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Determination of Microbiological, Chemical, Physical and Sensory Properties of Pickles Produced from Organic Kımı Plant Using Whey at Different Concentrations During Storage

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Abstract:
Effects of fortification with Kımı plants and whey produced from Çeçil cheese on the chemical, microbial and sensory properties of Kımı pickle samples during storage time (20th and 40th days) were investigated in the study. Differences in microbiological and chemical changes were found to be statistically significant ($P < 0.05$) during storage period. Whey added Kımı pickles containing statistically higher lactic acid bacteria counts than the control samples. Protein and dry matter rates of whey added Kımı pickle samples were also found to be higher than the control groups. According to the results of sensory analysis, control and 10% whey added K1 samples were preferred by the panellists during ripening more than the others (K2, K3, K4, and K5). This study results might give opinions about the lactic acid bacteria (LAB) population associated with traditional whey added Kımı pickles and constitute a LAB strain resource for further studies involving the development of starter cultures.

Keywords: Organic kımı plant, Biotechnology, Whey, Nutraceutical ingredient, Pickle production

Farklı Konsantrasyonlarda Peynir Altı Suyu Kullanılarak Organik Kımı Bitkisinden Üretilen Turşuların Mikrobiyolojik, Kimyasal, Fiziksel ve Duyusal Özelliklerinin Depolama Süresince Belirlenmesi

Öz

Bu çalışmada Çeçil peynirinden elde edilen peynir altı suyunun farklı konsantrasyonları ve Kımı bitkisi kullanılarak üretilen Kımı turşu örneklerinin (20 ve 40 gün) depolama süresince kimyasal, mikrobiyolojik ve duyusal özelikleri incelenilmiştir. Örneklerin depolama boyunca mikrobiyolojik ve kimyasal özelliklerindeki değişiklikler önemli ($P < 0,05$) bulunmuştur. Kontrol örnekleri ile karşılaştırıldığında peynir altı suyu ekli turşu örneklerinde istatistiksel olarak daha yüksek laktik asit bakteri sayısına rastlanılmıştır. Peyniraltı suyu ilaveli örneklerde protein ve kurumadde oranları da kontrol grubundan yüksek bulunmuştur. Duyusal değerlendirme sonucunda kontrol ve %10 peynir altı suyu ilaveli K1 örneği diğer örneklerden (K2, K3, K4 ve K5) depolama boyunca daha çok beğenilmiştir. Bu çalışma sonuçları geleneksel olarak üretilen Kımı turşularındaki laktik asit bakteri popülasyonu hakkında bilgi vererek daha ileride yapılacak olan çalışmalarda starter kültür geliştirilmesinde bir kaynak olarak kullanılabileceği hakkında fikir verebilir.

Anahtar Kelimeler: Organik kımı bitkisi, Biyoteknoloji, PAS, Nutrasötik bileşikler, Turşu üretimi

1. Introduction

Turkey is rich in plant diversity harbouring approximately 10.000 naturally growing plant species 2991 of which are known to be endemic. The flora of Turkey has been added 354 new plant species according to more recent plant lists (Özhatay and Kültür, 2006; Altundağ and Özhatay, 2008-2009; Özhatay et al., 2009). Turkish people often consume some naturally growing plant species in their diets (Altundağ and Özhatay, 2008-2009). One of such species is called Kımı (Gımı, Gımıgımı Mendi, Mendo, Banda, Mendik and Piçekli in other acronyms) in its local name and has two species as Anthriscus

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sylvestris and A. nemorosa common in the area (Güneş and Özhatay, 2011). Locals often consume Kımı plant in pickles (Anonymous, 2014). USA regulations define pickle to be a kind of food a low-acid food to which acid is added, a water activity above 0.85 and finished equilibrium pH of 4.6 or below (GPO, 2013; Acosta et al., 2015). Acidic food have good shelf – life under low pH conditions and light thermal treatment (Little et al., 1976; Tucker and Featherstone, 2011) because of the fact Clostridium botulinum spores cannot germinate and grow (and consequently produce toxin) at or below pH 4.6 (Acosta et al., 2015). Such a situation may show pickling to be a good way of preserving food (Little et al., 1976). However, food quality is not ensured in the case of inconstant and septic conditions (Sakai et al., 2014). In spite of traditionally produced pickle in Turkey for only family consumption, it can be produced industrially and exported in the form of canned pickle by large food companies (Ulu, 2001; Sürücüoğlu and Özçelik, 2003). Pickled vegetables are naturally fermented by different species of lactic acid-producing bacteria (Hutkins, 2006; Sakai et al., 2014; Di Cagno et al., 2014). Food fermented suitably can provide useful flora to human intestine thus regulating and making healthy digestive system. In fermentation process, natural and beneficial bacteria cause vegetables to give delicious sour taste and stay with rich vitamin content. Lactic acid fermentation can preserve natural plant content and improve its quality, taste and aroma (Bamforth, 2005; Çetin, 2011). Kımı plant can be used in pickle as a food material differently from classical vegetables (carrots, cabbage,.. per example) while whey, is a precious by-product obtained in cheese production process. Under usual cheese production conditions, a 10 L whey represents 1 kg cheese (Özmihci and Kargı, 2007) Whey is composed mainly of lactose (70 to 72%), whey proteins (8 to 10%) and minerals (12 to 15%), which can change according to mineral ratio, acidity and the structure of whey proteins (Kosseva et al., 2009). Whey can involve organic matters, like carbohydrates (4-5%), lactose, proteins (nearly 1%,) fats (around 0.4-0.5%), lactic acid (below 1%) and mineral salts [1 to 3%; Gannoun et al., 2008; Kosseva et al., 2009) and be used in a broad range of food products from beverage powders, nutrition bars, soups, bakery, confectionery coatings and desserts to ice cream and frozen dairy (Cuartas-Uribe et al., 2009). Nutritional value of whey comes from its extractable bioactive compounds and almost in its every use no nutrition loss is seen, however; there is no case in related literature where whey is used in Kımı pickle. Therefore, the objective of the present study is to introduce the production of traditional whey added Kımı pickle, with unique taste and high nutritional value, untested aroma to be offered to consumers' taste and possible contribution of the product to the country's economy.

2. Materials and Methods

2.1. Materials

Chemicals used in the study were obtained from commercial Sigma-Aldrich (USA) and Merck (Germany) firms. Kımı plants were obtained from hand harvested when plants generally reached up to a 10 cm height in Ardahan province of Turkey (Fig. 1).

2.2. Production of Kımı Pickles

Because of the lack of previous studies on Kımı pickle, "Kımı pickle" is adopted to be used such local and traditional type of pickle as a term. Preparation method of Kımı pickle was composed from old villagers who have long been producing it with traditional way in which they add whey of a local cheese, "Çeçil" in Turkish acronym in East Anatolia Region, was added in the pickle. Çeçil cheese is granted its unique odour by its whey and it is made of fatless cow's milk prepared by

mixing fresh and old milk stored overnight and removing its cream to make butter.

This mixture of fatless milk at about 35°C was heated up to 55°C and added rennet. When flocks were seen in a pot, they were taken to cheese clothes made of plastic strips and Çeçil cheese curd and whey were produced. Production phases of the home-made traditional Kımı pickle are shown in Fig. 2.

Fig. 1. The Map of Ardahan Province

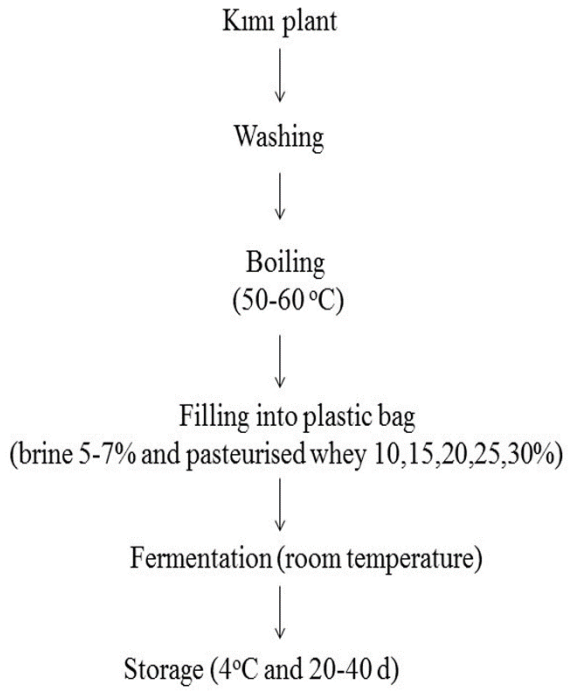

Fig. 2. Flow chart for the home-made traditional preparation of Kımı pickle

Following the production process, pickle samples were divided into six groups as C (Control; without whey), K1 (10% whey added), K2 (15% whey added), K3 (20% whey added), K4 (25% whey added) and K5 (30% whey added). The samples were transported to cold storage (4oC) and experimental pickle samples were stored for 20 and 40 days. Image of ready to consume Kımı pickle and Kımı plant are given in Fig. 3. Such form of Kımı pickle can be consumed deliciously after roasting.

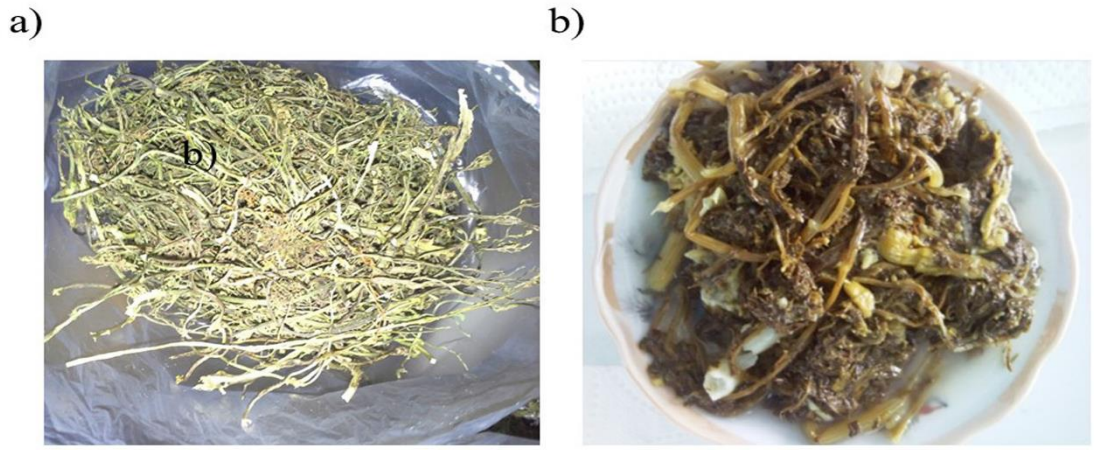

Fig. 3. a) Dried Kımı plant **b)** Traditional preparation of Kımı pickle

2.3. Microbiological analysis of Kımı pickle samples

For each sample, 11 g cheese was taken and diluted in 99 mL of 0.85% (w/v) sterile saline solution. Then, a Stomacher (Lab. Stomacher Blander 400 BA 7021, Sward medical) was used to homogenise the samples in a sterile polyethylene bag for 1.5 min. Sterile 9 mL 0.85% (w/v) NaCl solution was used for dilution and the number of total aerobic mesophilic bacteria (TAMB; Merck, at 30±1°C for 48 h; Harrigan, 1998); lactic acid bacteria (in MRS; Merck, at 30°C for 48 h in anaerobic conditions; Papamanoli et al., 2003); lactic acid bacteria (in M17; Merck, at 30°C for 48 h; Papamanoli et al., 2003); yeast-moulds (Potato Dextrose Agar, Oxoid, at 25°C for 5 to 7 days; Speck 1984) and coliform and Enterobacteriaceae (Violet Red Bile Agar, Oxoid and Violet Red Bile Dextrose Agar, Merck 1.10275.0500, at 37ºC for 24 h; Harrigan, 1998) were counted, respectively.

2.4. Chemical analysis of Kımı pickle samples

The dry matter quantity in 100 g of sample was calculated gravimetrically (g/100 g) (Cemeroğlu, 1992). Acidity and pH of pickles were measured according to AOAC (2002) while salt rate was found by titrating the filtrate prepared for the determination of acidity with 0.1 N $AgNO_3$ using 5% $K_2Cr_2O_7$ indicator after its neutralisation (Özgümüş, 1999). Protein content was calculated by the micro Kjeldahl method according to AOAC (1983).

2.5. Sensory Analysis

Kımı pickle samples were subjected to sensorial analysis by eight experienced panellists on 20 and 40 days of storage period according to the method of Altuğ (1993). Samples were scored by the panellists considering five sensorial properties; appearance, colour, odour, flavour and firmness. Panellists evaluated the experimental pickle samples by grading them on a scale of from 1 to 10 as 10–8 very well, 7–6 good, 5–4 bad and 3–1 unacceptable.

2.6. Statistical analysis

Completely randomised experimental design was adopted with factorial arrangement in the study involving six treatment groups (i.e. C, K1, K2, K3, K4 and K5 samples), five whey addition rates (10, 15, 20, 25 and 30%), two storage time (20 and 40 days) and two replicates. Variance analysis test (ANOVA) was used to evaluate data statistically and then Duncan's multiple range tests were used to define mean distribution through statistical

software (SPSS 17.0; Chicago, IL, USA; SAS, 1998).

3. Results and Discussion

Table 1 represents milk and whey composition used in traditional production process of Çeçil cheese and preparation of Kımı pickle.

Table 1. Chemical and microbiological analysis of milk and whey

Analysis	Milk	Whey
TAMB (log cfu/mL)	6.76±0.29	6.82±0.61
LAB grown on MRS Agar (log cfu/mL)	6.77±0.28	5.71±0.35
LAB grown on M17 Agar (log cfu/mL)	6.35±0.72	5.23±0.50
Yeast and Mould (log cfu/mL)	5.13±0.46	3.81±0.41
Coliform Group Bacteria (log cfu/mL)	4.16±1.10	3.87±0.39
Dry matter (%)	11.00±0.63	7.12±0.49
Fat (%)	4.2±0.42	1.00±0.21
Ash (%)	0.82±0.29	0.39±0.47
Acidity (°SH)	10.43±0.02	7.99±0.52
pH	6.35±0.32	5.13±0.39
Protein (g/100 g)	4.31±0.31	2.90±0.61

3.1. Microbiological characteristics of Kımı pickles

Table 2 presents the findings obtained from microbiological analysis conducted on Kımı pickle samples. Microbiological counts of solid and brine samples were found to be significantly different ($P < 0.05$) on 20 and 40 days and TAMB counts of K5 pickles were determined to be higher than the others. It can be seen in Table 2 that TAMB in pickle samples was found as 4.66 to 7.29 log cfu/mL in solid part, while as 5.02 to 7.83 log cfu/mL in brine part. Yıldız (2011) found similar results obtaining TAMB counts in solid to change between 2.84 and 6.60 log cfu/mL, while in brine 3.04 and 6.36 log cfu/mL. The number of LAB species can be used for producing fermented vegetables in different parts of the world including Turkey (Aktan et al., 1998; Özçelik et al., 1998; Erten and Tangüler, 2010). In this respect, *L. plantarum* is accepted to be the most important species (Hutkins, 2006; Abriouel et al., 2008). In the present study, LAB count in MRS was found to be 5.52 to 8.18 log cfu/mL and 6.09 to 8.62 log cfu/mL in solid and brine, respectively. Paramithiotis et al. (2010) stated that LAB is quite effective in cauliflower pickle while Yıldız (2011) found the number of LAB (MRS) in solid to be between 4.70 and 8.06 log cfu/mL and in brine between 5.81 and 8.09 log cfu/mL, which were similar to the present study. Turgut (2006) reported that LAB (MRS) counts to be 1.67 log cfu/mL in initial fermentation and 6.89 log cfu/mL in the last fermentation of cucumber pickles similarly to that reported by Elmacı et al. (2015) in Çubuk pickles.

Table 2. Results of the microbiological analysis related to the pickles manufactured from Kımı (log cfu/mL)

Samples	Treatment	Storage period (days)	TAMB	Lactic acid bacteria (in MRS)	Lactic acid bacteria (in M17)	Coliforms	Yeast and Mould
C	Solid	20	5.52±0.06^{d}	6.20±0.03^{a}	6.63±0.01^{d}	1.03±0.01^{b}	3.35±0.00^{c}
		40	5.33±0.01^{c}	6.01±0.02^{c}	5.87±0.03^{bc}	0.90±0.00^{a}	2.69±0.02^{b}
	Brine	20	6.36±0.04^{c}	7.33±0.01^{c}	7.06±0.02^{c}	2.61±0.09^{d}	4.93±0.02^{f}
		40	6.03±0.01^{c}	7.04±0.04^{d}	6.31±0.08^{d}	1.54±0.02^{d}	3.17±0.02^{e}
K1	Solid	20	5.02±0.02^{ab}	7.79±0.05^{f}	6.46±0.03^{d}	1.43±0.07^{bc}	3.20±0.02^{c}
		40	5.00±0.00^{b}	7.05±0.01^{e}	5.44±0.05^{b}	0.90±0.00^{a}	4.07±0.10^{b}
	Brine	20	6.09±0.02^{b}	8.19±0.02^{e}	7.08±0.04^{c}	3.30±1.30^{e}	4.17±0.02^{e}
		40	5.86±0.10^{d}	7.14±0.03^{f}	6.62±0.02^{e}	1.24±0.04^{c}	3.86±0.02^{f}
K2	Solid	20	5.43±0.60^{b}	6.53±0.08^{c}	5.83±0.02^{b}	0.90±0.00^{a}	1.99±0.00^{b}
		40	4.66±0.08^{a}	5.85±0.05^{b}	4.76±0.27^{a}	0.90±0.00^{a}	1.99±0.00^{b}
	Brine	20	5.30±0.04^{a}	7.05±0.03^{a}	6.81±0.08^{bc}	1.74±0.01^{b}	0.90±0.00^{a}
		40	5.02±0.02^{a}	6.28±0.05^{b}	5.45±0.00^{a}	1.00±0.00^{b}	0.90±0.00^{a}
K3	Solid	20	4.99±0.02^{a}	6.80±0.06^{d}	5.57±0.24^{a}	1.99±0.00^{c}	3.18±0.49^{c}
		40	5.04±0.05^{b}	5.52±0.16^{a}	4.57±0.03^{a}	1.99±0.00^{b}	2.17±0.02^{c}
	Brine	20	5.27±0.00^{a}	7.60±0.04^{d}	6.46±0.04^{a}	0.90±0.00^{a}	3.85±0.02^{d}
		40	5.19±0.02^{b}	6.09±0.02^{a}	5.75±0.00^{b}	0.90±0.00^{a}	2.79±0.12^{cd}
K4	Solid	20	6.51±0.05^{d}	7.14±0.01^{e}	6.24±0.04^{c}	1.32±0.00^{b}	0.90±0.00^{a}
		40	6.09±0.02^{d}	6.10±0.01^{d}	5.36±0.02^{b}	0.90±0.00^{a}	0.90±0.00^{a}
	Brine	20	7.12±0.04^{d}	8.20±0.02^{e}	7.01±0.01^{c}	2.29±0.02^{d}	2.68±0.03^{c}
		40	6.61±0.09^{d}	6.97±0.02^{c}	6.13±0.02^{c}	1.07±0.02^{b}	1.35±0.00^{b}
K5	Solid	20	7.20±0.09^{e}	6.52±0.03^{b}	6.33±0.02^{c}	0.90±0.00^{a}	2.00±0.00^{b}
		40	7.29±0.10^{e}	8.18±0.04^{f}	7.47±0.00^{c}	0.90±0.00^{a}	1.30±0.49^{b}
	Brine	20	7.45±0.01^{e}	7.27±0.16^{b}	6.55±0.01^{b}	2.04±0.05^{c}	2.36±0.01^{b}
		40	7.83±0.02^{e}	8.62±0.04^{e}	7.94±0.01^{e}	1.03±0.00^{b}	2.06±0.07^{c}

*Mean values followed by different letters in the same column are significantly different ($P < 0.05$).
Abbreviations: C: control (without whey); K1: 10% w/w Kımı pickle added whey; K2: 15% w/w Kımı pickle added whey; K3: 20% w/w Kımı pickle added whey; K4: 25% w/w Kımı pickle added whey; K5: 30% w/w Kımı pickle added whey

Table 3. Results of the chemical analysis related to the pickles manufactured from Kımı plants

Samples	Treatment	Storage period (days)	pH	Dry weight (g/100 g)	Protein (g/100 g)	Titratable acidity (g/100mL)	Salt (g/100 mL)
	Solid	20	3.47±0.01^{a}	6.23±0.02^{a}	0.86±0.01^{a}	1.08±0.02^{b}	4.56±0.03^{d}
C		40	3.60±0.02^{a}	6.00±0.00^{e}	0.94±0.01^{a}	1.09±0.04^{b}	4.14±0.01^{c}
	Brine	20	3.15±0.03^{a}	5.55±0.06^{b}	1.12±0.00^{a}	1.15±0.02^{a}	5.08±0.04^{c}
		40	3.20±0.03^{a}	5.10±0.01^{a}	1.18±0.01^{a}	1.10±0.02^{b}	4.95±0.02^{c}
	Solid	20	3.76±0.02^{b}	6.57±0.04^{a}	0.98±0.00^{a}	1.10±0.01^{b}	3.83±0.19^{b}
K1		40	3.75±0.02^{b}	6.51±0.01^{a}	1.07±0.03^{b}	0.88±0.02^{a}	3.32±0.02^{b}
	Brine	20	3.67±0.04^{bc}	5.82±0.02^{c}	1.28±0.01^{a}	1.07±0.06^{a}	4.25±0.11^{b}
		40	3.76±0.03^{d}	5.27±0.02^{b}	1.27±0.02^{b}	1.03±0.02^{a}	4.14±0.05^{b}
	Solid	20	3.86±0.02^{c}	6.20±0.02^{d}	1.00±0.00^{a}	1.05±0.04^{b}	4.82±0.05^{c}
K2		40	3.64±0.02^{a}	6.77±0.02^{b}	1.07±0.02^{b}	1.00±0.02^{b}	4.25±0.02^{c}
	Brine	20	3.70±0.02^{bc}	5.00±0.00^{a}	1.24±0.01^{a}	1.22±0.10^{b}	5.23±0.03^{c}
		40	3.49±0.02^{b}	5.56±0.02^{c}	1.30±0.04^{b}	1.20±0.02^{c}	5.12±0.02^{d}
	Solid	20	3.95±0.04^{d}	6.96±0.01^{e}	1.70±0.06^{c}	1.14±0.08^{c}	4.01±0.01^{c}
K3		40	3.80±0.02^{c}	6.88±0.08^{b}	1.87±0.02^{c}	1.08±0.03^{b}	3.70±0.11^{b}
	Brine	20	3.75±0.0^{c}	6.30±0.12^{d}	2.03±0.02^{b}	1.38±0.02^{c}	4.21±0.04^{b}
		40	3.70±0.03^{d}	6.39±0.01^{d}	2.17±0.02^{c}	1.22±0.02^{c}	4.14±0.01^{b}
	Solid	20	3.87±0.04^{c}	7.77±0.00^{c}	1.16±0.01^{b}	0.90±0.03^{a}	4.00±0.00^{c}
K4		40	3.78±0.03^{b}	7.84±0.03^{e}	1.19±0.23^{b}	0.69±0.01^{a}	3.84±0.03^{b}
	Brine	20	3.87±0.02^{d}	6.77±0.02^{e}	2.15±0.04^{b}	1.13±0.02^{a}	5.24±0.04^{c}
		40	3.55±0.01^{c}	6.52±0.02^{e}	2.26±0.00^{d}	1.10±0.01^{b}	5.00±0.00^{c}
	Solid	20	3.92±0.01^{d}	8.44±0.04^{d}	2.13±0.00^{d}	0.97±0.02^{a}	2.50±0.00^{a}
K5		40	3.53±0.04^{a}	8.05±0.09^{e}	2.01±0.01^{d}	0.52±0.02^{a}	2.46±0.01^{a}
	Brine	20	3.62±0.03^{b}	7.09±0.02^{f}	2.62±0.04^{c}	1.03±0.02^{a}	3.51±0.02^{a}
		40	3.28±0.05^{a}	6.29±0.04^{d}	2.95±0.00^{e}	0.98±0.01^{a}	3.29±0.02^{a}

*Mean values followed by different letters in the same column are significantly different ($P < 0.05$).

LAB (M17) counts were between 4.57 and 7.47 log cfu/mL in solid and 5.45 and 7.94 log cfu/mL in brine in convenience with that reported by Yıldız (2011). Elmacı et al. (2015) found the LAB counts on M17 Agar plates to range from 2.52 to 7.94 log cfu/mL in Çubuk pickles in agreement with the findings in the present study. Addition of whey can be said to affect significantly ($P < 0.05$) the microbial counts of pickles (Table 2). Counts of yeast and mould were found to range between 0.90 and 4.07 log cfu/mL in solid and 0.90 and 4.93 log cfu/mL in brine in the present study similarly those found by Yıldız (2011). Gözütok (2013) reported the number of yeast and mould to change between 2.81 and 2.79 log cfu/mL in pickles Tokatlı et al. (2013) stated it to range from 3.17 to 4.91 log cfu/mL in 2 – month storage period. Coliform counts were found in solid to be in the range of 0.90 to 1.99 log cfu/mL while between 0.90 and 3.30 log cfu/mL in brine in the present study while in Gözütok (2013) it was between 1 and 3.87 log cfu/mL. None of the studies mentioned (Yıldız, 2011; Tokatlı et al., 2013) including the present one detected Enterobacteriaceae in any of the samples at the end of the storage period. However, Fleming et al. (1995) found counts of Enterobacteriaceae to be 3.5 log cfu/mL at initial fermentation but none in the following fermentation process. Such results may be dependent on the preparation and ripening techniques of pickles.

3.2. Physical and chemical characteristics of Kımı pickles

Table 3 presents chemical components of Kımı pickle samples. Statistically significant chemical changes were determined in solid and brine samples ($P < 0.05$) during ripening period. The pH value was found in solid part changing between 3.47 and 3.95 in solid and 3.15 and 3.87 in brine. In Yıldız (2011), pH in solid was reported to change between 3.51 and 3.73 and 3.39 and 3.96 in brine, which is not convenient with that found in the present study because of increased whey concentration. Previous studies on pH reported different values e.g. 3.74 (Gözütok, 2013), 3.31 to 3.43 (İç, 2000) and 3.90 (Ogabi and Pamir, 1973) during a ripening period of 30 days. Li et al. (2015) found after monitoring whole fermentation process that pH in pickles decreased sharply in the first 24 h and then gradually until reaching stability (around pH 3) after 60 h fermentation in Chinese pickles. Dry matter content was found to be 6.00 to 8.44 g/100g and 5.10 to 7.09 g/100 g in solid and brine parts of pickle, respectively while they were 5.05 to 8.71% and 3.56 to 6.80% in solid and brine parts in Cingöz (2005) differently from the results of the present study due maybe to the dry matter content of whey up to 8.12% because of which dry matter content of whey added Kımı pickle samples was higher than that of control group. In another study (Anonymous, 1987), dry matter rate was found in cucumber pickle samples to be 4.52g/100 g. Protein rate was found in the present study to range from 0.86 to 2.13 g/100 g in solid and 1.12 to 2.95 g/100 g in brine, which was higher in whey added samples than control group. Such a high protein content may result from high protein concentration of milk and whey (Table 1) containing a protein rate of 3.90 g/100 g. Protein content was detected in a previous study (Gürbüz, 1991) to be 0.55 g/100 g in cucumbers pickle. Acidity of Kımı pickle samples was observed to range between 0.52 and 1.14 g/100 mL in solid and 0.88 and 1.22 g/100 mL in brine, which were found in previous studies (Anonymous, 1987; Aktan et al., 1998) to be 0.70 to 1.30% and 0.72 to 1.62% in solid and 0.70 to 1.40% and 0.68 to 1.22% in brine, respectively. It was also reported by Elmacı et al. (2015) that mean titratable acidity of pickle brine samples was 0.48 g/100 mL ranging from 0.04 to 1.31 g/100 mL. Present study determined salt content to be between 2.5 and 4.82 g/100 mL in solid while 3.29 and 5.24 g/100 mL in brine while in Yıldız (2011) and Cingöz (2005) it was 2.76 to 4.58% and 3.51 to 7.02% in solid and 1.25 to 5.11% and 2.28 to 5.44% in brine, respectively. Maximum allowable pickle salt content is up to 6 to 7% in Turkish food standards (Anonymous, 1993) showing that saltiness level of all samples in the study is in the acceptable limit.

3.3. Sensory results

Sensory scores of Kımı pickle samples are given in Figure 4a and 4b in a scale ranging from 0 (inconsumable) to 10 (extra ordinary) in a radar plot. A significant difference ($P < 0.05$) was found between the properties of samples e.g. for appearance, colour, odour, flavour and firmness. Experienced panellists preferred the pickle samples containing whey in the rate of 10% and C (control without whey) more than the others. This situation might have been adversely affected their flavour and texture due to increased whey concentration.

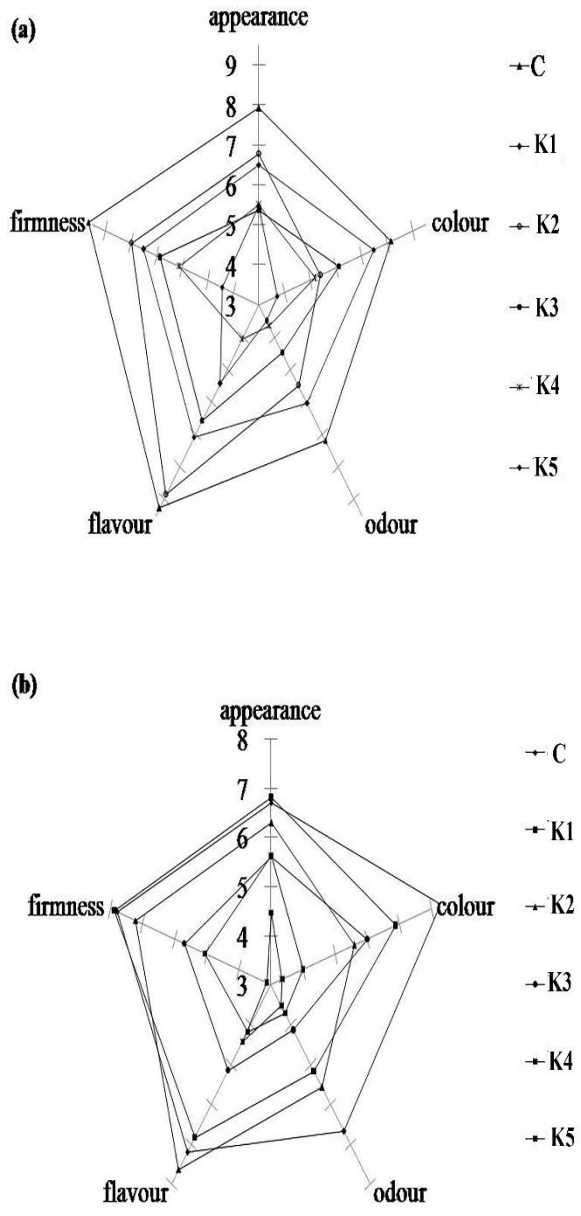

Fig. 4. Changes in sensory characteristics of Kımı pickle in 20 **(a)** and 40 **(b)** days of storage.

4. Conclusions

Main conclusion of the study may be that whey and Kımı plant can be successfully used in pickle production as a good natural source of nutritive ingredients. Kımı pickle, in this respect, is acceptable to be a suitable source of nutritional and an ingredient for the food industry. Therefore, whey may be accepted to be an ingredient in pickle industry adding value to Kımı pickle and improving its physico-chemical and nutritional properties. Further whey added Kımı pickle samples were received the highest scores by panellists 10 % whey added sample and control in our study. However, there is not enough data dealing with the functionality of Kımı in pickle. The results of present study may be important both whey can be presented as one of the different evaluation possibilities and Kımı plant, a wild plant, can be opportunity in terms of introduce. The last emphasis may be on lactic acid fermentation as a method of preserving food a good solution for reducing the use of chemical preservatives in fermented vegetables.

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