

**Determination of Physicochemical Properties of Cracked Green cv. Sari Ulak Olives Fermented By Different Chloride Salts <sup>1</sup>**

Rasha DALLOUL

Huseyin ERTEN

Department of BIOTECHNOLOGY

Department of FOOD  
ENGINEERING

**ABSTRACT**

**Sodium** chloride is essential ingredient during the table olive fermentation, however lowering the sodium intake is advised by authorities due to high sodium intake causing some health problems. The aim of this study was to evaluate the influence of partial replacement of NaCl with different chloride salts of KCl, MgCl<sub>2</sub> and CaCl<sub>2</sub> on the physicochemical, microbiological and sensory characteristics of fermented cracked cv. Sari Ulak green table olives. The values of pH and total acidity as lactic acid of cracked table olives were in the range of 4.00-4.58 and 5.34-6.07 g/kg respectively. The numbers of lactic acid bacteria, yeasts, non-*Saccharomyces* spp. and total mesophilic aerobic bacteria increased during the fermentations. Coliform bacteria did not survive after two weeks. Sensory analysis showed that the most preferred trail is with NaCl brine followed by NaCl+KCl combination and then NaCl+MgCl<sub>2</sub> salt treatment. The trail which conducted by CaCl<sub>2</sub> along with NaCl, was not preferred because of the bitter taste.

**Keywords:** Sari Ulak, cracked table olive, fermentation profile, chloride salts, lower sodium chloride.

**ÖZ**

**Sodyum** klorür sofralık zeytin fermantasyonunda elzem bir ingredienttir. Bununla birlikte, yüksek miktarda sodyum tüketiminin bazı sağlık sorunlarına sebep olması nedeniyle, otoriteler sodyum tüketiminin azaltılmasını tavsiye etmektedir. Bu çalışmanın amacı Sarı ulak çeşidinden sofralık fermente kırma yeşil zeytin üretiminde sodyum klorürün farklı klorür tuzları kullanarak azaltılmasının sofralık kırma zeytinin fizikokimyasal, mikrobiyolojik ve duyuşal özellikler üzerine etkisinin incelenmesidir. Sofralık kırma zeytinlerin pH değeri 4.00-4.58 arasında ve toplam asitlik, laktik asit cinsinden, 5.34-6.07 g/kg arasında değişmiştir. Fermantaston sırasında laktik asit bakterileri, toplam maya, *Saccharomyces* spp. dışında maya ve toplam mezofilik aerobik bakteri sayıları artmıştır. Koliform bakteriler iki hafta sonra ortamdaki izole edilememiştir. Duyuşal analiz sonuçlarına göre en fazla beğenilen

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<sup>1</sup> Aynı başlıklı Yüksek Lisans tezinden üretilmiştir.

örnek NaCl tuzu kullanılarak üretilen zeytinler olmuş ve bu örneği sırasıyla NaCl+KCl ve NaCl+MgCl<sub>2</sub> tuz kombinasyonları izlemiştir.

**Anahtar Kelimeler:** Sarı Ulak, Kırık sofralık zeytin, Fermentasyon profili, Klorür tuzları, Düşük sodyum klorür

## **Introduction**

In this study, the fermentation of cracked green table olives from Sarı Ulak variety was done by using KCl, MgCl<sub>2</sub> and CaCl<sub>2</sub> salts with NaCl in the fermentation brine in order to partially reduce the NaCl salt. The physiochemical properties, which detect the quality of the product, examined and determined in all over the process. The pH value for fermented olives was ranged from 4.00 to 4.58, total acidity for fermented olives was detected as 5.34- 6.07 g/mL. Total dry matter for fermented olives was between 30.31-32.85% and the total ash was between 3.86-6.42%.

## **Material and Methods**

In this research green olives of Sarı Ulak variety were obtained from Tarsus District, after harvesting on November 2016. The fermentation were carried out in 5-litre food grade plastic containers. The "Sanyo MIR-153", "Aqua Lytic AL654 and "Velp Scientifica FTC 90E" brand incubators with adjustable temperature were used for the growth of microorganisms. "Hirayama (Japan)"brand autoclave was used for sterilization. For pH determination "Mettler Toledo Ion/ S220" brand pH meter was used. For dry matter determination, "Venticell 222" brand fan oven was used. For ash analysis, "Protherm PLF 110/15" model oven was used. Color measurements for L\*, a\*, b\* values, were determined with color measurements device "Minolta marka CR100".

## **Method**

Olives were harvested by hand in November 2016 when they reached harvest maturity (yellow-green) for green olives. Approximately 20 kg of olives were transported to the Cukurova University Faculty of Agriculture Department of Food Engineering as soon as possible. Olive fruits were sorted to remove damaged, crushed, soft and different coloured olives. Olives were cracked by stone. Then olives were fermented in four different brines containig different chloride salts (Figure 3.1). They were 8 % NaCl, 4 % NaCl + 4% KCl, 4 % NaCl + 4 % CaCl<sub>2</sub> and 4 % NaCl + 4 % MgCl<sub>2</sub>. Brine including 8 % NaCl salt alone was used as control.



Figure 1. Fermentation of cv. Sarı Ulak

Each brine was given a code number as follows:

- A code for control brine containing 8 % NaCl
- B code for brine containing 4 % NaCl + 4% KCl
- C code for brine containing 4 % NaCl + 4 % CaCl<sub>2</sub>
- D code for brine containing 4 % NaCl + 4 % MgCl<sub>2</sub>

The results are evaluated by those codes. Olive fruits were putted into plastic containers, then filled with suitable brines and covered with food grade perforated disks in plastic disks to block the olives from floating and closed loosely to let CO<sub>2</sub> gas out. Fermentations were carried out in duplicate at room temperature. The amount of chloride salts in brines were always kept at 8 %. The salinity of brines during the fermentation was controlled by Bome and if necessary different chloride salts were added to the brines. For monitoring the fermentation development, pH and total acidity of the brines were followed. When the fermentation process was completed, table olives were packaged and stored at +4°C for physical, chemical and sensory analyses.

## Analyses

### Physical and Chemical Analyses

#### Maturity Index

It was used also to determine the exact harvesting time of the different fruits olives varieties. To determine the maturity index (MI), randomly selected 100 grains of olive fruits were taken. Then the olives fruits were separated into eight groups according to their skin colours. Maturity index is the total of the number of olives in each group have been multiplied by the score, with the sum, then have been divided by 100 (Sibbet and Ferguson, 2005).

#### The Number of Olive Fruits Per Kg

100 g of olive samples was weighed and the number of fruits in kg was determined by counting how many fruits were in this amount (Özdemir et al., 2011).

#### **The 1000 Olive Weight**

Randomly selected 100 olives were weighed and multiplied by 10 to calculate the weight of 1000 olives.

#### **Fruit Dimensions**

The width and height of 20 randomly chosen olive fruits were measured with a caliper with a sensitivity of 0.1 mm (Anon., 1997).

#### **Flesh/Stone Weight Ratio**

100g of randomly chosen olive fruits were weighed, then their stones were removed with olive pitting machine. The removed stones were weighed separately. The percentages of the weights were calculated, then the % flesh was divided by % Stone (Yazıcıoğlu, 1966).

#### **Color Analyses**

The color of the olive samples was measured with a Konica Minolta Chroma Meter CR-400 (Japan) colorimeter. L \*, a \*, b \* values were determined. L \*\*, "a \*\* and "b \*\* values were obtained during the color measurement and the values of "L" darkness to brightness, "+ a \*" redness, "-a \*" greenness, "+ b \*" "- b \*" indicates going to the yellowness and blueness respectively (Gould, 1977). Hue (Color tone) and C the chroma values were calculated with the following formula (Artes et al., 2002).

$$\text{Hue} = [\arctan (b^*/a^*)]$$

$$C = [(a^{*2} + b^{*2})^{1/2}]$$

#### **Total Dry Matter Determination**

Dry matter determination in olives was made according to Cemeröglu (2010).

#### **Total Ash Determination for processed olives**

Ash in processed olives were determined at 500 ° C in an ash oven (Cemeröglu, 2010).

#### **pH Determination**

The pH level of brines and olive samples were analysed using pH meter (A.O.A.C., 1990).

#### **Determination of Total Acidity**

Total acidity expressed as lactic acid was determined by titrating the sample up to pH 8.2 with 0.1N NaOH (Anon, 1990).

#### **Sensory Evaluation**

In sensory tests, the method given by Marsilio et al (2000) was used. 11 selected panelists evaluated the fermented green cracked table olives for their odor, taste, salinity, color, bitterness, hardness, color of flesh and general acceptance. For this purpose, 9-point hedonic scale was used. According to this scale, 9 "Highest" (like extremely) and 1 "Lowest" (dislike extremely) has been evaluated. Form used in the analyses was given in Figure 3. 4. In sensory analysis, the "Preference (ranking) Test" (Figure 3. 5) was applied to determine the most preferred method among different fermentation technological processes within different chlorine salt applications. In the preference test, olive samples were presented to the panelists and ranked from the most favored to least preferred (Altuğ and Elmacı, 2005).

#### **Statistical Analyses**

The results of physicochemical properties of raw material and chemical, sensory characteristics of processed olives was compared statistically by IBM SPSS Statistics 22 program. Duncan multiple comparison test was applied to significant differences. The level of significance was assessed as  $P = 0.05$  (Özdamar, 2015).

#### **Results and Discussion**

##### **General Composition of Olives Used in Experiments**

In processed table olives, the size and the general appearance are very important characteristics for quality determination. Determination of the quality and the price of the table olives are made according to physical characteristics such as the number of olives per kg, flesh/ stone ratio, color and maturity index etc. (Uylaşer et al., 2008). Some physicochemical properties of the Sarı ulak olives variety that used in this study are given in Table 1.

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Maturity index	0.48±0.000
The number of olive fruits per kg	198±12.020
The 1000 olive weight (kg)	4.81±0.193
Flesh/ Stone ratio	4.37±0.141
The average fruits length (mm)	1.53±0.354
The average fruits width (mm)	0.88±0.173

pH	5.13±0.049
<b>Color</b>	
L* values	69.79±3.178
a* values	-10.93±5.465
b* values	+38.25±5.099
Hue values	74.05
C values	39.78
Total acidity (g/ kg)	0.2±0.000
Total dry matter (%)	34.39±0.388

As shown in Table1, the number of olive fruits per kilogram is 198. Özyay and Borcaklı (1996) and Şahin et al (2000) detected that the number of olive fruits from Gemlik variety per kilogram was 318 and 304 pieces. Uylaşer et al (2008) reported that the number of olive fruits, also from Gemlik variety was 272 pieces/ kg. The number of olive fruits per kilogram in this study were lower than the values reported in other studies. In present study the 1000 olive weight was 4.81kg, while in another study on Gemlik variety of black olives it was 4.25 kg (Erdogan, 2014). The flesh /stone ratio was 4.37. The fruit length of the Sarı Ulak olive variety used in this experiment was measured as 1.53 mm and the fruit width was measured as 0.88 mm. Kumral (2005) and Uylaşer et al (2008) detected that the fruit length of the fresh olives from Gemlik variety was 20.40 and 21.37 mm and the fruit width was 14.40 and 16.68 mm. The pH of this study was similar to some previous studies like the study made by Lopez-Lopez et al (2004) determined the pH of green olives as 3.69. In another study on Gemlik variety of black olive, L \* values were 24.43 ± 1.57; a \* values were 4.13 ± 1.28; b \* values were 1.05 ± 0.83; Hue values were 14.49 + 5.13 and the C values were found to be 4.28 ± 1.13 (Erdogan, 2014).The total acidity level of Sarı Ulak olives determined as 0.2 g/Kg in terms of lactic acid by titration with 0.1N NaOH. López-López et al (2004) detected that the titratable acidity for ripe green olives was 0.64%. In olive samples of the Manzanilla types, some parameter values of titratable acidity were nearly below 0.5 g/100mL.

### **Chemical and Microbiological Analyses During the Fermentaion Process of green cracked Sarı Ulak olives**

#### **The pH and the Total Acidity of the Brines of Sarı UlakOlives Variety during the fermentation**

The changes in the pH and the total acidity in brines with different chloride salts mixtures during fermentation are given in Figures 2, 3 respectively.

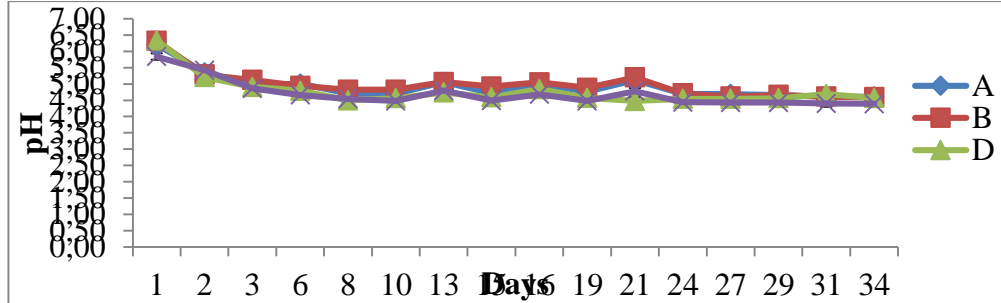


Figure 2. The pH of the brines during the fermentation (A: 8 % NaCl, B: 4 % NaCl+ 4 % KCl, C: 4 % NaCl+ 4 % CaCl<sub>2</sub>, D: 4 % NaCl+ 4 % MgCl<sub>2</sub>)

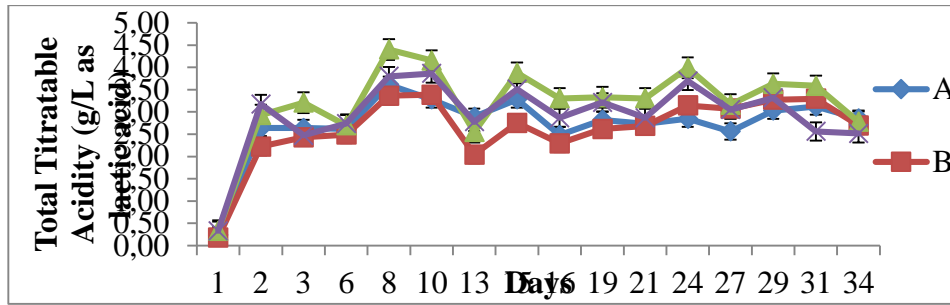


Figure 3. Changes in total acidity during the fermentation (A: 8% NaCl, B: 4% NaCl+ 4%KCl, C: 4% NaCl+4 % CaCl<sub>2</sub>, D: 4% NaCl+ 4% MgCl<sub>2</sub>)

In all the fermentation brines, the titratable acidity values remarkably increased in the first two days, then oscillated a little until the end of the fermentation. At the beginning of the olive fermentation, the total acidity values varied from 0.18- 0.33 g/L in terms of lactic acid. The highest acidity value was observed in 8th day for D coded brine and it was 4.40 g/L. The least acidity value during the fermentation was related to B brine. It was 2.04 g/L in 13th day of the process. The acidity values for A and B treatments were close to each other during the fermentation process. Panagou et al (2011) found the highest total acidity level in experiments which carried out with KCl and CaCl<sub>2</sub> salts in a study of table olive production with different chloride salts.

#### Physiochemical Analyses of Processed Cracked Green Table Olives

The physiochemical analyses of fermented Sarı Ulak variety are given in Table 4.2

Table 2. The physiochemical analyses of fermented Sarı Ulakvriety of cracked table olives at different salt brines (A: 8% NaCl, B : 4%NaCl+ 4%KCl, C: 4 %NaCl+ 4% CaCl<sub>2</sub>, D: 4% NaCl+ 4% MgCl<sub>2</sub>)

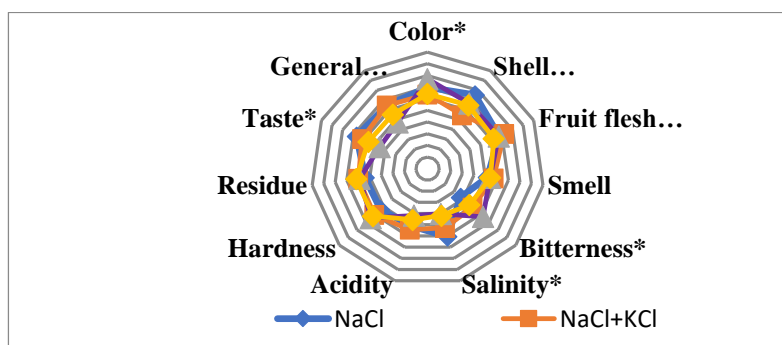
	A(control)	B	C	D
<b>Total Acidity(g/Kg)*</b>	5.79±0,000 <sup>b</sup>	5.34±0,063 <sup>d</sup>	6.07±0,091 <sup>a</sup>	5.57±0,127 <sup>bc</sup>
<b>pH</b>	4.00±0,007 <sup>d</sup>	4.58±0,014 <sup>a</sup>	4.44±0,005 <sup>c</sup>	4.53±0,005 <sup>b</sup>
<b>Total Ash (%)</b>	6.42±0,671 <sup>a</sup>	4.89±0,113 <sup>b</sup>	5.27±0,007 <sup>b</sup>	3.86±0,127 <sup>c</sup>
<b>Total Dry Matter (%)</b>	30.31±0,353	31.28±0,890	32.85±0,770	30.40±3,917

The final pH value was ranged from 4.00- 4.58. The highest value was for the olives fermented in B brine. Panagou et al ( 2011) found specific results in a study of natural black olives fermentation. They found that the final values pH ranged from 3.9- 4.2. Erdogan (2014) detected the pH value as 4.19-4.89 for fermented Gemlik olive. The total acidity expressed as lactic acid ranged from 5.34- 6.07 g/kg. The highest value was obtained for brine C, while the lowest one was in brine B. Panagou et al ( 2011), found that the higher values of acidity as 8.6 and 8.3g of lactic acid /L of fermenting brine, were measured in brines of 4% NaCl and 4% KCl and 4% NaCl and CaCl<sub>2</sub>. In another study the total acidity was in the range of 8.1- 9.7 g as lactic acid /L.

### Sensory Analyses

After the fermentation process was completed, sensory analyses was performed. The sensory analyses results are given in the Figure 4. and the preference test results are given in Table 4.3. For sensory analyses, the parameters used were: color, taste, smell, bitterness, flesh color, brightness, acidity, salinity, residue, hardness and general acceptability.

Figure 4. The results of sensory analyses for fermented Sarı Ulak olives





\*Properties indicated with superscript symbol (\*) were significant statistically ( $p<0,05$ ).

Table 3. The results of preference test for fermented Sarı Ulak olives (A: 8% NaCl, B: 4% NaCl+ 4% KCl, C: 4% NaCl+ 4% CaCl<sub>2</sub>, D: 4% NaCl+ 4% MgCl<sub>2</sub>)

Experemints	Total points
NaCl	18
NaCl+KCl	25
NaCl+MgCl <sub>2</sub>	33
NaCl+CaCl <sub>2</sub>	35

### Conclusion

This study was aimed to examine the influence of partial replacement of NaCl with different chloride salts (KCl, MgCl<sub>2</sub> and CaCl<sub>2</sub>) on the physical, chemical, and sensory characteristics of cracked green table olives obtained from cv. Sarı Ulak of Tarsus District. The pH values of fermented cracked Sarı Ulak olives varied from 4.00-4.58 and total acidity expressed as lactic acid in the range of 5.34-6.07 g/L. According to the sensory analysis, table olives obtained from NaCl containing brine was preferred the most and followed by NaCl+KCl containing brine in the second rank, while brine containing NaCl+MgCl<sub>2</sub> was in the third rank. The NaCl+CaCl<sub>2</sub> containing brine was not accepted by most of the panelists due to the better taste and hardness. Further studies need to clear the partial replacement of NaCl with different chloride salts for better knowledge of cracked table olive processing.

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