GIDA
THE JOURNAL OF FOOD
E-ISSN 1309-6273, ISSN 1300-3070

Research / Araştırma
GIDA (2020) 45(3) 448-460
doi: 10.15237/gida.GD19160

INVESTIGATION OF SOME QUALITY PARAMETERS OF PICKLED PEPPER PRODUCED BY LOW VALUE DAIRY BY-PRODUCTS

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Received / Geliş: 10.12.2019; *Accepted* / Kabul: 20.04.2020 *Published online* / Online baskı: 04.05.2020

Gunes, R., Cetin, B. (2020). Investigation of some quality parameters of pickled pepper produced by low value dairy by-products. GIDA (2020) 45(3) 448-460 doi: 10.15237/gida.GD19160

Güneş, R., Çetin, B. (2020). Süt endüstrisi yan ürünleri ile üretilen biber turşusunun bazı kalite parametrelerinin araştırılması. GIDA (2020) 45(3) 448-460 doi: 10.15237/gida.GD19160

ABSTRACT
In this study, traditional pickled pepper was produced in 3 different formulations by using whey cheese and cheese crumbs, which are obtained as a by-product in the cheese-making process. In the scope of the study, the microbiological, chemical and sensory properties were examined during the 5 months of storage period. The initial *E. coli* contents of the samples were determined as 3.71, 2.73, 4.72 log cfu/g respectively and it was not detected in any of the group at the end of the 21st day. The 2nd group was the most acceptable in terms of taste (5.9-6.6), smell (6.2-6.6) and visual appearance (6.3-6.7) for 4 months. It was observed that there was no change in the chemical parameters of all groups that could negatively affect consumption during the storage period. As a result of the study, it was shown that a high value-added product can be produced by using dairy by-products.
Keywords: Pickled pepper, whey cheese, cheese crumbs, dairy by-product

SÜT ENDÜSTRİSİ YAN ÜRÜNLERİ İLE ÜRETİLEN BİBER TURŞUSUNUN BAZI KALİTE PARAMETRELERİNİN ARAŞTIRILMASI

ÖZ
Bu çalışmada, süt endüstrisinde yan ürün olarak elde edilen düşük katma değerli kırık peynirler ve lor peyniri kullanılarak 3 farklı formülasyonda geleneksel peynirli (sütlü) biber üretimi gerçekleştirilmiştir. Çalışma kapsamında, ürünlerin mikrobiyolojik, kimyasal ve duyusal özellikleri 5 aylık depolama süresi boyunca incelenmiştir. Mikrobiyolojik analizlere göre, örneklerin başlangıçtaki *E. coli* içeriği sırasıyla 3.71, 2.73, 4.72 log kob/g olarak belirlenmiş ve 21. günün sonunda hiçbir grupta tespit edilmemiştir. Duyusal analiz sonuçlarına göre, 2. grup 4 ay boyunca tat (5.9-6.6), koku (6.2-6.6) ve görsel açıdan (6.3-6.7) en çok beğenilen grup olmuştur. Kimyasal analiz sonuçları göz önüne alındığında ise, depolama süresince tüm grupların parametrelerinde tüketimi olumsuz yönde etkileyebilecek bir değişikliğin olmadığı gözlenmiştir. Çalışma sonucunda, süt endüstrisi yan ürünleri kullanılarak katma değeri yüksek bir ürünün üretilebileceği ortaya konmuştur.
Anahtar kelimeler: Biber turşusu, lor peyniri, peynir kırığı, süt yan ürünleri

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INTRODUCTION

In the food industry, large amounts of food wastes or by-products, are released as a result of the manufacturing process, many of which are immediately discarded or used to produce low-value products (animal feed, fertilizer, etc.) (Gomez and Martinez, 2018; Torres-León et al., 2018). However, efficient utilization of these materials is very important not only for the prevention of environmental pollution (Garcia-Garcia et al., 2016), but also for creating value-added products (Kowalska et al., 2017). On the other hand, today's consumers have begun to prefer foods with high nutritional value, containing fewer additives, high shelf-life and that can meet the requirements of their lifestyle (Siró et al., 2008; Román et al., 2017). Therefore, this change in consumer awareness and developing food technology have led to an increase in studies on the evaluation of food wastes and/or by-products (Teixeira et al., 2014; Sharma et al., 2016). Because, food wastes and by-products are rich in various bioactive components, such as polysaccharides, proteins, fats, fibers, flavor compounds, phytochemicals and health-beneficial bioactive compounds (Helkar et al., 2016). In this regard, valorizing of food wastes and by-products can lead to the recovery of these compounds which can be utilized in food, nutrition, and many non-food applications.

The dairy industry has shown huge growth in many countries and dairy products processing generates a high amount of by-products and wastes. The main wastes generated are whey, dairy sludges and waste-water (Sarkar et al., 2006; Ahmad et al., 2019). However, many attempts have been made to evaluate these wastes and by-products released in the dairy industry (Chandra et al., 2018; Wong et al., 2018). Today, especially cheese by-products are evaluated in different ways. The great importance is given to the evaluation of whey released during cheese production in different developed countries. In this context, various products are made from the whey, and these products are used directly or as an additive in yoghurt production, meat industry, bread making, ice cream production, and animal feeds (Krolczyk et al., 2016; Ganju and Gogate, 2017). On the other hand, cheese crumbs, another by-product of cheese making, which breaks off from cheese during molding and packaging or leftovers in tin cheeses are sold at a lower cost in the market.

In dairy products, type of milk (cow, buffalo, goat, sheep, etc.), processing methods, consumer preference, legal standards, countries of origins, and different ingredients play a major role in increasing product diversity (Najgebauer-Lejko et al., 2014; Mehta, 2015). Pickled pepper that fermented with milk-based ingredients, is an example of this, especially among the indispensable tastes of Thrace cuisine and is a highly preferred product. However, there is very little information available on that topic. Although the name and the production method changes in different parts of southeastern Europe (the Balkans), two main raw materials used in the product are milk or milk-based products and sweet or hot peppers. In this regard, an important factor that makes the product unique is the pepper used in the production. The peppers used for this product resemble to the bell peppers but they are more fleshy, thin-skin, generally hot taste, yellow, light green and sometimes red-orange in color with a pointed-conical tip compared to other peppers. This pepper is also called "Somborka" in different regions of the Balkans.

The studies on pickled peppers fermented with dairy ingredients are very limited compared to other fermented dairy products. Coşkun and Gök (2012) researched some properties of pickled peppers with milk prepared by using *Lactobacillus plantarum* and *Leuconostoc mesenteroides* cultures and compared them pickled peppers with a milk-like product that sold in Tekirdağ and homemade pickled peppers that produced in Kırklareli region. In a different study belonging to the same research group, the effects of using different yeast cultures on some properties of the same product were studied (Coşkun and Gök, 2018). Therefore, in the scope of the present study, it was aimed to increase the recognition of this product from traditional to conventional and produce it by using dairy by-products (whey cheese and cheese crumbs). In this context, pickled pepper samples

with 3 different formulations were produced and analysed (microbiological, chemical and sensorial) for 5 months to determine the optimized product formulation. According to the analyses, it was determined which formulation would be suitable for the commercial production.

MATERIALS AND METHODS

Materials

In the present study, pickled pepper production was carried out in Kırklareli University Food Engineering Department Laboratory. Original sweet Somborka peppers were used in the study and cheese samples (cheese crumbs and whey cheese) were obtained from a local company. The pH, fat, and salt content of cheese crumbs and whey cheese were 5.51, 5.13, 17 %, 4.5 % and 4.14 %, 1.33 %, respectively. Other ingredients, full-fat cow's milk, sunflower oil, and table salt were purchased from the market. The selective mediums (Potato Dextrose Agar for total yeasts and moulds, Violet Red Bile Dextrose Agar for Enterobacteriaceae, Tryptone Bile X-glucuronide Agar for *E. coli*, de Man, Rogosa and Sharpe Agar for Lactobacilli, M17 Agar for Lactic streptococci count) used in the microbiological analyses were obtained from Merck (Darmstadt, Germany) and all other chemicals were of the analytical grade.

Methods

Production of pickled pepper by using dairy by-products

Firstly, sweet Somborka peppers were washed and cleaned from their seeds. In order to release the excess water of the peppers, the inner parts were treated with salt (60 g/kg pepper) and kept for 10-12 hours. At the end of the period, the water formed in the peppers were excluded.

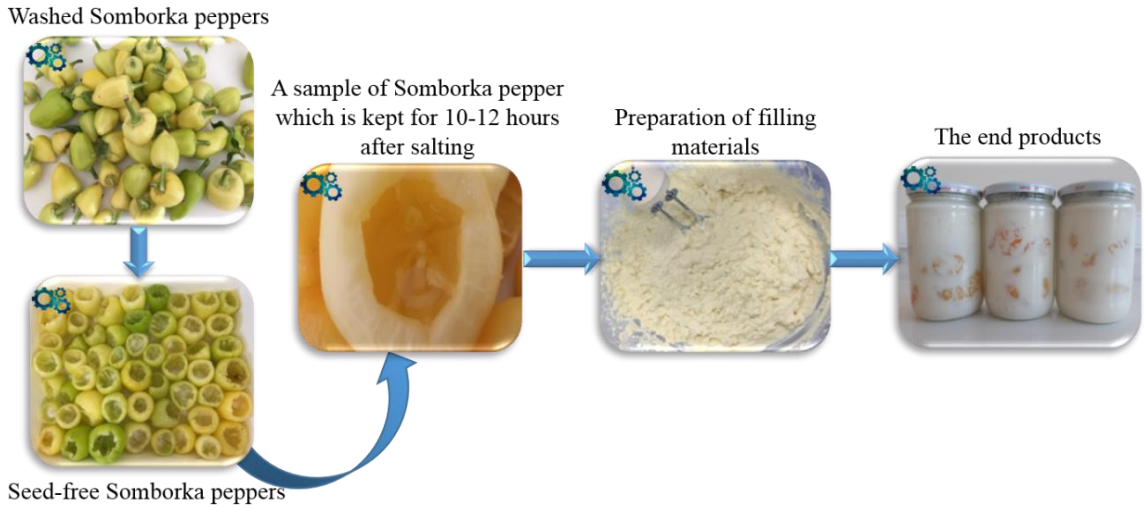


Figure 1. Production steps of pickled pepper by using dairy by-products.

In the production step (Figure 1), three different filling materials (3.6 kg) were used in the preparation of the samples. Firstly, the solid part of the filling material (2.7 kg) of 3 groups consisting of the mixture of dairy by-products, was obtained by mixing cheese crumbs and whey cheese in a ratio of 2:1, 1:1, and 1:2, respectively. In order to balance the consistency, 900 g of full-fat cow's milk was added to all filling materials and all ingredients were mixed with a blender until a homogeneous mixture was obtained. In the end, the peppers were stuffed with these filling materials and placed into 1 L glass jars with an average of 6-8 Somborka peppers. Then, the jars were filled with the remaining material in such a way that there would be no cavities around the peppers and in the jars. Before closing the jars, 5 mL sunflower oil was added to the surface to

prevent the spoilage. Finally, the jars were closed tightly and were placed into the refrigerator at +4 °C.

Chemical analyses

In the chemical analyses, titratable acidity (%), pH, Gerber method for fat (%), and Mohr method for salt (%) analyses were performed (AOAC, 2000). For three sample groups, the chemical analyses were performed on the 15th, 21st and 30th days of the first month and once a month in the last 4 months during the storage period. On the other hand, the initial titratable acidity, pH, fat, and salt ratios of the filling materials were also determined.

Microbiological analyses

In the microbiological analyses, Enterobacteriaceae (ISO 2017), *E. coli* (ISO 2001), total yeasts and moulds (ISO 2008), lactic streptococci (Reuter, 1985), and lactobacilli (ISO 2015) counts were performed. Firstly, 10 g sample was taken from each group into the sterile bags under sterile conditions. Then, 90 mL of sterile physiological saline (0.85% NaCl in distilled water) was added and the bags were homogenized in a stomacher (VWR Star Blender LB 400) for 1 min at normal speed. Serial dilutions were prepared by diluting the main dilution to the desired levels. Bacterial colonies were counted at the end of the optimum incubation temperature and time according to the bacterial species. The analyses were carried out on the 15th, 21st and 30th days of the first month and then once a month for 5 months of storage. Microbial cultivation and counting of the resulted colonies were done in duplicate and the results were given as means ± S.D. of log cfu per gram.

Sensory analysis

The sensory evaluation of pickled pepper was performed by using a seven-point scale (Figure 2). 15 un-trained panelists of different gender and age groups were recruited to assess the taste, smell, acidity, salty, visual appearance, and general acceptability of the samples. According to the analysis procedure, the panelists received the previously numbered samples (20 g, with filling material and peppers) that served on white plastic plates when they entered the evaluation cabins. The panelists were instructed to taste the samples and between each sample plate to drink water at room temperature to minimize the influence of the residue present on taste buds. Each panelist received an evaluation form (Figure 2) in which they should circle whether they liked or disliked the samples (Beinner et al., 2010). The sensory analysis was performed for 4 months starting from the 15th day when the samples were known to be ready to eat.

Use the number scale below to mark which number that you liked or disliked about the pickled pepper.

7- Very much liked	( ) Visual appearance
6- Liked a lot	( ) Taste
5- Liked	( ) Smell
4- Liked and did not like	( ) General Acceptability
3- Disliked	( ) Acidity
2- Much disliked	( ) Salty
1- Very much disliked	

Figure 2. The seven-point sensory evaluation form to assess the taste, smell, acidity, salty, visual appearance, and general acceptability of the samples.

Statistical analysis

The software SPSS 16.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for the analysis of variance (ANOVA) and Tukey's honestly significant difference test with $p = 0.05$ in order to determine the significant differences between the samples.

RESULTS AND DISCUSSIONS

Chemical analysis results of the samples

The results of the chemical analyses (pH, titratable acidity, salt, and fat) performed to determine the changes in the quality of the products for 5 months were summarised in Table 1. In fermented products, pH and total/titratable acidity are among the important parameters. The development of acidity is a natural indicator of bacterial growth, namely fermentation, and is mainly carried out by lactic acid bacteria. In this regard, firstly, the initial pH values of the filling materials used in the production of the samples were determined as 5.64, 5.55, and 5.47, respectively. Then, the pH values decreased during the storage period due to the increase in the population of lactic cultures and were determined as 4.65, 4.52, and 4.28 at the end of the storage period, respectively. Also, there were statistically significant differences between the pH values of the samples during the same storage time and the lowest values were observed in the 3rd group due to the higher use of whey cheese having low pH in the filling material ($p<0.05$). Another parameter, titratable or total acidity, was statistically significant between the groups and the highest values were determined in the last group due to the higher use of whey cheese. According to the results, the total acidity values of the samples generally increased during the storage time, and at the end of the period the values were found to be 1.06 %, 1.10 %, and 1.20 %, respectively.

Considering the salt content of the products, practically, the group with more cheese crumbs content should be more salty, while the salt content of the group with more whey cheese is expected to be lower. As shown in Table 1, the mean salt contents of the groups were found to be 3.79 %, 3.21 %, and 2.37 %, respectively. As expected, the lowest salt content was detected in the 3rd group and statistically significant differences were found between the salt contents of the groups ($p<0.05$). On the other hand, in the same group, there were statistically significant differences between the salt contents at different storage times ($p<0.05$). This can be explained by the fact that the peppers are variable in size, so they may contain different amounts of salt after the salting step in the production method, and the peppers and/or filling materials may not have been taken equally during sampling for analysis, and therefore, may have affected the results. For instance, in a study done by Coşkun and Gök (2012), different lactic acid bacteria were used in the production of pickled peppers with milk and it was determined the salt contents of the products varied between 3.04-3.39 %, which were close to the values obtained in our study.

In the present study, the mean fat content of the samples was 10.85 %, 9.88 %, and 7.89 %, respectively. The fat content of the white cheese crumbs was 17 % and it was higher than the whey cheese (4.5 %) used in the filling materials. Therefore, the fat content of the 1st group which contains more cheese crumbs was found to be higher than the other groups ($p<0.05$) and this can also be understood by looking at the fat content of the filling materials. As shown, the fat content of the end products in each group was higher than the amount of fat contained in the filling materials, which was due to the addition of sunflower oil (5 mL) on each jar in order to prevent spoilage.

Microbiological analysis results of the samples

In the present study, the microbiological quality of the experimental pickled pepper samples was examined for 5 months and the findings of Enterobacteriaceae (ENTR), *E. coli*, total yeasts and moulds, lactic streptococci, and lactobacilli counts were summarised in Table 2. The first three counts were evaluated as hygiene and quality indicators, and the last two were evaluated for positive effects on product characteristics and beneficial to consumer health.

Table 1. Chemical properties of the samples and their filling materials.

Sample	Time (day)	Group 1*	Group 2*	Group 3*
pH (25 °C)	0**	5.64 ± .03^{Aa}	5.55 ± .02^{Ab}	5.47 ± .02^{Ac}
	15	5.29 ± .01^{Ba}	5.08 ± .01^{Bb}	4.89 ± .05^{Bc}
	21	4.68 ± .02^{Ca}	4.58 ± .03^{Cb}	4.36 ± .04^{Cc}
	30	4.65 ± .01^{CDa}	4.55 ± .02^{CDb}	4.33 ± .06^{CDc}
	60	4.61 ± .02Da	4.54 ± .01^{CDb}	4.30 ± .03^{DEc}
	90	4.64 ± .01^{CDa}	4.57 ± .01^{Cb}	4.35 ± .03^{Cc}
	120	4.62 ± .03Da	4.55 ± .03^{CDb}	4.31 ± .01^{DEc}
	150	4.65 ± .02^{CDa}	4.52 ± .02^{Db}	4.28 ± .05^{Ec}
Titratable acidity (%)	0**	0.78 ± .05^{Eb}	0.81 ± .04^{Eab}	0.83 ± .02^{Ea}
	15	0.85 ± .07^{Dc}	0.90 ± .03^{Db}	0.98 ± .06Da
	21	0.90 ± .10^{CDb}	0.95 ± .01^{CDb}	1.12 ± .05^{Ca}
	30	0.91 ± .08^{CDc}	0.96 ± .02^{Cb}	1.14 ± .01^{BCa}
	60	0.93 ± .03^{BCb}	0.94 ± .04^{CDb}	1.18 ± .05^{ABa}
	90	0.95 ± .05^{BCc}	0.98 ± .01^{BCb}	1.15 ± .02^{BCa}
	120	0.98 ± .02^{Bb}	1.01 ± .05^{Bb}	1.17 ± .05^{ABa}
	150	1.06 ± .04^{Ab}	1.10± .06^{Ab}	1.20 ± .08^{Aa}
Salt (%)	0**	3.04 ± .02^{Ea}	2.54 ± .03^{Fb}	2.04 ± .05^{Ec}
	15	3.49 ± .03Da	2.96 ± .01^{Eb}	2.16 ± .03^{DEc}
	21	3.65 ± .03^{Ca}	3.16 ± .04^{CDb}	2.38 ± .01^{BCc}
	30	3.74 ± .01^{BCa}	3.30 ± .03^{ABCb}	2.21 ± .05^{CDc}
	60	3.94 ± .04^{Aa}	3.11 ± .02^{DEb}	2.58 ± .01^{Ac}
	90	3.85 ± .03^{ABa}	3.19 ± .07^{BCDb}	2.51 ± .03^{Ac}
	120	3.92 ± .01^{Aa}	3.36 ± .04^{ABb}	2.44 ± .03^{ABc}
	150	3.98 ± .05^{Aa}	3.40 ± .06^{Ab}	2.35 ± .02^{CDc}
	Mean value	3.79 ± .03	3.21 ± .04	2.37 ± .03
Fat (%)	0**	10.52 ± .11^{Fa}	9.39 ± .08^{Gb}	7.38 ± .09^{Gc}
	15	10.95 ± .13^{Ba}	9.61 ± .10^{Eb}	7.57 ± .06^{Fc}
	21	10.74 ± .21^{CDa}	10.10 ± .12^{ABb}	8.09 ± .11^{Bc}
	30	10.60 ± .15^{EFa}	9.79 ± .09^{Db}	7.75 ± .08^{Ec}
	60	11.10 ± .18^{Aa}	9.55 ± .08^{Fb}	7.96 ± .09^{Cc}
	90	10.65 ± .12^{DEa}	9.86 ± .11^{Cb}	7.85 ± .06^{Dc}
	120	11.12 ± .10^{Aa}	10.15 ± .14^{Ab}	8.12 ± .11^{Ac}
	150	10.83 ± .23^{Ca}	10.09 ± .13^{Bb}	7.93 ± .12^{Cc}
	Mean value	10.85 ± .15	9.88 ± .11	7.89 ± .09

**1 = The filling material of the first group consists of a mixture of 2:1 cheese crumbs and whey cheese, respectively. 2 = The filling material of the second group consists of a mixture of 1:1 cheese crumbs and whey cheese. 3 = The filling material of the last group consists of a mixture of 1:2 cheese crumbs and whey cheese, respectively.*

***0 = It refers to the chemical characteristics of the initial filling materials.*

There is no statistical difference between the results indicated by the same superscript capital letter within the column of the same chemical parameter (p>0.05).

There is no statistical difference between the results indicated by the same superscript small-case letter within the each same row (p>0.05).

Table 2. The microbiological characteristics of the filling materials and microbiological results of the samples for 5 months.

	Time (day)	Group 1*	Group 2*	Group 3*
Enterobacteriaceae	0**	$5.70 \pm .050^{Ac}$	$6.20 \pm .070^{Ab}$	$7.30 \pm .015^{Aa}$
	15	$5.46 \pm .030^{Bb}$	$5.52 \pm .015^{Bb}$	$7.09 \pm .045^{Ba}$
	21	$5.32 \pm .025^{Cc}$	$5.47 \pm .020^{Bb}$	$6.80 \pm .046^{Ca}$
	30	$5.04 \pm .020^{Dc}$	$4.60 \pm .025^{Cb}$	$6.38 \pm .030^{Da}$
	60	$4.70 \pm .050^{Ec}$	$4.31 \pm .045^{Db}$	$6.23 \pm .035^{Ea}$
	90	$4.53 \pm .025^{Fc}$	$3.32 \pm .030^{Eb}$	$5.06 \pm .032^{Fa}$
	120	$4.13 \pm .030^{Gc}$	$3.22 \pm .061^{Eb}$	$4.53 \pm .030^{Ga}$
	150	$2.92 \pm .030^{Hc}$	$2.80 \pm .045^{Fb}$	$3.27 \pm .026^{Ha}$
E. coli	0**	$3.71 \pm .057^{Ab}$	$2.73 \pm .035^{Ac}$	$4.72 \pm .025^{Aa}$
	15	$2.04 \pm .045^{Bb}$	$1.64 \pm .045^{Bc}$	$3.78 \pm .031^{Ba}$
	21	0	0	$1.79 \pm .045^{Ca}$
	30	0	0	0
	60	0	0	0
	90	0	0	0
	120	0	0	0
	150	0	0	0
Total Yeasts and Moulds	0**	$5.31 \pm .032^{Fc}$	$5.89 \pm .065^{Da}$	$5.45 \pm .025^{Db}$
	15	$5.52 \pm .020^{Ec}$	$6.12 \pm .032^{Cb}$	$6.64 \pm .045^{Ba}$
	21	$5.73 \pm .035^{BCc}$	$6.75 \pm .025^{Bb}$	$6.93 \pm .047^{Aa}$
	30	$6.83 \pm .032^{Ab}$	$7.14 \pm .045^{Aa}$	$7.07 \pm .060^{Aa}$
	60	$5.72 \pm .021^{BCb}$	$5.36 \pm .032^{Ec}$	$5.82 \pm .030^{Ca}$
	90	$5.62 \pm .030^{Da}$	$5.31 \pm .02^{Ec}$	$5.52 \pm .025^{Db}$
	120	$5.80 \pm .025^{Ba}$	$5.32 \pm .020^{Ec}$	$5.47 \pm .063^{Db}$
	150	$5.69 \pm .027^{CDa}$	$5.32 \pm .023^{Eb}$	$5.40 \pm .050^{Db}$
Lactobacilli	0**	$7.53 \pm .032^{Gc}$	$8.14 \pm .040^{Gb}$	$9.16 \pm .040^{Da}$
	15	$8.94 \pm .020^{Fc}$	$9.25 \pm .031^{Db}$	$10.63 \pm .072^{Ba}$
	21	$10.92 \pm .025^{Ab}$	$10.90 \pm .035^{Ab}$	$11.32 \pm .062^{Aa}$
	30	$9.75 \pm .025^{Bc}$	$10.77 \pm .025^{Ba}$	$10.69 \pm .040^{Bb}$
	60	$9.64 \pm .045^{Cc}$	$9.94 \pm .035^{Ca}$	$9.82 \pm .035^{Cb}$
	90	$9.12 \pm .020^{Ea}$	$9.13 \pm .025^{Ea}$	$8.79 \pm .045^{Eb}$
	120	$9.24 \pm .025^{Da}$	$9.26 \pm .036^{Da}$	$8.84 \pm .030^{Eb}$
	150	$9.22 \pm .046^{Da}$	$8.75 \pm .031^{Fb}$	$8.43 \pm .044^{Fc}$
Lactic Streptococci	0**	$6.91 \pm .042^{Ec}$	$7.74 \pm .025^{Fb}$	$9.30 \pm .051^{Da}$
	15	$8.40 \pm .046^{Db}$	$7.96 \pm .026^{Ec}$	$10.23 \pm .035^{Ba}$
	21	$9.14 \pm .026^{Cb}$	$8.43 \pm .021^{Dc}$	$11.17 \pm .025^{Aa}$
	30	$9.25 \pm .050^{BCb}$	$8.50 \pm .030^{Dc}$	$10.33 \pm .038^{Ba}$
	60	$9.35 \pm .090^{Bb}$	$9.38 \pm .062^{Ab}$	$9.74 \pm .035^{Ca}$
	90	$9.88 \pm .021^{Aa}$	$9.31 \pm .060^{ABb}$	$9.29 \pm .045^{Db}$
	120	$9.79 \pm .05^{Aa}$	$9.21 \pm .032^{Bb}$	$8.73 \pm .035^{Ec}$
	150	$8.27 \pm .064^{Db}$	$8.94 \pm .032^{Ca}$	$7.83 \pm .050^{Fc}$

**1 = The filling material of the first group consists of a mixture of 2:1 cheese crumbs and whey cheese, respectively. 2 = The filling material of the second group consists of a mixture of 1:1 cheese crumbs and whey cheese. 3 = The filling material of the last group consists of a mixture of 1:2 cheese crumbs and whey cheese, respectively.*

***0 = It refers to the microbiological characteristics of the initial filling materials.*

Microbial cultivation and counting of the resulted colonies were done in duplicate and the results were given as means ± S.D. of log cfu per gram

There is no statistical difference between the results indicated by the same superscript capital letter within the column of the same microorganism (p>0.05).

There is no statistical difference between the results indicated by the same superscript small-case letter within the each same row (p>0.05).

The organisms belonging to the family ENTR are important in relation to food spoilage and food safety aspects of diverse foods. These organisms have also been used as indicators of microbial quality and hygiene. However, the presence of low levels of ENTR in foods is accepted and does not represent a direct safety concern. Pasteurization of milk and prevention of post processing contamination can effectively control these organisms (Anand and Griffiths, 2011). According to the results, the highest ENTR count was detected in the 3rd group as 7.30 log cfu/g on the first day, while the lowest ENTR count was in the 2nd group as 2.80 log cfu/g at the end of the storage period. It was determined that the ENTR counts decreased significantly in all samples during the storage period ($p<0.05$), excepting the 15th and 21st days of the 2nd group ($p>0.05$). When the three groups were evaluated between each other, it was seen that the 3rd group contained the most ENTR during and after the storage period ($p<0.05$). This is thought to be directly related to the amount of whey cheese of the samples since the filling material of the 3rd group contains more whey cheese than the other two groups. Whey cheese is a product that is conducive to the development of pathogens. As lactic acid bacteria are not employed in the production of this sort of cheese, pathogens that constitute a risk in milk products can conveniently reproduce (Kamber, 2007).

E. coli has been used to indicate fecal contamination and the effectiveness of sanitation programs in different matrices and ready-to-eat foods (Buchanan and Oni, 2012). The count of *E. coli* in cheeses produced from whey should not exceed 2 log cfu/g according to the Turkish Food Codex Regulation on Microbiological Criteria in terms of process hygiene (Anonymous, 2011). On the other hand, according to TS 591, white cheese samples should not contain any *E. coli* in terms of microbiological features (Anonymous, 2013). According to the results of the present study, *E. coli* counts were determined in all samples as 3.71, 2.73 and 4.72 log cfu/g on the first day, respectively, but then it showed a decreasing trend in all three groups. In the first two groups, *E. coli* was not detected after 2 weeks, while in the last group 1.79 log cfu/g *E. coli* was detected in the 3rd week, and no *E. coli* was detected in any of the products during the following periods.

The yeasts and moulds are important microbial contaminants in the dairy industry. One of the reasons for the short shelf life of fresh whey cheeses is due to the growth of yeasts and moulds (Irkın, 2011). As shown in Table 2, the counts of the yeasts and moulds increased significantly until the 30th day of storage but it decreased after 60th day and the counts of the groups were determined as 5.69, 5.32 and 5.40 log cfu/g on the 150th day of the storage, respectively. It was stated that a low pH (4.2-4.6) is not suitable for the growth of the most spoilage bacteria (Robinson et al., 2006), but may promote the growth of yeasts and moulds that may adversely affect the appearance and taste of cheese (Robinson et al., 2002). In the literature, there are various dairy products containing parallel and/or different values to the amount of yeasts and moulds detected in our research (Hayaloglu et al., 2008; Kırdar et al., 2018).

Lactic acid bacteria (LAB) have complex nutritional requirements that are found in rich nutritional environments such as fermented foods and are essential to the formation of these products (Tannock, 2004). In general, LAB from several genera, including *Lactobacillus*, *Lactococcus*, *Streptococcus*, *Pediococcus*, and *Leuconostoc* are predominant in fermented foods (Rezac et al., 2018). LAB are responsible for the development of the flavor and texture of the products by taking part in the fermentation and preservation of foodstuffs (Tannock, 2004). The competition between lactic flora and potential pathogen microorganisms, decreasing of pH, and a_w are considered positive factors in order to ensure the safety of dairy products (Astegiano et al., 2014). In the present study, the initial total lactobacilli counts of the three groups were 7.53, 8.14, and 9.16 log cfu/g, respectively. Then, these counts reached the highest level in all 3 groups on the 21st day and were determined as 10.92, 10.90, and 11.32 log cfu/g, respectively. At the end of the storage period, a decrease was observed only in the 3rd group compared to the initial count. On

the other hand, the initial lactic streptococci counts of lactic acid bacteria were determined as 6.91, 7.74 and 9.30 log cfu/g, respectively. Again, the decreasing trend was seen only in the 3rd group towards the end of the storage period and there were statistically significant differences between the groups in both lactobacilli and lactic streptococci counts at the end of the storage ($p<0.05$). According to these data mentioned in Table 2 and considering all these reviews, it can be stated that pickled pepper produced by using low value dairy by-products is rich in LAB and is a high added value fermented product.

Sensory evaluation results of the samples

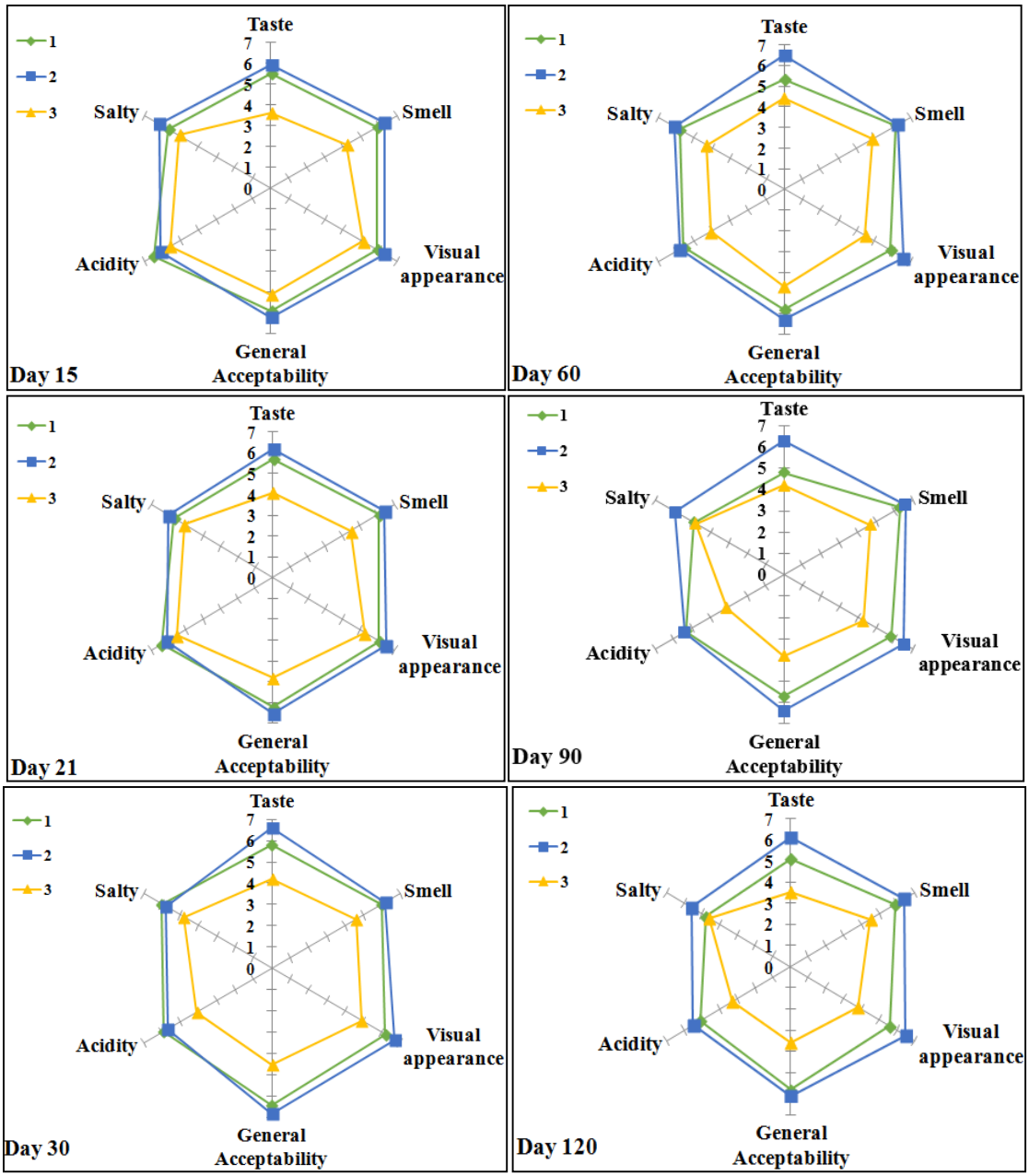
In the field of the food science, sensory analysis plays a major role in defining food quality. Because, sensory analysis can help identify imperative sensory characteristics driving acceptability and it can be useful to ascertain target consumers, product competitors and assess the new ideas (Singham et al., 2015; Yang and Lee, 2019). Sensory evaluation can determine the impact of scaling up pilot samples to large-scale manufacturing. Therefore, from a marketing perspective, in this study we aimed to determine which product formulation that mostly affects consumers' sensory satisfaction. According to the analysis, panelists assessed the samples in terms of six main sensory attributes (taste, smell, acidity, salty, visual appearance, general acceptability) and the results were depicted in Figure 3 by using spider/radar chart diagrams. Considering the results, it was observed that the highest scoring group was the 2nd in terms of all parameters. On the other hand, it was determined that the 1st and 2nd groups maintained the sensory quality criteria during the storage period of 4 months and this situation is considered to be a significant advantage in terms of sales and marketing.

Sensory evaluation is the most important criterion for acceptance or rejection of a food and appearance is the first characteristic perceived by the human senses having an important role in the identification and final selection of food (Sharif et al., 2017). In this regard, when the samples were evaluated in terms of visual appearance, it was observed that the 1st and 2nd groups had the highest and closest scores in the first month, whereas there was a difference between the two groups starting from the 2nd month and the scores of the 1st group decreased but still did not lose its visual appealing (5.6-5.9).

Other parameters, taste and smell, play an important role in appetite, food preferences, and food intake (Schiffman and Graham, 2000). According to the results, the last group had the lowest taste score (3.5-4.4). In this regard, it can be said that the use of whey cheese alone or high rate in the production of pickled pepper may be negative for consumers who are not familiar with this product. Also, the taste scores decreased in all groups towards the end of the storage time and the same trend was observed in the appearance and general acceptability parameters. However, when the scores of the taste, appearance and general acceptability parameters of the 1st and 2nd groups were examined in the last month, it can be concluded that the samples did not lose their consumer appeal during the storage period. As for the smell, the 2nd group had the highest scores (6.2-6.6) for 4 months. In the 1st and 3rd group, while the scores given by the panelists at the beginning of pickle formation were low, an increase was observed in the following periods.

Salt contributes to sensory characteristics, such as the aroma profile of foods, by increasing the volatility of the aroma compounds, or mouthfeel, by affecting the lubricating properties of saliva (Koliandris et al., 2010). For salty taste, the highest scores were given to the 1st and 2nd groups by the panelists while the lowest scores were given to the last group. In the 3rd group, the increase of whey cheese in the filling material reduced the salt content of the samples, which caused the panelists to give a low score because expecting a certain salt content in a product such as pickles. However, it should be noted that the salt detection threshold differs significantly between males and females, therefore, individual salt detection and recognition thresholds alone are not a determining factor on consumer acceptability (Mitchell et al., 2013). Finally, the acidity of the 3rd group affected consumers negatively in the sensory evaluation and caused

the lowest scores to be given. This is thought to be caused by the lower pH of whey cheese (5.13) than cheese crumbs (5.51) that used in the preparation of the filling materials. In addition, it can be said that this situation is related to the increase in acidity more than other groups due to the fact that lactic streptococci and lactobacilli growth is mostly in the 3rd group during the storage period. This is also consistent with the data in Tables 1 and 2, in which the results of the chemical and microbiological analyses are given.



1 = The first group consists of a mixture of 2:1 cheese crumbs and whey cheese, respectively.
2 = The second group consists of a mixture of 1:1 cheese crumbs and whey cheese.
3 = The last group consists of a mixture of 1:2 cheese crumbs and whey cheese, respectively.

Figure 3. Sensory analysis results of the samples for 4 months.

CONCLUSIONS

In the present study, whey cheese and cheese crumbs were used in the production of pickled peppers in order to evaluate the dairy industry by-products in different ways. The chemical, microbiological, and sensory analyses were performed in 3 different formulations. According to the results of the chemical analysis, the total acidity, pH, salt and fat values of the samples varied according to the ratio of cheese crumbs and whey cheese used in the formulation and the lowest salt and fat content were determined in the 3rd group containing the highest whey cheese in its formulation. Considering the results of sensory analysis, the most favored group was the 2nd group (cheese crumbs and whey cheese, 1:1). In all samples, *E. coli* was not detected on day 21 when the products are known to be ready to eat. As a result, the utilizing area of dairy by-products was expanded with this study and the product formulation was diversified in the commercial production of pickled pepper that fermented with dairy ingredients. In addition, the product formulation, which is important for both consumer appeal and product characteristics, was optimized utilizing dairy by-products and the results obtained in the study were gained to the literature and food manufacturers.

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