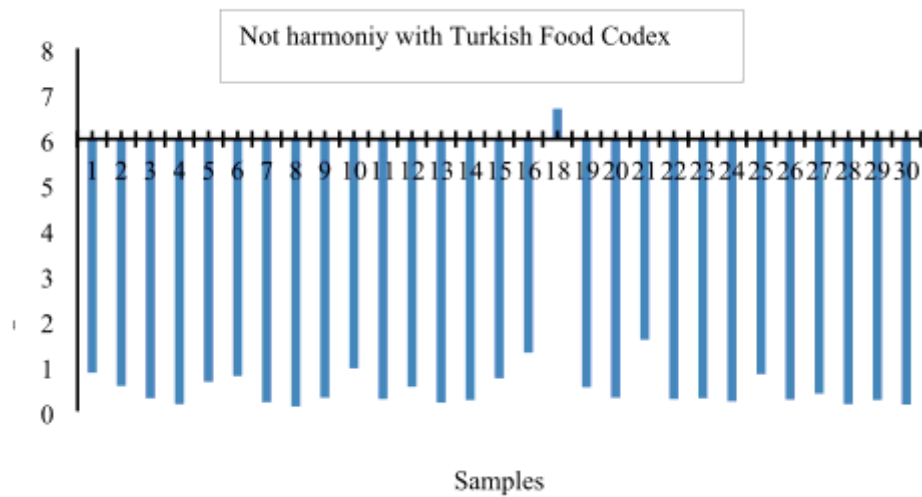


Figure 2

The salt contents of Çökelek samples.