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RESEARCH ARTICLE

Evaluation of physicochemical properties of çemengilik- A traditional meatball produced with fenugreek paste containing different tomato paste ratios

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ABSTRACT

The present study was carried out to determine the effects of fenugreek paste containing different ratios of tomato paste on some physicochemical properties of a traditional meatball. For this purpose, three groups of meatballs were produced and named as C (control, containing fenugreek paste without tomato paste), C1 (having the ratio of 4:1 fenugreek paste to tomato paste), and C1.5 (having the ratio of 3.5:1.5 fenugreek paste to tomato paste). It was determined that the addition of tomato paste had a lowering effect on the pH value. The exterior surface color parameters of all groups measured at the end of drying showed that C1.5 had the highest a* and b* values. Utilizing the ratio of 3.5:1.5 fenugreek paste to tomato paste (C1.5) resulted in lowest free fatty acid value. C1 had the lowest thiobarbituric acid value at the end of the processing stage. It was seen that utilizing tomato paste in the formulation of fenugreek paste had a significant decreasing effect on free fatty acid and thiobarbituric acid values. The results of the current study showed that a fenugreek paste to tomato paste ratio of 3.5:1.5 could be applied for manufacturing çemengilik to limit lipid oxidation and improve color properties.

Keywords: Color; Fenugreek paste; Lipid oxidation; Lycopene; Meatball; Tomato paste

INTRODUCTION

Numerous traditional meat products are prepared using various animal sources throughout the world. Kofte (meatballs) are one of these traditional meat products, which vary from country to country due to formulation, meat type, and cooking methods (Gagaoua and Boudechia, 2018). In Turkey, different types of meatballs are manufactured, such as Tekirdağ kofte, Sivas kofte, İnegöl kofte, Akçaabat kofte, Adana şiş kofte, Tire kofte, and çemengilik (fenugreek paste kofte). The specific properties of çemengilik are that they contain fenugreek paste in their formulation and are dried after portioning. The manufacturing process of çemengilik consists of three stages: mixing the minced meat with fenugreek paste (with a 2:1 ratio of meat: fenugreek paste), portioning, and drying (at 22–23°C, 55–60% humidity for 7–10 days). The drying process is generally achieved in room conditions without controlling the temperature or relative humidity (Ensoy et al., 2009). In a few studies, the quality parameters of çemengilik were investigated in which çemengilik was dried for seven days (Ensoy et al., 2009, 2010) or for eight days (Cevahiroğlu, 2015) under controlled temperature and relative humidity conditions. Ensoy et al. (2009) reported the titratable acidity, pH, and water activity (a_w) values of çemengilik as 1.85% (lactic acid %), 5.64, and 0.773, respectively. The researchers measured the protein, ash, fat, salt, and dry matter contents of çemengilik as 25.64%, 8.38%, 18.64%, 6.85%, and 71.07%, respectively. In another study, Cevahiroğlu (2015) stated that the pH and a_w values of çemengilik groups were in the ranges of 4.47–4.95 and 0.86–0.91, respectively. Ensoy et al. (2010) reported the total mesophilic bacteria, *Micrococcus-Staphylococcus* spp., lactic acid bacteria, and yeast-mold counts as 13.40 Log CFU/g, 10.06 Log CFU/g, 10.04 Log CFU/g, and 8.99 Log CFU/g, respectively. However, Cevahiroğlu (2015) noted that the total aerobic mesophilic bacteria, yeast-mold, and lactic acid bacteria counts were in the ranges of 9.28–9.47 Log CFU/g, 1.00–1.58 Log CFU/g, and 9.42–9.59 Log CFU/g, respectively.

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TABLE 1: General properties of fenugreek paste and tomato paste utilized in the production of çemengilik groups

Product	Brix°/ Dry matter%*	Fat%	Salt%	Color			pH	TA %	FFA%	Lycopene (μg lycopene/g sample)
				L*	a*	b*				
Fenugreek paste*	33.8	2.36	NM	29.54	20.29	51.55	5.84	0.85	12.00	NM
Tomato paste	38	0.98	2.06	24.55	31.56	42.15	4.59	2.06	-	208.11

NM: not measured

TABLE 2: The formulation çemengilik (kg)

Group	Minced meat	Fenugreek paste	Tomato paste	Fenugreek paste: tomato paste ratio	Salt
C	1.6	0.8	0	5:0	0.012
C1	1.6	0.64	0.16	4:1	0.012
C1.5	1.6	0.56	0.24	3.5:1.5	0.012

According to the TS1071/T2 Standard for Pastırma, the fenugreek paste should be prepared by mixing fenugreek seed flour (*Trigonella foenum-graecum*, 50%), smashed garlic (35%), red pepper (15%), and salt (1.5%) with water, and the paste should have a spreadable structure (TSE, 2016). Fenugreek seed flour, used in Turkey as a main ingredient of fenugreek paste, has a wide variety of uses all over the world (Beyzi, 2011; Benayad et al., 2014). Fenugreek seeds contain high levels of protein, vitamins, and minerals, such as calcium, phosphorus, iron, zinc, and manganese (Develi-Işıklı and Karababa, 2005; Bogdanovich et al., 2016). El Nasri and El Tinay (2007) stated that the moisture, fat, protein, dietary fiber, ash, and total carbohydrate contents of fenugreek seed were 6.87%, 7.14%, 28.40%, 9.30%, 3.28%, and 47.40%, respectively. In addition, fenugreek seed flour is an excellent source of dietary fiber, especially galactomannans. The extract of fenugreek seed is rich in polyphenols and flavonoids, such as quercetin, apigenin, vitexin, naringenin, tricin, and kaempferol (Chatterjee et al., 2010; Kenny et al., 2013). Furthermore, many researchers reported that the antioxidant activity of seed extracts was a result of their polyphenol and flavonoid contents (Kenny et al., 2013). Premanath et al. (2011) stated that fenugreek paste has also antimicrobial effect. From a functional food additive point of view, using fenugreek paste in the formulation of çemengilik should improve the nutritional value of the product.

In recent years, the studies on the addition of tomato paste and/or puree to meat products also showed improvements in the nutritional value due to the antioxidant effect of lycopene. The effects of using lycopene in the production of mortadella, sausage, fermented sausage, burgers, meatballs (Doménech-Asensi et al., 2013), tomato paste in beef burgers (Luisa García et al., 2009), tomato paste in sausage (Eyiler and Öztan, 2011), and tomato paste in beef meatballs (Candoğan, 2002; Makaracı and Yılmaz, 2010) were studied. Although only a few studies have been conducted on the physicochemical and microbiological properties of çemengilik, the effect of using tomato paste on the quality parameters of çemengilik has not been investigated. The aim of this study is to evaluate the effects of tomato paste on the physicochemical properties of çemengilik.

MATERIALS

Çemengilik production

Experimental çemengilik production with a meat: fenugreek paste ratio of 2:1 was repeated twice, involving three groups of çemengilik named C (control), C1, and C1.5 due to the different tomato paste ratios. The tomato paste ratios were decided according to the results of preliminary experiments of the current study. The ratios of fenugreek paste to tomato paste used in the production of the çemengilik groups were 5:0, 4:1, and 3.5:1.5 for the C, C1, and C1.5 groups, respectively.

The minced beef brisket meat, triple concentrated tomato paste, and fenugreek seed flour used in the production of çemengilik groups were obtained from a local market in Tokat. The fenugreek paste used in the production of all groups were prepared at the laboratory and the paste formulation consisted of 50% fenugreek seed flour, 35% smashed garlic, and 15% red pepper. The volume of water used to produce spreadable fenugreek paste was 650 mL per 500 g of fenugreek seed flour. To determine the general properties of tomato paste fat, salt, lycopene contents, and brix, pH, titratable acidity and color values were measured. The moisture, protein, fat, ash contents, and the pH, titratable acidity and color values of fenugreek paste were also analyzed (Table 1).

To produce çemengilik, the minced beef meat was subdivided into three groups, then fenugreek paste, tomato paste (for C1 and C1.5) and 0.50% salt were added (Table 2). All the groups were combined by using a Mainca 400 W RM-20 model mixer for five minutes. Following the mixing, all the çemengilik batches were portioned as 60 g, then dried for five days on stainless steel trays. The conditions of the drying stage were as follows: (step 1) at 20°C, 85% relative humidity for 48 hours; (step 2) at 18°C, 75% relative humidity for 72 hours. All the meatballs were turned upside down every 12 hours. After the drying stage, all the çemengilik samples were vacuum-packed using a vacuum machine (La Minerva Pack 10B, Italy) and then stored at -20°C until analysis. Three randomly selected çemengilik samples were removed at the

TABLE 3: Proximate composition of çemengilik groups (%)

Group	Moisture	Fat	Protein	Ash	Salt
C	54.74±2.12^{A}	7.63±0.50^{B}	20.82±0.71^{A}	2.53±0.52^{A}	1.39±0.26^{B}
C1	51.37±1.43^{B}	12.57±1.41^{A}	20.46±0.98^{A}	2.34±0.34^{A}	1.73±0.14^{A}
C1.5	47.95±2.91^{C}	11.56±2.53^{A}	20.07±0.58^{A}	2.54±0.45^{A}	1.78±0.12^{A}

Data are the mean ± standard deviation (n=4)
^{A,B,C}Means in a column not having common superscript letter are different (p<0.05).

sampling stages as follows: initial mixture, 2nd and 5th days of drying. The titratable acidity (TA), pH, water activity (a_w), color (CIE *L*a*b**), free fatty acid (FFA), and thiobarbituric acid (TBA) values were evaluated at each sampling stage. At the end of the drying stage, protein, fat, moisture, salt, and ash contents were determined.

METHODS

Proximate composition

The protein, fat, moisture, and ash contents of the çemengilik samples were analyzed according to AOAC (2003) methods. The salt contents of the samples were measured by using the method by Çiçek and Polat (2016).

pH, titratable acidity (lactic acid%), and water activity values (a_w)

The pH values of the çemengilik samples were measured using an Orion 420A pH meter; then, the sample slurries were titrated with 0.1 N NaOH to an endpoint of pH 8.30. The TA values were calculated as lactic acid % using the method of Çiçek and Polat (2016). The water activity values of the çemengilik samples were analyzed according to Çiçek and Polat (2016) by using a previously calibrated AquaLab Series 3 TE model (USA).

Lycopene content

The lycopene contents of the çemengilik samples were measured by using the method of Yıldız (2004) at each sampling stage. The following equations were used to calculate the lycopene contents of the samples, and the results were expressed as μg lycopene/g sample.

$$Abs_{503}<0.3: \frac{(2.56\times A_{503}-A_{472})\times 32.24}{Sample\ weight\ (g)} \quad \text{(Eq.1)}$$

$$0.6< Abs_{503}<0.3: \frac{(2.8\times A_{503}-A_{472})\times 32.24}{Sample\ weight\ (g)} \quad \text{(Eq.2)}$$

$$Abs_{503}> 0.6: \frac{62.43\times A_{503}}{Sample\ weight\ (g)} \quad \text{(Eq.3)}$$

Color

The color measurements (CIE *L*a*b**) were carried out before and after slicing from the surface of the product by using a Minolta Chroma Meter CR300 (Japan) (Çiçek and Polat, 2016).

Free fatty acid (FFA) and thiobarbituric acid (TBA) values

The lipids were extracted from 100 g of the çemengilik samples (Çiçek and Polat, 2016), and the FFA values were determined as oleic acid % according to the method of AOAC (2003). The TBA values of the çemengilik samples were determined by the method of Çiçek and Köse (2016), and the results were given as mg MA/kg sample.

Non-protein nitrogen content

The non-protein nitrogen (NPN) contents of the çemengilik samples were measured by the method of DeMasi et al. (1990), and the results were given as mg N per 100 g dry matter.

Statistical analysis

All experimental data were examined statistically using the SPSS 20.0 statistical package (International Business Machines Corporation [IBM], Armonk, NY, USA). The mean values for different fenugreek paste to tomato paste ratios and drying stages were subjected to variance analysis. If required, a Duncan multiple comparison test was performed to investigate the differences between the Results

RESULTS AND DISCUSSION

Proximate composition

The moisture, fat, protein, ash, and salt contents of the çemengilik samples are given in Table 3. Although using different ratios of tomato paste resulted in different moisture (47.95–54.74%), fat (7.63–12.57%), and salt (1.39–1.78%) contents ($P<0.05$), other parameters, such as protein (20.07–20.82%) and ash (2.34–2.54%) contents, of the çemengilik groups were generally constant with increasing tomato paste ratio ($P>0.05$). The results showed that utilizing triple concentrated tomato paste having high amount of water-soluble content (38 ºBrix, Table 1) resulted in a decrease in the moisture contents of C1 and C1.5 groups, while the fat and salt contents were both increased due to salt and fat content of tomato paste. Thus, the fat and salt contents of tomato paste were measured as 0.98% and 2.06%, respectively (Table 1). Calvo et al. (2008) also

TABLE 4: pH, TA (lactic acid%) and aw values of çemengilik groups during processing stages

Group	Processing stages								
	Initial mixture			2^{nd} day			5^{th} day		
	pH	TA	a_w	pH	TA	a_w	pH	TA	a_w
C	5.87 ± 0.07^{Aa}	0.79 ± 0.03^{Cc}	0.973 ± 0.013^{Aa}	5.78 ± 0.04^{Ab}	0.99 ± 0.08^{Ab}	0.970 ± 0.002^{Aa}	5.41 ± 0.02^{Ac}	1.29 ± 0.19^{Aa}	0.939 ± 0.009^{Ab}
C1	5.56 ± 1.01^{Ba}	0.86 ± 0.01^{Bb}	0.974 ± 0.001^{Aa}	5.43 ± 0.09^{Cb}	1.01 ± 0.13^{Ab}	0.965 ± 0.004^{Bb}	5.06 ± 0.06^{Bc}	1.56 ± 0.23^{Aa}	0.945 ± 0.004^{Ac}
C1.5	5.42 ± 0.01^{Ca}	0.91 ± 0.01^{Ab}	0.972 ± 0.034^{Aa}	5.56 ± 0.13^{Ba}	0.96 ± 0.11^{Ab}	0.960 ± 0.001^{Ca}	5.18 ± 0.25^{Bb}	1.49 ± 0.47^{Aa}	0.921 ± 0.020^{Bb}

Data are the mean ± standard deviation (n=4)
^{A,B,C}Means in a column not having common superscript letter are different (p<0.05).
^{a,b,c}Means in a row not having a common superscript letter are different (p<0.05).

TABLE 5: Lycopene contents of çemengilik groups during processing stages (μg lycopene/g sample)

Group	Processing stages		
	Initial mixture	2^{nd} day	5^{th} day
C	9.83 ± 0.55^{Cb}	18.88 ± 5.60^{Ca}	10.01 ± 1.28^{Bb}
C1	46.29 ± 4.06^{Ba}	32.21 ± 4.61^{Bb}	30.96 ± 4.94^{Ab}
C1.5	56.33 ± 5.24^{Aa}	49.35 ± 5.90^{Aa}	30.54 ± 4.55^{Ab}

Data are the mean ± standard deviation (n=4)
^{A,B,C}Means in a column not having common superscript letter are different (p<0.05).
^{a,b}Means in a row not having common superscript letter are different (p<0.05).

stated that increasing the tomato paste ratio resulted in a decrease in the moisture content of pork sausages. Ensoy et al. (2009) measured the moisture, fat, protein, ash, and salt contents of a traditionally produced çemengilik sample as 28.93%, 18.64%, 25.64%, 8.38%, and 6.85%, respectively. It was seen that the moisture content of the çemengilik samples was higher, while the fat, protein, ash, and salt contents were lower than the çemengilik investigated by Ensoy et al. (2009). This could be the result of utilizing a shorter drying period than those researchers and utilizing tomato paste in the formulation of the fenugreek paste.

pH, titratable acidity, and water activity (a_w)

The pH values of the initial mixtures were in the range of 5.42–5.87 (P<0.05) (Table 4), it was seen that increasing tomato paste ratio resulted in lower pH value, thus, the initial mixture of C1.5 had the lowest pH while C had the highest pH value (P<0.05). The results showed that increasing tomato paste ratio resulted in a decrease in the pH value of the çemengilik due to low pH value of tomato paste (pH 4.59, Table 1). Similarly, Candoğan (2002) stated that increasing the tomato paste ratio resulted in a decrease in the pH value of the meatballs. The pH values of the çemengilik samples decreased to the range of 5.06–5.41 at the end of the drying stage (P<0.05) (Table 4). Although the lowest pH was measured in C1, the difference between C1 and C1.5 was not significant (P>0.05). Ensoy et al. (2009) measured the pH value of the çemengilik groups as 5.64, which was similar to the pH value of the C group. However, Cevahiroğlu (2015) reported lower pH values, which were between 4.47 and 4.95, for the çemengilik groups containing the same ratios of tomato paste. This could be explained by the lactic acid formation during longer ripening/drying stage. Thus, the quality parameters of ripened/dried meat products vary depending on the ripening conditions such as temperature, humidity, and duration of ripening/drying period (Çiçek and Polat, 2016).

The TA values of the initial mixtures were between 0.79% and 0.91% lactic acid (P<0.05, Table 4). It was determined that utilizing tomato paste resulted in increases in the TA values of the initial mixtures of C1 and C1.5 groups in comparison with C group (P<0.05), this could be explained by the high titratable acidity value of tomato paste (2.15%, Table 1). Although the TA values of all groups increased to the range of 1.29–1.56% lactic acid at the end of the drying stage (P<0.05) (Table 4), the difference between the çemengilik groups was not significant (P>0.05). Similar increases in the TA values of çemengilik during drying were also reported by Ensoy et al. (2009).

The water activity values (a_w) of the initial mixtures were measured as 0.973, 0.974, and 0.972 for C, C1, and C1.5, respectively (P>0.05) (Table 4). The a_w values of the çemengilik samples decreased during drying and reached the range of 0.921–0.939 at the end of the drying stage (P<0.05). It was seen that C1.5 had the highest tomato paste ratio and the lowest a_w value (P<0.05). Cevahiroğlu (2015) reported that the a_w values of the çemengilik were between 0.86 and 0.91. Additionally, Ensoy et al. (2009) noted that the a_w value of the çemengilik sample was 0.773, which was lower than the findings of the current study. This could be explained by the longer duration of the ripening/drying period utilized by the researchers. Çiçek and Polat (2016) also stated that the increasing lactic acid content during ripening causes protein denaturation which effects the release of water from the product.

Lycopene content

Lycopene has an antioxidant effect in the elimination of free radicals resulting from oxidative changes (Sabbağ and Sürücüoğlu, 2011). The lycopene content of tomato paste used in the manufacturing of C1 and C1.5 groups was measured as 208.11 μg lycopene/g sample (Table 1). Candoğan (2002) measured the lycopene content of tomato paste used in the production of meatballs as 48.38 mg/100 g, which was lower than the findings of

TABLE 6: CIE *L*a*b values of slice surface of çemengilik groups during processing stages**

Group	Processing stages								
	Initial mixture			2nd day			5th day		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
C	34.65±2.10^{Aa}	15.67±1.63^{Aa}	58.52±3.81^{Aa}	33.99±2.17^{Ab}	16.63±1.92^{Aa}	57.42±3.92^{Aa}	35.48±2.54^{Aa}	15.29±0.95^{Aa}	58.22±2.83^{Aa}
C1	35.29±2.17^{Ab}	16.48±1.68^{Aa}	60.03±3.61^{Aa}	34.51±1.33^{Ab}	16.49±1.19^{Aa}	58.67±2.14^{Aa}	37.30±2.27^{Aa}	16.46±1.92^{Aa}	60.39±4.00^{Aa}
C1.5	34.46±3.45^{Aab}	15.46±1.98^{Aa}	58.43±5.48^{Aa}	32.48±2.05^{Bb}	16.99±1.61^{Aa}	55.32±3.42^{Ba}	36.49±2.66^{Aa}	15.98±2.46^{Aa}	58.85±5.50^{Aa}

Data are the mean ± standard deviation (n=4)
^{A,B}Means in a column not having common superscript letter are different (p<0.05).
^{a,b}Means in a row not having common superscript letter are different (p<0.05).

TABLE 7: CIE *L*a*b values of exterior surface of çemengilik groups during processing stages**

Group	Processing stages								
	Initial mixture			2nd day			5th day		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
C	34.65±2.10^{Aa}	15.67±1.63^{Aa}	58.52±3.81^{Aa}	33.70±2.03^{Aa}	9.22±1.77^{Bb}	52.67±4.97^{ABb}	27.69±2.35^{Bb}	7.40±1.40^{Cc}	43.01±2.76^{Cc}
C1	35.29±2.17^{Aa}	16.48±1.68^{Aa}	60.03±3.61^{Aa}	32.36±1.60^{Ab}	12.90±1.99^{Ab}	55.08±2.67^{Ab}	30.47±2.93^{Ab}	9.89±1.12^{Bc}	46.54±2.17^{Bc}
C1.5	34.46±3.45^{Aa}	15.46±1.98^{Aa}	58.43±5.48^{Aa}	31.03±4.41^{Ab}	14.11±2.57^{Aa}	49.33±4.72^{Bb}	29.41±2.22^{ABb}	11.62±1.01^{Ab}	50.17±3.70^{Ab}

Data are the mean ± standard deviation (n=4)
^{A,B,C}Means in a column not having common superscript letter are different (p<0.05).
^{a,b,c}Means in a row not having common superscript letter are different (p<0.05).

the current study. The lycopene contents of the initial mixtures of çemengilik samples were between 9.83 and 56.33 μg lycopene/g sample (Table 5). It was determined that increasing the tomato paste ratio resulted in an increase in lycopene content; thus, C1.5, having the highest tomato paste ratio, had the highest lycopene content among the initial mixtures (P<0.05). Calvo et al. (2008) also reported that the lycopene content of dried sausages increased as a consequence of increasing the amount of tomato paste used in the production. Although the C group was produced without adding tomato paste, the lycopene content of C group could be originated from powdered red pepper. Thus, Selahle et al. (2015) noted the lycopene content of powdered red pepper as 10.91 μg/g. Although the lycopene content of the C group showed slight increases and decreases during manufacturing, the lycopene contents of both C1 and C1.5 showed significant decreases during the drying stages (P<0.05), and the lycopene contents were measured as 10.01, 30.96, and 30.54 μg lycopene/g sample at the end of the drying stage for C, C1, and C1.5, respectively. This decrease in the lycopene content of the çemengilik groups could be explained by the degradation reactions of lycopene that occur during drying (Goula and Adamopoulos, 2005).

Color

CIE *L*a*b** measurements were carried out both from the slice (Table 6) and exterior surfaces of the çemengilik samples (Table 7). The *L**, *a**, and *b** values of the tomato paste were 24.55, 31.56, and 42.15, respectively, while the *L**, *a**, and *b** values of the fenugreek paste were measured as 29.54, 20.29, and 51.55, respectively (Table 1). It was determined that the *L**, *a**, and *b** values of initial mixtures were in the ranges of 34.46–35.29, 15.46–16.48, and 58.43–60.03, respectively. Furthermore, the results showed that utilizing tomato paste did not affect the CIE *L*a*b** values of çemengilik mixtures (P>0.05). Although the *L** values of all the çemengilik slices showed slight decreases on the 2nd day of drying, the *L** values increased to the range of 35.48–37.30 at the end of the drying stage (P<0.05). While the C1 group had the highest *L**, *a**, and *b** values at the end of the drying stage, the difference between the çemengilik groups was not significant (P>0.05) (Table 6). However, Cevahiroğlu (2015) noted significant decreases in the L* and a* values of the çemengilik samples containing similar ratios of tomato paste. This could be explained by the longer duration of drying stage which was resulted in formation of metmyoglobin (Cevahiroğlu, 2015).

On the other hand, utilizing tomato paste and the drying stage had a significant effect on the *L**, *a**, and *b** values of the exterior surfaces of the çemengilik groups (P<0.05) (Table 7). Thus, L* values of C1 and C1.5 showed significant decreases on the 2nd day of drying (P<0.05) while the decrease of L* value of C was not significant (P>0.05). The b* values of all groups decreased on the 2nd day of drying (P<0.05). The a*values of C and C1 showed significant decreases at the same stage of drying (P<0.05) while the decrease of a* value of C1.5 was not significant (P>0.05). The drying stage resulted in decreases in the *L**, *a**, and *b** values of the exterior surfaces of the çemengilik groups (P<0.05) and were in the ranges of 27.69–30.47, 7.40–11.62, and 43.01–50.17 at the end of the drying stage, respectively. Although C1 had the highest L* value at the end of the drying stage, the difference between the L* values of C1 and C1.5 was not significant (P>0.05). It was also seen that C1.5 had the highest a* and b* value

TABLE 8: FFA (oleic acid%) and TBA (mg MA/kg sample) values of çemengilik groups during processing stages

Groups	Processing stages					
	Initial mixture		2nd day		5th day	
	FFA	TBA	FFA	TBA	FFA	TBA
C	6.65±0.25^{Ac}	1.63±0.29^{Ac}	7.95±0.27^{Ab}	2.51±0.41^{Ab}	11.19±0.64^{Aa}	3.13±0.26^{Aa}
C1	5.83±0.74^{ABc}	1.42±0.20^{ABc}	7.74±0.73^{Ab}	1.62±0.13^{Bb}	10.19±0.37^{Ba}	2.06±0.11^{Ba}
C1.5	4.88±0.85^{Bb}	1.20±0.31^{Bb}	5.98±0.80^{Bb}	1.57±0.20^{Bb}	9.28±0.44^{Ca}	2.24±0.68^{Ba}

Data are the mean ± standard deviation (n=4)
^{A,B}Means in a column not having common superscript letter are different (p<0.05).
^{a,b,c}Means in a row not having common superscript letter are different (p<0.05).

TABLE 9: NPN values of çemengilik groups during processing stages (mg NPN/100 g dry matter)

Group	Processing stages		
	Initial mixture	2nd day	5th day
C	1080.67±20.24^{c}	1239.84±39.88^{b}	1448.77±21.34^{a}
C1	1063.61±54.57^{b}	1257.63±77.98^{ab}	1301.65±76.11^{a}
C1.5	1063.07±76.13^{b}	1254.88±71.01^{ab}	1289.50±41.59^{a}

Data are the mean ± standard deviation (n=4)
^{a,b,c}Means in a row not having common superscript letter are different (p<0.05).

at the end of the drying stage (P<0.05). Cevahiroğlu (2015) and Ensoy et al. (2009) also stated that drying resulted in decreases in CIE *L*a*b** values of the çemengilik samples. This decrease could be explained by the formation of metmyoglobin during drying (Cevahiroğlu, 2015). The data showed that the ratio of fenugreek paste to tomato paste of 3.5:1.5 was resulted in better color parameters.

Free fatty acid (FFA) and thiobarbituric acid (TBA) values

The higher FFA value of initial mixtures ranging between 4.88% and 6.65% oleic acid was a result of FFA value of fenugreek paste (12.0% oleic acid, Table 1). The results showed that increasing tomato paste ratio resulted in decreased FFA values of initial mixtures of C1 and C1.5, thus, C1.5 had the lowest FFA value (P<0.05) (Table 8). Utilizing increasing rates of tomato paste and decreasing rates of fenugreek paste (Table 2) in these groups could result in lower FFA values, thus the FFA value of fenugreek paste was measured as 12.0% oleic acid. The FFA values of the çemengilik samples showed significant increases on the 2nd day of drying (except C1.5) and reached the values of 11.19%, 10.19%, and 9.28% at the end of the drying stage for C, C1, and C1.5, respectively (P<0.05). Ensoy et al. (2009) measured the FFA value as 9.03% oleic acid of çemengilik samples produced without tomato paste. Many researchers have noted that both endogenic and exogenic lipase activity results in increases in FFA values during the ripening/drying stages of meat products (Ordonez et al., 2009; Çiçek and Polat, 2016). In addition, the results in Table 8 show that the FFA value was decreased with the increasing ratio of tomato paste; thus, C1.5 had the lowest FFA value at each sampling stage of drying (P<0.05). This could be the result of both higher tomato paste ratio utilized in C1.5 and the antimicrobial effect of lycopene that decreased the lipase activity of microorganisms. Thus, Ranjbar and Ranjbar (2016) reported that lycopene had an antimicrobial effect on foodborne microorganisms especially on pathogens.

The TBA values of the çemengilik samples were measured to evaluate the lipid oxidation reactions that occurred during the drying stages of the çemengilik. The TBA values of the initial mixtures of the çemengilik groups increased from the range of 1.20–1.63 mg MA/kg sample to the range of 2.06–3.13 mg MA/kg sample at the end of the drying stage (P<0.05) (Table 8). Similar increases in the TBA values of the çemengilik samples during drying were also determined by Ensoy et al. (2009). The results in Table 8 showed that C1 had the lowest TBA value at the end of the drying stage (P<0.05); on the other hand, the difference between C1 and C1.5 was not significant (P>0.05). The results indicate that utilizing tomato paste limited the lipid oxidation reactions. Candoğan (2002) also reported that increasing the tomato paste ratio resulted in lower TBA values of the meatballs in comparison with the control group. This could be explained by the antioxidant activity of lycopene (Eyiler and Öztan, 2011).

Non-protein nitrogen content (NPN)

The NPN values of initial mixtures were measured as 1080.67, 1063.61, and 1063.07 mg/100 g dry matter for C, C1, and C1.5, respectively (Table 9). The NPN values of all the çemengilik groups showed increases during drying and reached the values of 1448.77, 1301.65, and 1289.50 mg/100 g dry matter for C, C1, and C1.5, respectively (P<0.05). Although the highest NPN value was measured in the C group, the difference between the NPN values of the çemengilik groups was not significant (P>0.05). Although the changes in the NPN values of the çemengilik during manufacturing were not investigated in the previous studies, many researchers noted increases in NPN content of meat products manufactured by fermentation and/or drying stages (Soriano et al., 2006; Candoğan and Acton, 2001).

CONCLUSIONS

The findings of the current study showed that utilizing tomato paste resulted in lower FFA and TBA values. C1.5, having the fenugreek paste to tomato paste ratio of 3.5:1.5, had the highest *a** and *b** color measured from the exterior surface in comparison with the other groups at the end of drying. It can be concluded that tomato paste could be used in the formulation of fenugreek paste with a ratio of 3.5 parts fenugreek paste to 1.5 parts tomato paste in order to limit the lipid oxidation and improve the color properties of the product.

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Authors' contributions

Ümran ÇİÇEK: Research hypothesis, methodology and experimental procedures, analysis, data collection, statistical analysis, manuscript writing.

Duygu ÇABUK KÖK: Research hypothesis, methodology and experimental procedures, analysis, data collection.

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