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The effect of table olive preparing methods and storage on the composition and nutritive value of olives

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RESUMEN

Efecto del almacenamiento y métodos de preparación de aceitunas de mesa sobre la composición y valor nutritivo de las aceitunas.

Tres tipos de aceitunas de mesa –verdes estilo español, negras naturales estilo kalamata y negras naturales –fueron preparadas a partir de aceitunas de la variedad *Memecik* y su composición química y valor nutritivo fue analizado durante su procesado y almacenamiento. Se determinaron: la humedad, la grasa y su composición en ácidos grasos, la fibra cruda y proteína, los azúcares totales y reductores, el cloruro sódico y la ceniza, la acidez, el pH y algunos minerales en muestras de pulpa de aceituna de mesa. El valor calórico de los tres tipos de aceitunas fueron calculados a partir del contenido en proteína, hidrato de carbono y grasa. Todos los resultados obtenidos durante el procesado y almacenamiento para los tres tipos de aceitunas de mesa son discutidos minuciosamente.

PALABRAS-CLAVE: Aceituna de mesa – Almacenamiento – Composición química – Métodos de preparación – Valor nutritivo.

SUMMARY

The effect of table olive preparing methods and storage on the composition and nutritive value of olives.

Three types of table olives –green ,kalamata and black– were prepared from Memecik variety olives, chemical composition and nutritive values were examined during the processing and storage. Data are provided for moisture, oil and its fatty acid composition, crude fiber and protein, total and reducing sugars, sodium chloride and ash, titratable acidity, pH value and some minerals in table olive flesh samples.The caloric values of three types of olives were calculated by using the content of protein, carbohydrates and oil. Results for three types of table olives obtained during processing and storage are discussed in detail.

KEY-WORDS: Chemical composition – Nutritive value – Processing methods – Storage – Table olives.

1. INTRODUCTION

Olive fruit is an important agricultural product in Mediterranean countries. Because it is a valuable foodstaff and olive cultivation is a branch of agriculture that holds noteworthy position in the economy of producer countries.The world production of olive fruit is about 12 980 000 tons (1). About ninety percent are used for oil production and ten percent for table olives. The average yearly amount of fresh olives produced over the last five years period in Turkey is 818 000 tons,of which 106 340 tons are processed for table olives and the rest are used for oil production (2). Although Turkey is the fourth country in the production of fresh olives, it is the second greatest producer in the world for table olives after Spain (1,3). Many olive varieties have been used for table olives in Turkey, among them Memecik, Gemlik, Domat, Ayvalik, Uslu and Edincik Su are the major cultivars. Olive cultivars containing a low percentage of oil with a high sugar content are usually used as table olives, however, certain olive cultivars are suitable for both table olives and oil production (4).The Memecik variety alone constitues more than 50% of olive production in the Egean Region of Turkey and it has been used both for table olives and oil production (5).

Edible table olives are prepared in different ways. Mainly three commercial types of table olives are processed in olive producing countries. They are kalamata type olives, green type olives and black type olives. It is estimated that 39.7% world olive production is processed as green olives, 40% is produced as black and the rest (20.3%) is used for preparation of all the other commercial types (3). In order of production amounts in Turkey, the black table olives is the largest then follows the green and kalamata type olives.

The main constituents of the olive fruit are oil, water, sugars, proteins, anthocyanins and oleouropein (4). These compounds are influenced by the method of processing of table olives. It was reported that the sugar content of the olives decreased significantly after processing while the sodium content increased (6). Water treatment and fermentation process also affect the nutritional constituents of olive fruit. A reduction in the content of tocopherols was reported after water treatment and fermentation (7). It was also reported that fat content of olives increased

slightly during table olive processing, whereas nitrogen and carbohydrate contents decreased during lactic fermentation (8).

Several methods of preparing of table olives have been used in commercial scale in olive producing countries. All steps and conditions of processing may affect the composition and nutritive value of table olives. Although some work related with composition of raw olives have been done, little information is available on the changes that the olive constituents undergo during their processing and storage. Turkey is both top producer and consumer of table olives. As a matter of fact, no published research was found on the composition and alterations of olives during preparation and preservation of Turkish table olives. The aim of this study was to focus on the changes of some components of table olive fruits occurred during processing and storage ,in order to provide more information for selected processing techniques in Turkey,considering their nutritional value and quality of table olives during processing and storage.

2. MATERIALS AND METHODS

2.1. Material

Olive fruit samples belonging to Memecik variety were hand-picked from trees at three different stages of maturity –green, pink or purple and black– in the orchard of Olive Research Institute, Bornova,Izmir-Turkey. The above three different type of olives were prepared by the following methods:

A. Green table olives (Spanish style): Olives were hand-picked when they had a green-yellow surface colour and normal large-size. The collected samples were subjected to sorting with regard to their size and immediately put into a tapped plastic container, capacity of 15 kg. 2 % NaOH solution was added into the plastic container and the olives were left 8 hours in that solution. During this debittering process, penetration of sodium hydroxide solution into the olive flesh was controlled by cutting the fruit halfway down its length to see haw far the solution has penetrated the flesh from time to time. After penetration of NaOH in a depth corresponding to 2/3 of flesh thickness, the solution was poured with the aid of tap container and the fruits were subjected to a water washing several times to eliminate the excess of alkali remaining on the fruits. At the end of this period the water was removed and 8% NaCl solution was added to cover the olives. The amount of NaCl in the brine was determined at three days intervals, because its concentration diminishes during fermentation. For this reason, the reduced amount of sodium chloride was added into the solution after each of determimation. pH value is eight at the beginning of fermentation and it should be dropped to 6 within two days. For this reason, the pH value of the solution was measured from time to time and adjustment was made by addition of citric acid to reduce the pH to 6 during the fermentation. Under such conditions, fermentation completes within one month. At the and of fermentation the pH value is 4.7.

B. Kalamata type olives: To prepare kalamata type table olives, the fruit samples were hand-picked when its colour turned from pink to purple. Then the olives were cut twice on a cutting machine automatically. Incised olive fruits were put into the plastic container previously filled with tap water. The water was changed at two days intervals initially then two change of water per week was made during 40 days. Afterwards, the olives were placed into the 8 % NaCl solution and stored at ambient temperature in the laboratory.

C. Black table olives: Fully ripened black olives were hand-picked and sorted. Healthy and undamaged fruits were put into the plastic container with a capacity of 15 kg, containing 10 % NaCl solution. The concentration of NaCl of brine was controlled every month to adjust its amount to the initial level and the olives were stored at ambient temperature in the laboratory.

2.2. Chemical analysis

The experiments were carried out at the beginning, during alkaline treatment for green table olives and after fermentation at four months intervals for all table olive samples. All analysis were done on the flesh of olive fruit samples three times. The seed were removed and the flesh samples were blended in a Waring model mechanical blender (capacity of 1000 ml) and homogenised. Aliqouts from this homogenate were used for analyses.

Titratable acidity (as lactic acid), pH value and sodium chloride content were determined according to the Turkish Standards (9) . Oil content was determined by Soxhlet extraction using n-hexane as described by IUPAC (10). Fatty acid methyl esters were prepared by methylation of the lipids according to IUPAC (10).One gram of oil was used for metilation and 5.0 μl of methyl esters was injected into the column. Gas chromatography of the methyl esters was conducted on a Pye Unicam (model 204) equipped with a hydrogen flame ionisation detector. The carrier gas was nitrogen at a flow rate of 30 ml/min. A glass column, of 200 X 0.5 cm outer diameter, packed with DEGS 10% on 80-100 mesh Chromosorb was used for fatty acid analysis. The column temperature was 180 ^{o}C. The peak areas were integrated using a Hewlett-Packard PC integrator.

Sugar analyses (total and reducing), crude fiber and calculation of caloric value were performed according to the method described by Vamvoukas et

al, (11*)*. For the determination of sugar , 25 g of olive flesh sample were mixed with 125 ml of 1:1(v/v) ethyl alcohol-water solution. 1.0 g $CaCO_3$ was added and then it was left for 1 hour at 80°C in oven. The tannins and colored substances were precipitated by adding basic lead acetate. Total reduced sugars in filtrated samples were determined by the Lane-Eynon volumetric method. The concentration of iron, zinc, calcium, sodium and potassium were determined using a flame atomic absorbtion spectrophotometer (Pye Unicam model SP8) with a deuterium background corrector. Sodium and potassium were also determined by flame emission techniques. Moisture content was determined by oven drying method at 103 °C ± 1. Total ash and protein were determined according to the AOAC method (12). Kjeltec apparatus (model Gerhardt Vapodest 30) was used for nitrogen digestion and distillation. Crude protein was expressed as 6.25 x N. The "paired t test" was used for statistical analysis by using Minitab PC (version 11) (Minitab Statistical Software, USA).

3. RESULTS AND DISCUSSION

The data for the characteristics of table olives obtained during the period of this study are given in Tables I-III. Results show that the moisture content of green olives was 64.84 g/100g when harvested. Pink or purple coloured olives and ripened black olives contained 51.18 g/100g and 55.37 g/100g moisture respectively. The moisture content of table olive fruits increased during the storage in brine. Similar results were reported by Balatsoures (6). Ash content of the olive fruit samples prepared in different methods increased after processing. A slight increase was also found in insiced table (kalamata) olives during the first period of storage. A rapid increase in the ash content of black table olives was detected. During the elimination of bitterness with NaOH solution, there has been an increase in the amount of ash for green type table olives. The amount of ash was remained constant in the other storage periods for all type table olives. It was reported that this increase is due to the brine NaCl retention in the flesh (11).

The acidity of raw green olives was found to be 0.11 g/100g, (as lactic acid). The alkaline treatment and washing process caused to decrease in the acidity of olive fruits. After fermentation, it increased to the value of 0.43 g/100g. Four months later, the acidity reduced again and remained constant as 0.09 g/100. The reason of this reduction in the acidity is that the carboxylic acids present in the olive flesh are dissolved in the brine and then chemical equilibrium is formed. As shown in table II, the acidity of

Table I

Results for green table olive fruit samples obtained during processing and storage*

Characteristics	Initial values	After alkaline treatment	After fermentation	Storage times (months) 4	8	12
Moisture (%)	64.84 ± 0.20	73.73 ± 0.10	73.35 ± 0.20	73.30 ± 0.15	68.80 ± 0.10	72.28 ± 0.10
Oil (%)	14.86 ± 0.07	14.00 ± 0.05	14.28 ± 0.12	14.70 ± 0.15	15.28 ± 0.02	14.82 ± 0.06
Protein (%)	1.36 ± 0.04	1.36 ± 0.01	1.32 ± 0.02	1.18 ± 0.03	1.26 ± 0.09	1.08 ± 0.04
Ash (%)	1.42 ± 0.07	1.94 ± 0.03	5.89 ± 0.07	5.92 ± 0.04	5.79 ± 0.08	5.89 ± 0.06
Acidity (%, as lactic acid)	0.11 ± 0.01	0.02 ± 0.01	0.43 ± 0.01	0.09 ± 0.01	0.09 ± 0.01	0.09 ± 0.01
pH	4.6 ± 0.1	8.0 ± 0.1	4.7 ± 0.05	4.6 ± 0.1	4.3 ± 0.2	4.3 ± 0.1
NaCl (%)	-	-	3.90 ± 0.1	3.95 ± 0.07	3.66 ± 0.1	4.09 ± 0.1
Reducing sugar (%)	1.41 ± 0.06	0.39 ± 0.09	ND	ND	ND	ND
Total sugar (%)	2.90 ± 0.11	0.97 ± 0.05	ND	ND	ND	ND
Crude fiber (%)	5.05 ± 0.56	4.12 ± 0.18	4.60 ± 0.16	3.38 ± 0.15	3.61 ± 0.18	4.30± 0.17
Caloric value (g/100g of flesh)	154.4 ± 1.0	-	134.5 ± 0.95	138.2 ± 1.0	143.2 ± 1.05	138.2 ± 1.0
Fatty acid composition (%)						
$C_{16:0}$	18.23 ± 0.65	18.11 ± 0.42	17.38 ± 0.45	17.19 ± 0.10	17.00 ± 0.52	16.42 ± 0.94
$C_{16:1}$	1.60 ± 0.30	1.53 ± 0.32	1.57 ± 0.30	1.49 ± 0.09	1.44 ± 0.09	1.56 ± 0.16
$C_{18:0}$	0.91 ± 0.15	0.93 ± 0.31	1.79 ± 0.22	1.93 ± 0.5	1.80 ± 0.15	1.54 ± 0.31
$C_{18:1}$	69.20 ± 5.05	69.29 ± 4.06	67.38 ± 2.93	69.33 ± 2.05	67.26 ± 1.82	67.48 ± 1.58
$C_{18:2}$	8.61 ± 1.69	9.04 ± 1.98	9.76 ± 1.12	9.12 ± 0.52	10.56 ± 0.53	11.89 ± 1.10
$C_{18:3}$	1.09 ± 0.34	1.09 ± 0.16	1.41 ± 0.56	0.73 ± 0.18	1.19 ± 0.14	1.09 ± 0.10
Minerals						
Sodium (g/100g)	0.020 ± 0.005	1.539 ± 0.003	1.533 ± 0.010	1.998 ± 0.005	2.178 ± 0.006	2.251 ± 0.012
Potassium (g/100g)	0.294 ± 0.038	0.268 ± 0.016	0.113 ± 0.031	0.056 ± 0.009	0.071 ± 0.012	0.079 ± 0.004
Calcium (g/100g)	0.044 ± 0.009	0.036 ± 0.003	0.044 ± 0.010	0.029 ± 0.005	0.037 ± 0.006	0.033 ± 0.012
Iron (mg/100g)	0.8 ± 0.1	1.2 ± 0.1	0.9 ± 0.1	0.7 ± 0.1	0.7 ± 0.1	0.7 ± 0.1
Zinc (mg/100g)	7.5 ± 0.95	-	5.3 ± 0.3	6.1 ± 0.3	6.1 ± 0.1	6.0 ± 0.1

* mean of three determinations ± SD
ND: Not detected.

Table II
Results for kalamata table olive fruit samples obtained during processing and storage*

Charecteristics	Initial values	After debittering	Storage Times (months)					
			4	8	12	16	20	24
Moisture (%)	51.18 ± 1.0	67.47 ± 0.62	65.66 ± 0.11	60.43 ± 0.16	63.52 ± 0.67	59.08 ± 0.12	58.23 ± 0.28	63.95 ± 0.25
Oil (%)	21.90 ± 0.20	21.65 ± 0.20	21.50 ± 0.25	21.72 ± 0.11	18.70 ± 0.26	21.90 ± 0.06	22.30 ± 0.16	21.94 ± 0.11
Protein (%)	1.36 ± 0.04	1.05 ± 0.01	1.00 ± 0.01	1.00 ± 0.02	1.00 ± 0.01	1.30 ± 0.02	1.10 ± 0.03	1.26 ± 0.04
Ash (%)	1.43 ± 0.11	2.72 ± 0.09	2.88 ± 0.07	4.03 ± 0.07	4.63 ± 0.09	4.45 ± 0.03	4.43 ± 0.03	4.52 ± 0.04
Acidity (%, as lactic acid)	0.25 ± 0.06	0.11 ± 0.02	0.23 ± 0.02	0.45 ± 0.04	0.45 ± 0.02	0.45 ± 0.03	0.45 ± 0.03	0.45 ± 0.04
NaCl (%)	-	-	3.70 ± 0.04	2.56 ± 0.06	3.65 ± 0.12	4.24 ± 0.07	4.17 ± 0.03	4.02 ± 0.07
pH	3.6 ± 0.06	5.70 ± 0.05	5.4 ± 0.01	5.8 ± 0.01	4.7 ± 0.01	4.8 ± 0.01	4.8 ± 0.05	5.4 ± 0.01
Reducing sugar (%)	1.93 ± 0.05	ND	ND	ND	ND	ND	ND	ND
Total sugar (%)	2.06 ± 0.05	ND	ND	ND	ND	ND	ND	ND
Crude fiber (%)	4.15 ± 0.73	3.10 ± 0.21	4.8 ± 0.18	5.18 ± 0.14	4.63 ± 0.12	4.79 ± 0.21	3.67 ± 0.51	3.64 ± 0.12
Caloric value (Cal./100g of flesh)	213.5 ± 3.1	199.6 ± 5.1	198 ± 3.5	199.9± 2.2	174.2 ± 2.6	202.6 ± 3.2	206.4 ± 2.9	201.5 ± 3.1
Fatty acid composition (%)								
$C_{16:0}$	12.8 ± 1.0	12.8 ± 0.53	13.48 ± 0.30	12.79 ± 0.24	13.44 ± 0.49	12.46 ± 0.10	14.06 ± 0.13	1 2.36 ± 0.51
$C_{16:1}$	0.45 ± 0.06	0.73 ± 0.04	1.62 ± 0.17	0.90 ± 0.16	1.18 ± 0.03	0.98 ± 0.12	0.86 ± 0.04	1 .18 ± 0.07
$C_{18:0}$	1.91 ± 0.11	1.95 ± 0.04	2.01 ± 0.06	1.43 ± 0.11	1.58 ± 0.08	2.26 ± 0.26	1.56 ± 0.31	1 .28 ± 0.13
$C_{18:1}$	73.23 ± 2.00	73.8 ± 3.71	70.64 ± 2.52	74.03 ± 2.00	72.04 ± 2.43	72.79 ± 2.45	71.62 ± 2.54	7 2.19 ± 2.29
$C_{18:2}$	10.30 ± 0.3	9.26 ± 0.39	10.77 ± 0.14	9.71 ± 0.75	10.20 ± 0.25	11.06 ± 0.19	10.69 ± 0.33	1 1.83 ± 0.83
$C_{18:3}$	1.09 ± 0.08	0.99 ± 0.16	1.48 ± 0.23	0.93 ± 0.20	0.11 ± 0.03	0.26 ± 0.02	0.95 ± 0.10	1 .16 ± 0.09
Minerals								
Sodium (g/100g)	0.047 ± 0.002	0.025 ± 0.006	2.076 ± 0.024	1.658 ± 0.042	2.093 ± 0.050	2.090 ± 0.050	2.120 ± 0.010	2 .034 ± 0.020
Potassium (g/100g)	0.457 ± 0.011	0.404 ± 0.016	0.029 ± 0.009	0.114 ± 0.012	0.139 ± 0.011	0.164 ± 0.020	0.182 ± 0.006	0 .168 ± 0.01
Calcium (g/100g)	0.047 ± 0.003	0.050 ± 0.005	0.045 ± 0.05	0.035 ± 0.007	0.032 ± 0.002	0.028 ± 0.02	0.029 ± 0.08	0 .027 ± 0.004
Iron (mg/100g)	2.7 ± 0.1	0.8 ± 0.1	0.9 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	0 .6 ± 0.1
Zinc (mg/100g)	1.3 ± 0.1	1.0 ± 0.3	0.5 ± 0.1	0.7 ± 0.1	0.6 ± 0.2	0.6 ± 0.1	0.7 ± 0.1	0 .9 ± 0.1

* mean of three determinations ± SD
ND: Not detected

kalamata type table olives decreased at the beginning, since washing with water eliminates the acidic compounds from the flesh and the lactic acid production from the sugars have not started yet in that stage of processing. Similar behavior in acidity was observed in black table olives from beginning to the end (Table III).

The initial pH value of green olives was found to be 4.61. After alkaline treatment, it reached to 8.02. Then it dropped to 4.68 and this value was remained almost constant during the storage. The final pH value was 4.27. For the elimination of bitterness of olive flesh, the washing with water has been repeated several times for kalamata type olives and this washing process was caused a decrease of the pH value. It can be seen in tables 1-3, the pH values of kalamata type table olives varied from 3.67 to 5.7 after one month. A small reduction was observed after the first four months storage and it remained constant untill before final measurement. On the other hand, black table olive samples had higher initial pH values than the others. Because as the olive ripens, the pH value rises. As shown in tables 1-2, the initial pH value of the black table olives was 5.1. At the first period it decreased to 4.4 (after four months) and in the following intervals, there has been a rise for black type olives.

Olive fruit normally does not contain sodium chloride when harvested. During the preparation and storage of table olives, NaCl is diffused into the flesh. The amount of sodium chloride ranged between 2.56 g/100g and 4.09g/100g for all types of table olive flesh samples. As far as we know, there is no literature about the relationship between the amount of NaCl in the brine and its diffusion into the olive flesh. For this reason, it is not possible to comment on the concentration of salt for table olives.

Total and reducing sugar content ranged from 2.06 g/100g to 2.9 g/100g and 1.41 g/100g to 1.93 g/100g respectively. Initial total and reducing sugar values for kalamata type olives were 2.06 g/100g and 1.93 g/100g respectively.After debittering process sugar was not detected in that type of olive samples.Raw green table olives contained total and reducing sugar as 2.90 g/100g and 1.41g/100g respectively. Unprocessed black table olives contained 2.20g/100g total sugar and 1.90g/100g reducing sugar.Similar situations in sugar content of olive samples were observed during processing steps and storage for green and black table olives.An important reduction in the amount of sugar was found during the stage of preparation and fermentation as well, but only traces of sugar were detected after fermentation for all types of table olive samples. This may be depended on the fact that they

Table III
Results of black table olive fruit samples obtained during processing and storage*

Charecteristics	Storage times (months)						
	Initial values	4	8	12	16	20	24
Moisture (%)	55.37 ± 0.11	56.76 ± 0.81	55.30 ± 0.20	54.03 ± 0.20	55.51 ± 0.35	54.61 ± 0.61	56.17 ± 0.41
Oil (%)	26.55 ± 0.7	26.36 ± 0.4	28.43 ± 0.2	26.34 ± 0.4	25.10 ± 0.42	25.80 ± 0.10	25.48 ± 0.29
Protein (%)	1.31 ± 0.04	1.26 ± 0.02	1.09 ± 0.04	1.58 ± 0.12	1.35 ± 0.06	1.38 ± 0.03	1.49 ± 0.02
Ash (%)	1.83 ± 0.05	6.55 ± 0.09	5.76 ± 0.05	6.35 ± 0.12	5.70 ± 0.22	5.76 ± 0.06	5.93 ± 0.03
Acidity (%, as lactic acid)	0.13 ± 0.02	0.25 ± 0.01	0.45 ± 0.02	0.45 ± 0.01	0.45 ± 0.01	0.45 ± 0.02	0.45 ± 0.01
pH	5.1 ± 0.2	4.4 ± 0.05	5.0 ± 0.08	5.1 ± 0.1	5.8 ± 0.05	5.8 ± 0.1	6.0 ±0.09
NaCl (%)	-	4.44 ± 0.05	4.39 ± 0.08	4.97 ± 0.02	5.12 ± 0.04	4.82 ± 0.12	4.97 ± 0.16
Reducing sugar (%)	1.90 ± 0.03	0.41 ± 0.02	ND	ND	ND	ND	ND
Total sugar (%)	2.20 ±0.07	1.42 ± 0.11	ND	ND	ND	ND	ND
Crude fiber (%)	4.79 ± 0.6	5.63 ± 0.5	3.91 ± 0.15	5.00 ± 0.14	4.49 ± 0.13	4.04 ± 0.16	3.23 ± 0.23
Caloric value (Cal /100 g of flesh)	255.8 ± 5.50	242.9 ± 2.9	260.7 ± 2.5	244.2 ± 2.7	231.9 ±2.6	238.4 ± 2.9	236.0 ± 3.6
Fatty acid composition (%)							
$C_{16:0}$	11.65 ± 1.65	12.71 ± 0.7	11.85 ± 0.69	11.38 ± 0.5	10.48 ± 0.73	11.39 ± 0.5	10.75 ± 0.53
$C_{16:1}$	0.64 ± 0.07	1.57 ± 0.37	1.02 ± 0.29	1.04 ± 0.22	0.67 ± 0.12	0.87 ± 0.04	0.76 ± 0.09
$C_{18:0}$	2.12 ± 0.13	2.04 ± 0.12	1.89 ± 0.16	2.25 ± 0.15	2.21 ± 0.16	1.81 ± 0.12	1.86 ± 0.15
$C_{18:1}$	73.64 ± 3.26	72.85 ±2.67	75.47 ± 2.1	73.90 ± 2.08	76.30 ±1.45	74.55 ± 3.13	75.03 ± 2.58
$C_{18:2}$	10.82 ± 0.8	9.54 ± 1.26	8.27 ± 0.82	9.94 ± 0.93	9.61 ±0.65	10.48 ± 0.46	10.31 ± 0.22
$C_{18:3}$	0.94 ± 0.18	1.29 ± 0.27	1.09 ± 1.00	1.00 ± 0.09	0.50 ±0.02	0.88 ± 0.09	1.18 ± 0.14
Minerals							
Sodium (g/100g)	0.027 ± 0.004	2.046 ± 0.011	2.042 ± 0.006	2.466 ± 0.018	2.122 ± 0.021	2.501 ± 0.049	2.344 ± 0.028
Potassium (g/100g)	0.590 ± 0.092	-	-	0.335 ± 0.067	0.331 ± 0.035	0.326 ± 0.012	0.376 ± 0.033
Calcium (g/100g)	0.025 ± 0.002	0.011 ± 0.006	0.022 ± 0.004	0.023 ± 0.001	0.019 ± 0.003	0.012 ± 0.001	0.011 ± 0.002
Iron (mg/100g)	1.7 ± 0.1	1.3 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	1.2 ± 0.1	1.1 ± 0.1	1.1 ± 0.1
Zinc (mg/100g)	0.8 ± 0.3	0.4 ± 0.1	0.7 ± 0.3	0.7 ± 0.2	0.4 ± 0.1	0.4 ± 0.1	0.2 ± 0.1

* mean of three determinations ± SD
ND: Not detected

were partly converted to lactic, acetic and formic acids etc. (11) and processing operations, such as sodium hydroxide solution, washing treatments and storage in brine were caused high sugar loss in olive fruit (13).

Crude fiber values varied between 4.5 g/100g and 5.5 g/g for all type table olives. The highest value was found in the non processed green table olives. During the fermentation and storage for 24 months, crude fiber showed a fluctuation for table olives. Nevertheless, the last measured value were lower than initial values. Nosti Vega et al., (14) reported that the content in crude fiber, protein and vitamines decreased due to the elaboration process for table olives. The differences between the examined table olive preparation methods were not found significant in crude fiber statistically ($P<0.05$).

Two factors are important to estimate the caloric value of table olives. One is the flesh to pit ratio and the other is the content of protein, carbohydrate and oil of the flesh.The caloric value of green table olives was lower than the others because of their low oil content. The black table olives had the highest caloric value. They were calculated as 154.36, 213.52 and 255.84 calory per 100 gram for raw green, kalamata and black table olives respectively. The caloric value was proportional to that of their oil content which is mainly related. In general, it decreased during preparation and storage for all type table olives and the effect of table olive preparing methods were found to be significant statistically ($P<0.01$). This result is in good agreement with the values reported by Nosti Vega et al,(14).

The value of crude protein of raw table olives was 1.36 percent for both green and kalamata type olives. Black olives contained 1.31g protein per 100 gram olive flesh when harvested. Nitrogen content of green and kalamata type olives decreased at the end of storage, wheras there was a rise for black table olives which might be originated from the sampling errors. Our findings (except black olives) were in good agreement with the literature values (11,14).The protein content of green and kalamata type table olives was found to be 1.08 g/100g and 1.26g/100g respectively at the last period of storage. This reduction can be attributed to the losses during treatment with sodium hydroxide and washing with water and some of olive flesh protein can be diffused into the brine and supports growth of lactic acid bacteria (6).

Green table olives contained oil 14.86 (%) when harvested. Whereas pink or purple coloured and black olives contained 21.9 (%) and 26.55 (%) oil respectively. The oil content of the olive fruit

increases during the olive growing and ripening . Although small variations have been found in the oil content of three type table olives, the oil content of the olive samples did not change during the preparing methods and storage as compared to the their initial values. Fatty acid composition of the oil obtained from green, kalamata and black olives showed differences depending on the degree of olive ripeness. Palmitic acid percentage was found to be highest in green raw olives, followed by kalamata and black table table olives, since palmitic acid and oleic acid contents of the olive flesh decrease while linoleic acid increases (5). In the present study, the increase in linoleic acid depends on the progress of ripening of olive fruit. Stearic acid showed a similar behavior for all type table olives. Oleic acid, which is the major fatty acid in the olive flesh, showed differencess due to the table olive preparing methods. Although a regular variation has not been found in the percentage of oleic acid content, a small reduction was observed for green and kalamata type table olives at the end of storage, whereas an opposite situation was seen in black type table olives.

The results of analysis indicated that the sodium content of examined table olives increased during processing and storage. This increase was originated from the treatment of NaOH for removing bitterness and addition of NaCl during fermentation. Upon the salt concentration, sodium is diffused into the olive flesh and the amount of sodium of flesh increases. Calcium, potassium and zinc, showed a decrease during processing as compared to their initial values for all type table olives. This may be originated from washing water used for processing. As shown in tables 1-3, the iron content of the flesh had a fluctuation during the preparing and storage of table olives. It is thought that the iron in the olive flesh can be dissolved and transported into the brine.

As compared to the initial values of table olives, it is concluded that the water soluble constituents and minerals (Ca,K, Fe,Zn) of table olives were affected during processing and storage. The caloric value of olive flesh samples was also affected by the preparing table olive methods.

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