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Determination of the Effect of Garden Cress (*Lepidium sativum* L.) on the Ripening Parameters of White Cheese

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ABSTRACT

The aim of this study is to reveal the effect of *Lepidium sativum* L. on the ripening characteristics of White cheese. A control White cheese without garden cress and White cheeses with four different concentrations of garden cress (0.6-1.2-1.8-2.4%) were produced and their dry matter, fat, and protein contents; pH and titratable acidity levels; water-soluble nitrogen (WSN) and trichloroacetic acid-soluble nitrogen (TCA-SN) were determined and electrophoretograms showing α- and β-casein degradation rates were obtained for the storage of 90 days. The addition of garden cress did not affect WSN and TCA-SN values significantly (P>0.05). Both α- and β- casein degradations increased with storage; the latter being relatively less broken down. The degradation levels for α-casein were similar for all cheese types while β-casein was more degraded when garden cress was included in the cheeses. There was no statistically significant difference between cheese samples in terms of sensory properties (P>0.05). The results suggest that garden cress may carry a β-casein specific protease and could be conveyed with White cheese successfully. This study will contribute to the limited knowledge on the utilization of garden cress in food products. Also, the application of garden cress is thought to expand the product variety in the market.

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Tere Otunun (*Lepidium sativum* L.) Beyaz Peynirin Olgunlaşma Parametrelerine Etkisinin Belirlenmesi

ÖZET

Bu çalışmanın amacı, tere otunun (*Lepidium sativum* L.) Beyaz peynirin olgunlaşması üzerine etkisini belirlemektir. Kontrol Beyaz peynir ve dört farklı tere otu konsantrasyonu (%0.6-1.2-1.8-2.4) içeren Beyaz peynirler üretilmiş ve bunların kurumadde, yağ ve protein içerikleri; pH ve titre edilebilir asitlik seviyeleri; suda çözünür azot (WSN) ve triklorasetik asit (TCA)'te-çözünür azot (TCA-SN) oranları belirlenmiş ve 90 günlük depolama süresince α- ve β-kazein parçalanma oranlarını gösteren elektroforetogramlar elde edilmiştir. Tere otu katkısının WSN ve TCA-SN oranları üzerinde istatistiksel olarak anlamlı bir etkisi tespit edilememiştir (P>0.05). Hem α- hem de β- Kazein parçalanma düzeyi, depolama periyodu boyunca artarken β-Kazeinin α-Kazeine kıyasla daha az parçalandığı gözlenmiştir. α-Kazein için parçalanma seviyeleri tüm peynir türleri için benzer iken, tere otu ilave edilen peynirlerde β-Kazeinin daha fazla parçalandığı belirlenmiştir. Duyusal özellikler açısından peynir örnekleri arasında istatistiksel olarak önemli bir farka rastlanmamıştır (P>0.05). Sonuçlar, tere otunun β-Kazeine özgü bir proteaz taşıyabileceğini ve Beyaz peynirin tere otu tüketiminde taşıyıcı olarak başarılı bir şekilde kullanılabileceğini göstermektedir. Bu çalışma, tere otunun gıda ürünlerinde kullanımı hakkındaki sınırlı bilgiye katkıda bulunacaktır. Ayrıca, tere otunun

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INTRODUCTION

Spices and herbs are usually not consumed alone but mostly used as an additive to make the foods more tasty, appealing, and presentable. With over 200 years of history, Turkish Otlu cheese is one of the best examples of herby foods containing approximately 25 different kinds of herbs including *Allium vinarale, Chaerophyllum macropodum,* and *Antriscus nemorosa*. These herbs not only give the characteristic flavor to Otlu cheese but also extend its shelf life, owing to their antimicrobial properties (Hayaloglu and Fox, 2008; Tarakci and Temiz, 2009). Also, the addition of spices to cheese reduces the need for salt thereby limits the structural problems generated due to salt (Ayar and Akyüz, 2003). Different cheese products have been fortified with a variety of spices and herbs including chili pepper, thyme, mint, cumin, nutmeg, clove, cinnamon, black pepper, cumin, oregano, and fennel to bring antimicrobial properties (Masatcıoğlu and Avşar, 2005; Shan et al., 2011; Akarca et al., 2016).

Lepidium sativum L., a member of the *Brassicaceae (Cruciferae)* family, has a short vegetation time. Except for very hot seasons, it can be grown pretty much all year long everywhere in Turkey and also in India, China, and Africa (Yanmaz et al., 2010). Annual garden cress production of Turkey was 31 tons in 2005 and with an increasing trend, it reached 2762 tons in 2019 (TSI, 2020). It is usually combined with other foods, especially when cooked, to suppress its bitter taste. The leaves are consumed either raw in salads or as cooked with vegetable curries and used as a garnish, especially in Indian and Iranian cuisines due to its spicy, tangy, and peppery flavors (Mali et al., 2007; Sharma and Agarwal, 2011). The leaves are not only important sources of macro elements such as sodium, potassium, calcium, magnesium, and phosphorus, but also rich in some trace elements such as iron, zinc, and manganese. They are also rich in vitamins A, B, C, and K (Yanmaz et al., 2010; Hassan et al., 2011). Garden cress was one of the 26 vegetables tested from the Iranian diet with an extraordinarily high antioxidant activity, even higher than that of quercetin (Souri et al., 2004). The volatile compounds acquired from crushed leaves were found to have antibacterial activity against *Bacillus subtilis* and *Micrococcus pyogenes* var. *aureus* and they also showed lower activity against *Escherichia coli* (Sharma and Agarwal, 2011). Therefore, the leaves are used as therapeutics for a variety of health issues including asthma and cough. The leaves are mildly stimulant, diuretic, and useful in scorbutic diseases and liver complaints (Mali et al., 2007). It also helps in the alleviation of anemia due to its high iron content (Jain and Grover, 2018). Finally, *L. sativum* leaves are rich in essential amino acids; isoleucine, leucine, phenylalanine, tyrosine, and valine but poor in sulfur-containing amino acids; methionine and cysteine. Due to relatively rich essential amino acid content, e.g., methionine, cheese could be a potential complementary conveyor of garden cress to fulfill the need of consuming garden cress with other foods as indicated by Hassan et al. (2011).

Recently, there has been a growing interest in the utilization of natural additives that can accelerate the ripening while contributing to the sensory properties of cheese. We believe that this is the first work on the use of garden cress aiming to improve the ripening characteristics of cheese. To present an alternative functional cheese product to the consumers, this research aims to investigate the effects of *L. sativum* L. on some chemical, biochemical properties, and ripening characteristics of White cheese.

MATERIALS and METHODS

Preparation of garden cress

Fresh *L. sativum* L. was purchased from a local bazaar in Ordu, Turkey. Only its leaves were picked for further processing. After washing under tap water, the leaves were sliced into short strips using a knife and added to curd in this form (Figure 1). The garden cress concentrations applied to cheeses have been determined in preliminary trials.

Cheese production

Cheese production was carried out twice based on the method given by Tarakçı and Deveci (2019). White cheeses were produced from pasteurized (85 °C, 20 s) cow milk in a local dairy plant (Sül-Meh-Ser Körpe LLC, Samsun, Turkey). The pasteurized milk was cooled down to 32-35 °C, then the starter culture (%0.1 milk basis; a mixture of *Lactococcus lactis* subsp. *lactis* and *Lactococcus lactis* subsp. *cremoris*), calcium chloride (0.02% milk basis), and calf rennet (1:16000 MCU/mL) was added followed by an incubation period of approximately one hour at the already indicated temperature range. Coagulum was cut into approximately 1 cm^3 cubes and let it set. Once it reached the required pH range between 5.1 and 5.4, the whey was removed, and the curd pieces were collected in a cheesecloth. The curds were pressed slightly in order to remove some of the remaining whey. Then, the whole curd was divided into 5 equal portions. Simultaneously, *L. sativum* L. strips were added into the curds at four different concentrations (0% (C), 0.6% (T1), 1.2% (T2), 1.8% (T3), and 2.4% (T4), curd weight basis) and gently mixed until a homogenous pile was obtained. An additional manual pressing step (0.2 kgf/cm^2) was applied approximately 2h until a firm structure was obtained. The curds were shaped in a circular form (15 cm diameter and 4 cm height) and dry-salted (3%, w/w) to make it suitable for vacuum-packaging and also, enhance the rind formation. Finally, they were vacuum-packed and stored at 4 °C for 3 months (Figure 1). All the analyses were performed on the 1st, 30th, 60th, and 90th days of storage.

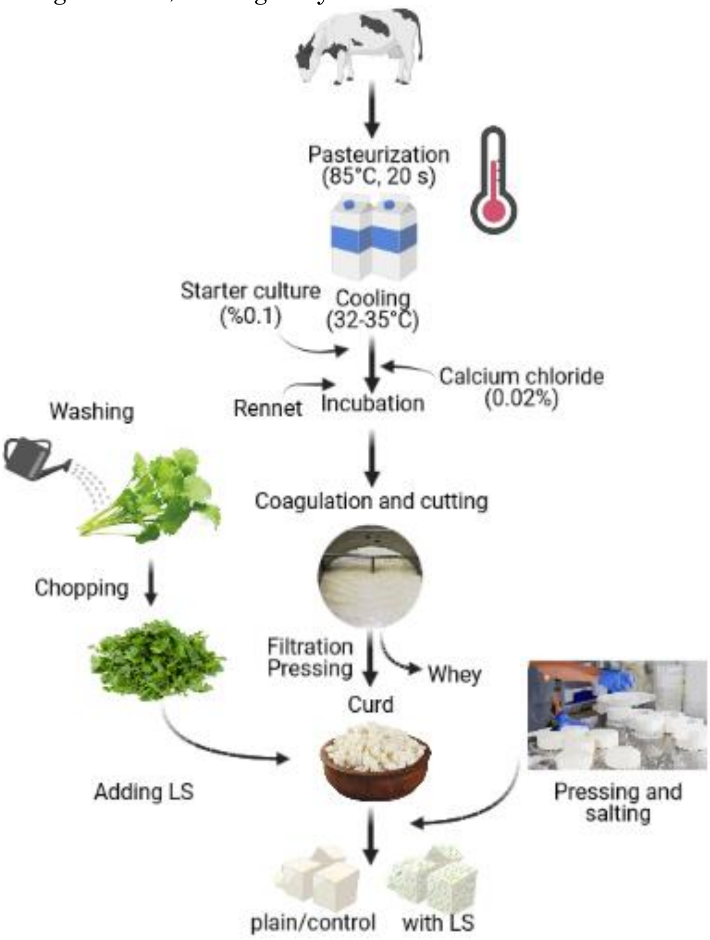

Figure 1. A flow diagram for the production of LS-added White cheeses
Şekil 1. LS-katkılı Beyaz peynirlere ilişkin üretim akış diyagramı

Chemical analysis

The dry matter ratio of cheeses was determined using a gravimetric method according to IDF (2004). The Gerber-van Gulik method was followed to determine the fat content (Nielsen, 2003). To determine titratable acidity and pH, cheese slurries (10%, w/v) were prepared, and the filtrates were used. The filtrates were titrated with 0.1 N NaOH, in the presence of phenolphthalein indicator to determine the total titratable acidity as lactic acid % (AOAC, 1990) and a pH meter (model Starter 3100; OHAUS, NJ, USA) probe was immersed into the filtrates for pH measurements. The salt content was determined according to the Mohr method. Briefly, the previously prepared cheese filtrates were titrated with 0.1 N $AgNO_3$ using potassium chromate as the indicator (Nielsen, 2003).

An automatic distillation unit (UDK-149; VELP Scientifica, Usmate, Italy) was used to determine the total nitrogen contents of the cheese samples based on the Kjeldahl method (IDF, 1993). The nitrogen concentrations were multiplied by a factor of 6.38 in order to determine total protein concentration (%). The filtrate used for pH and titratable acidity was used for determination of water-soluble nitrogen (WSN%) while this filtrate was treated with 12% trichloroacetic acid (TCA) for 2 hours at room temperature to determine TCA-soluble nitrogen

(TCA-SN%). They were determined using the same setup and the values were expressed as the percentage of total nitrogen (Bütikofer et al., 1993).

Proteolysis and urea–polyacrylamide gel electrophoresis (Urea-PAGE)

Urea-PAGE was performed in a vertical type electrophoresis system (SE600X Chroma Deluxe; Hoefer Inc., MA, USA) according to the method of Ardö and Polychroniadou (1999) modified by Celik et al (2018). The cheese samples (100 mg) were dissolved in 2 mL sample buffer (1.5 g tris methylamine, 49 g urea, 0.15 g bromophenol blue, 2 mL 2-mercaptoethanol, and 0.4 mL HCl per 100 mL). Samples were run in an electrode buffer (0.3% tris methylamine, 1.46% glycine, pH=8.4) using a 1.5 mm thick stacking (4% acrylamide, pH 7.6) and separating (12.5% acrylamide, pH 8.9) polyacrylamide gels, solidified with ammonium persulphate and TEMED solutions, until the tracking dye front reached to the bottom of the gel slab at 300 V (ELITE 300, Wealtec Corp., NV, USA). An aqueous solution of Coomassie Briliant Blue G250 (0.2%, w/v) was applied for staining and images of the gels were captured with a scanner (Epson V750 Pro, Seiko Epson Corp., Japan) and digitized for quantification of the intensity of the bands using the Total Lab 1D (v12.2; Phoretix, Newcastle upon Tyne, UK) gel analysis software.

Sensory analysis

Sensory tests were conducted with a panel of ten panelists at Ordu University Faculty of Agriculture. The cheeses were graded on the basis of six criteria: (i) color and appearance; (ii) taste and flavor; (iii) body and structure, (iv) odor, (v) saltiness, and (vi) LP/cheese harmony. Using a hedonic scale, the panel was asked to grade the samples with a score of 1 to 5: 1 is being unacceptable and 5 being very good. The panel was informed about the cheese samples prior to the analysis and the cheese samples were served as 15–20 g portions with water.

Statistical analysis

All measurements were performed in duplicate. Statistical analyses of the data were carried out using Minitab 17.1.0 statistical software (State College, PA). Two-way analysis of variance (two-way ANOVA) was performed for the determination of statistical differences between cheese types and ripening periods; then, differences found statistically significant were subjected to Tukey test ($\alpha = 0.05$). For statistical evaluation of the sensory data, Kruskal-Wallis non-parametric test was applied using median values and pairwise differences, if any, were denoted.

RESULTS and DISCUSSION

Gross composition

The dry matter contents of cheeses were between 41.33 and 46.24% during the storage period of 90 days (Table 1).

Except for T2, there was no significant change observed in dry matter contents of cheese samples during storage ($P>0.05$). However, significant differences were determined for “dry matter” and “salt in dry matter” considering storage time x cheese type interaction ($P<0.05$). All cheese types fulfilled the minimum dry matter requirement of for fresh and ripened White cheese by Turkish Food Codex (TFC, 2015). These values are little under the values of six different types of spicy White cheeses (approximately 45-50% dry matter content) reported by Tarakçı and Deveci (2019). The fat in dry matter ratios ranged between 30.24 and 41.02%. The cheese samples can be classified as semi-fat cheese (25%≤fat in dry matter<45%) according to TFC (2015). Considering salt contents, the initial salt ratios of cheeses were quite high but they were stabilized with the extended time of storage. The salt in dry matter concentrations ranged between 7.44% and 13.95% (Table 1). The high concentrations of salt determined on the 1st day are likely due to residual salt from dry-salting application. These salt concentrations exceed the maximum salt level in dry matter of 6.5% (TFC, 2015). On the other hand, the salt content of the 100 traditional Van Herby cheese collected from the city center were found to be between 5.85% and 11.70% with an average value of 8.64% (Ekici et al., 2019). Considering that raw milk is utilized in traditional Herby cheese production, the high salt content of Herby cheeses could be attributed to addition of extra salt to avoid microbial spoilage in the study by Ekici et al. (2019). No significant effect of garden cress concentration was determined on the protein and fat contents of cheese samples ($P>0.05$) but salt ($P=0.008$). However, storage time was found to be significantly effective on all components ($P<0.05$).

pH and titratable acidity

Reduction in pH or increase in titratable acidity is usually a result of lactic acid accumulation due to microbial activity however; additional ingredients may also affect the titratable acidity level of cheeses. The pH values of cheese samples ranged between 5.05 and 5.58 during storage time (Table 2). Addition of garden cress increased the initial pH values of cheeses. On the other hand, the pH values of cheeses with garden cress reduced during storage while pH of the control cheese did not change that much. Confirming these findings, increase in titratable acidity of the control cheese is lower than the garden cress added cheeses (Table 2).

Table 1. Changes in gross composition of cheese samples during storage

	Cheese types *Peynir çeşitleri*	Storage time (days) *Depolama süresi (gün)* 1st	30th	60th	90th
Dry matter (%) *Kuru madde (%)*	C	44.67±0.94	45.00±0.47[A]	44.50±0.71	43.83±0.24[AB]
	T1	46.24±0.35	44.50±0.71[A]	45.50±1.65	42.33±0.94[B]
	T2	45.50±0.71[a]	41.33±0.47[Bb]	42.50±0.24[b]	42.50±0.24[ABb]
	T3	44.17±0.71	44.83±0.24[A]	44.17±0.24	44.33±0.47[A]
	T4	43.67±1.41	44.33±0.94[A]	43.00±0.47	43.67±0.00[AB]
Fat (%) *Yağ (%)*	C	14.00±0.00	16.50±0.00	16.75±0.35	13.25±2.47
	T1	14.75±0.35[b]	15.75±0.35[ab]	16.00±0.00[a]	13.25±0.35[c]
	T2	14.50±0.71	16.00±1.41	15.50±0.71	13.50±0.71
	T3	15.25±1.06	16.50±0.71	16.00±1.41	14.50±0.00
	T4	13.25±0.35[c]	18.25±0.35[a]	16.00±0.00[b]	14.00±0.71[c]
Protein (%) *Protein (%)*	C	21.14±0.51[A]	15.94±1.54	17.03±0.00	20.95±1.58
	T1	19.68±0.00[AB]	16.67±2.57	14.22±0.64	20.49±0.40
	T2	17.31±0.74[B]	15.76±2.31	15.31±1.16	20.21±1.05
	T3	19.87±1.80[AB]	17.94±0.26	16.03±1.93	20.39±0.79
	T4	19.87±0.26[AB]	17.40±1.03	15.40±0.26	19.65±1.85
Salt (%) *Tuz (%)*	C	6.23±0.29[Aa]	3.48±0.12[b]	3.83±0.46[b]	3.48±0.12[b]
	T1	5.15±0.00[ABa]	3.69±0.00[c]	4.15±0.00[b]	3.60±0.04[d]
	T2	4.07±1.12[B]	3.54±0.12	3.28±0.41	3.74±0.00
	T3	4.88±0.29[ABa]	3.45±0.00[b]	3.63±0.08[b]	3.48±0.12[b]
	T4	3.25±0.12[Bb]	3.77±0.21[ab]	3.80±0.08[a]	3.51±0.08[ab]
Fat in dry matter (%) *Kuru maddede yağ (%)*	C	31.35±0.66	36.67±0.38	37.65±1.39	30.24±5.81
	T1	31.89±0.53[ab]	35.40±1.36[a]	35.19±1.28[ab]	31.30±0.14[b]
	T2	31.86±1.06	38.73±3.86	36.47±1.46	31.76±1.49
	T3	34.55±2.96	36.67±1.57	36.22±3.01	32.71±0.35
	T4	30.37±1.79[b]	41.02±0.29[a]	37.21±0.41[a]	32.06±1.62[b]
Salt in dry matter (%) *Kuru maddede tuz (%)*	C	13.95±0.35[Aa]	7.74±0.36[b]	8.62±1.16[b]	7.94±0.33[b]
	T1	11.13±0.08[ABa]	8.28±0.13[b]	9.14±0.33[b]	8.50±0.29[b]
	T2	8.96±2.59[B]	8.56±0.20	7.71±1.02	8.81±0.05
	T3	11.06±0.48[ABa]	7.67±0.00[b]	8.21±0.14[b]	7.85±0.36[b]
	T4	7.44±0.04[B]	8.49±0.69	8.84±0.10	8.04±0.19

C: Control cheese without LS. The other cheeses contain garden cress with the following concentrations: T1: 0.6%, T2: 1.2%, T3: 1.8%, and T4: 2.4%. Different capital letters in the same column indicate significant differences between cheese types and different small letters in the same row indicate significant differences between storage days (P < 0.05).

Table 2. Changes in the pH and titratable acidity levels of White cheese samples during storage
Çizelge 2. Depolama süresince Beyaz peynir pH ve titre edilebilir asitlik değerlerinde meydana gelen değişimler

	Cheese types *Peynir çeşitleri*	Storage time (days) *Depolama süresi (gün)* 1st	30th	60th	90th
pH	C	5.25±0.01[B]	5.32±0.00[A]	5.26±0.01[A]	5.29±0.11
	T1	5.58±0.01[Aa]	5.28±0.01[Bb]	5.20±0.02[Abc]	5.15±0.03[c]
	T2	5.37±0.16[ABc]	5.21±0.01[Cbc]	5.08±0.00[CDb]	5.14±0.02[a]
	T3	5.39±0.01[ABa]	5.29±0.01[Bb]	5.13±0.04[BCc]	5.21±0.02[bc]
	T4	5.37±0.07[ABa]	5.35±0.00[Aa]	5.05±0.01[Db]	5.12±0.06[b]
Titratable acidity (%) Titre edilebilir asitlik (%)	C	1.28±0.21[a]	1.33±0.09[a]	1.44±0.05[a]	1.73±0.04[Ca]
	T1	1.02±0.01[c]	1.34±0.06[b]	1.40±0.01[b]	2.15±0.01[ABa]
	T2	1.11±0.13[a]	1.45±0.04[a]	1.64±0.10[a]	2.02±0.02[ABa]
	T3	1.25±0.14[c]	1.42±0.03[bc]	1.69±0.13[ab]	1.92±0.01[BCa]
	T4	1.19±0.12[c]	1.41±0.10[bc]	1.73±0.09[b]	2.24±0.12[Aa]

C: Control cheese without LS. The other cheeses contain garden cress with the following concentrations: T1: 0.6%, T2: 1.2%, T3: 1.8%, and T4: 2.4%. Different capital letters in the same column indicate significant differences between cheese types and different small letters in the same row indicate significant differences between storage days (P<0.05).

Furthermore, titratable acidity of all cheeses increased during storage period. Both pH and titratable acidity was significantly affected by storage time and cheese type and their interaction (P<0.05).

Similarly, the addition of spices reduced the pH of Sürk cheese (Masatcıoğlu and Avşar, 2005), Cottage cheese (Regu et al., 2016) and Ras cheese (Hamad et al., 2020); and increased the titratable acidity of Mozzarella (Akarca et al., 2016) during storage. On the other hand, Gezmiş and Tarakçı (2020) determined that the control cheese without any spices had the highest titratable acidity among all spice added the Circassian cheeses.

WSN and TCA-SN

Proteolysis is a useful indicator of ripeness in cheese. The TCA-SN includes nitrogen fractions from 2—20 amino acids together with free ones while WSN is nitrogen fractions soluble in water and referred as the ripening index of cheese (Sousa and Malcata, 1997). Both WSN and TCA-SN rates increased throughout the ripening period and with increasing concentrations of LS, and their interactions (P<0.05) (Table 3). Complying with the current results, Sürk, a traditional Turkish cheese containing a mixture of spices, was shown to have higher WSN values compared to the control cheese without any spices during one month of storage (Masatcıoğlu and Avşar, 2005). Furthermore, Hamad et al. (2018) and Aktypis et al. (2018) found that the increasing concentrations of herbs increased the WSN values of cheeses. On the contrary, Mozzarella cheese was found to have lower ripening index when spices were included (Akarca et al., 2016). Addition of black cumin gave similar WSN and TCA-SN values while addition of red- and isot-pepper caused a reduction. On the other hand, mint and thyme were found to increase WSN and TCA-SN values compared to control cheese (Tarakçı and Deveci, 2019).

Table 3. Changes in the WSN/TN and TCA-SN/TN levels of White cheeses during storage
Çizelge 3. Depolama süresince Beyaz peynirlere ait WSN/TN ve TCA-SN/TN değerlerine ait değişimler

	Cheese types *Peynir çeşitleri*	Storage time (days) *Depolama süresi (gün)* 1st	30th	60th	90th
WSN/TN (%)	C	6.15±0.32^{Bc}	8.10±0.30^{Dc}	14.31±0.31^{Bb}	19.01±1.16^{Ba}
	T1	6.65±0.00^{Bd}	12.55±0.00^{Cc}	16.79±0.10^{Ab}	20.85±0.51^{ABa}
	T2	7.53±0.05^{Ad}	15.85±0.12^{Ac}	16.50±0.11^{Ab}	21.71±0.01^{ABa}
	T3	6.51±0.03^{Bc}	14.00±0.52^{Bb}	16.84±0.46^{Ab}	21.33±1.48^{ABa}
	T4	6.62±0.10^{Bd}	14.47±0.19^{Bc}	16.81±0.00^{Ab}	23.27±0.35^{Aa}
TCA-SN/TN (%)	C	4.20±0.44^{Ac}	5.55±0.13^{Bb}	5.51±0.23^{Cb}	8.07±0.21^{Ba}
	T1	2.81±0.17^{Bc}	6.31±0.03^{ABb}	6.98±0.14^{Bb}	11.03±0.81^{ABa}
	T2	3.29±0.21^{Abc}	6.75±0.38^{Ab}	7.63±0.27^{Bb}	11.28±0.31^{ABa}
	T3	3.02±0.09^{Bc}	6.29±0.17^{ABb}	9.17±0.29^{Aa}	11.13±1.32^{ABa}
	T4	3.26±0.24^{ABc}	6.49±0.09^{Ab}	9.43±0.44^{Ab}	12.84±1.50^{Aa}

C: Control cheese without LS. The other cheeses contain garden cress with the following concentrations: T1: 0.6%, T2: 1.2%, T3: 1.8%, and T4: 2.4%. WSN: Water-soluble nitrogen, TCA-SN: Trichloroacetic acid-soluble nitrogen TN: Total nitrogen. Different capital letters in the same column indicate significant differences between cheese types and different small letters in the same row indicate significant differences between storage days (P<0.05).

Urea-PAGE

In all cheese samples, α-casein degradation was more intense compared to β-casein (Figure 2) and similar results were also obtained by (Tarakçı and Deveci, 2019). Considering β-casein fraction, the addition of garden cress increased the degradation rate, especially in T2. On the other hand, considering the degradation rates of α-casein, it is seen that there is no significant difference between cheeses. Spices are usually more effective on α-casein of White cheese as determined by Tarakçı and Deveci (2019). In a study by Shori et al. (2020), extended ripening of Cheddar cheese enhanced the degradation of α_s- and β-caseins more in *Allium sativum* added cheese compared to plain cheddar. These results suggest that garden cress may possess a unique proteolytic activity which is more specific to β-casein.

Sensory analysis

Sensory scores for each period are shown in Figure 3. Sensory results indicate that the scores for cheese samples are very close to each other for all the criterion tested. Also, no significant differences were determined between neither cheese types nor storage periods according to the Kruskal-Wallis test applied (P>0.05). The structural properties of cheese samples were less appreciated when high concentrations of garden cress were included probably due to more fragile structure they gained. Similarly, saltiness level was most admired for control, T2, and T1 cheeses. The color and appearance score was lowered with the garden cress addition since the inclusion of spices/herbs/plants is not a tradition for consumption of White cheese. On the other hand, T3 and T4 cheeses were more preferred in terms of taste and flavor, odor, and LS/cheese harmony however the difference between samples was not significant (P>0.05).

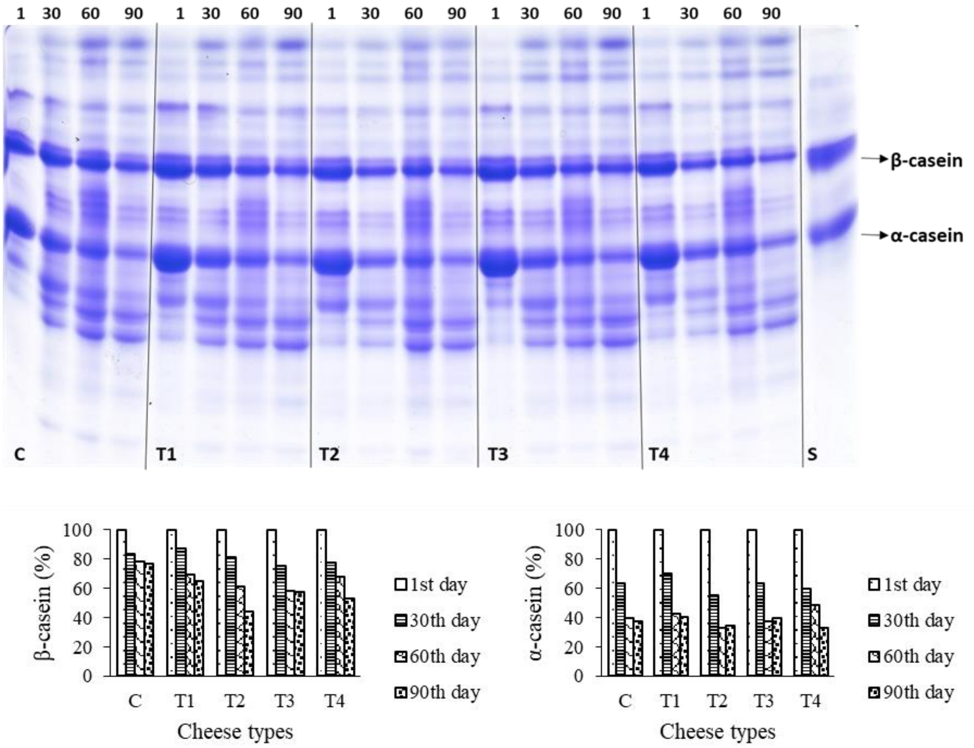

Figure 2. Electrophoretogram of cheese samples and graphs of changes in the levels of β-casein (left) and α-casein (right) during storage

Şekil 2. Peynir örneklerine ilişkin elektroforetogramlar ve depolama süresince β-Kazein (sol) ve α-Kazein (sağ) seviyelerindeki değişimlere ait grafikler

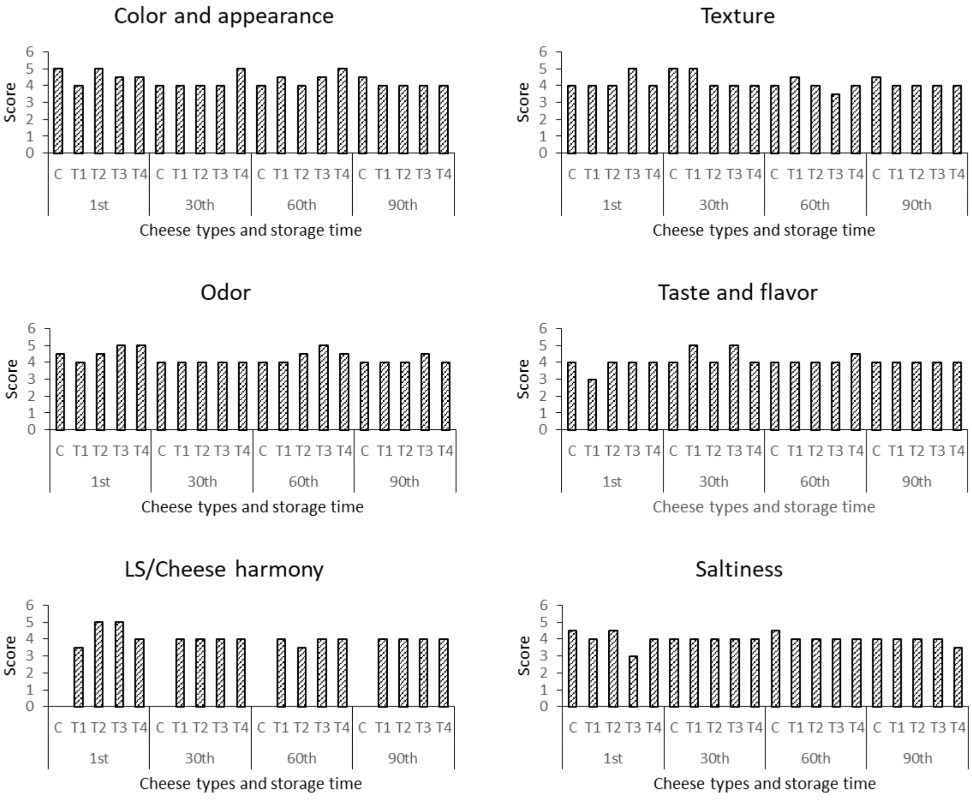

Figure 3. Sensory scores of cheese samples during storage.

Şekil 3. Depolama süresince peynirlerin duyusal skorları.

CONCLUSIONS

The incorporation of garden cress contributed to both WSN and TCA-SN levels of White cheeses, while the increase in the latter was more apparent. Considering casein fractionations, garden cress, regardless of its concentration, boosted the degradation of β-casein. No statistical difference has been determined between cheese types regarding sensory properties. Overall, the results indicate that White cheese could be used as a suitable conveyor for garden cress and contribute to the ripening level, specifically by β-casein degradation. Further comprehensive studies are required to get a clear picture of the effect of garden cress on the casein fractionation

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Author Contribution Statement

ZT and ÖFÇ have designed the study. ÖK and SK executed the experiment and collected the data under the guidance of ÖFÇ. ÖFÇ wrote the article and ZT reviewed the article critically.

Conflict of Interest Statement

All authors declare that they have no conflicts of interest..

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