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Evaluation of Table Olive Produced From Some New Egyptian Varieties

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ABSTRACT

The aim of this study was to evaluate the chemical composition, fatty acid profile, total polyphenols, and sensory attributes of table olives produced from three olive fruit cultivars (Giza 102, Giza 92, and Serscola) at different ripening stages (green and black). The samples were collected from the Horticulture Research Institute farm in Giza, Egypt. Analyses of some physical properties were conducted, including fruit weight (FW), pit weight (PW), flesh weight (FLW), FW/PW ratio, FLW/PW ratio, and the length and width of the three olive cultivars. Based on the mean values, the highest fruit weight was observed in Giza 102 (7.99g), followed by Giza 92 (7.61g) and Serscola (3.17g). Giza 102 had the lowest pit weight (0.95g), followed by Serscola (1.06g) and Giza 92 (1.45g). Regarding the FW/PW and FLW/PW ratios, Giza 102 exhibited the best ratios, 8.40 and 7.41, respectively. The quality of processed green and black table olives was mainly influenced by the olive variety and the processing method. Two processing methods were employed: natural fermentation for green olives and the Spanish style for green olives, in addition to black olive preparation. The results showed that moisture content increased during processing and fermentation. The highest crude oil content was obtained from black olives of the Serscola cultivar. Meanwhile, total sugar, total polyphenols, and phenolic compounds decreased during processing and fermentation.

1. Introduction

Table olives are produced from the fruit of the olive tree (*Olea europaea*) and are among the most popular foods in Mediterranean countries, having been a staple of their diet for centuries. Egypt is one of the leading producers of table olives (IOC 2021). Table olives are considered one of the most significant fermented foods in global trade, with an annual production of 2,846,500 tonnes, depending on the season (IOC 2022). The primary processing methods include the Spanish style, naturally black olives in brine, and ripe olives (Californian style). However, there are numerous other processing methods, many of which are strongly influenced by cultural practices (Fernandez 1997 and Cillidag 2013). According to the IOC (2004), olives are classified into three types based on color, which is largely determined by the degree of maturity at harvest: green, turning color, and black. Green olives are harvested when the fruit has reached full size, with colors ranging from green to straw yellow. Olives at the turning color stage exhibit shades of rose, wine-rose, blush, or brown and are harvested before full ripeness. Black olives are harvested when fully ripe or just before complete ripeness. Natural black ripe olives, as defined by the IOC (2020), are made from fruits harvested at full ripeness or just before. This type accounts for 30% of the global trade in black olives, particularly the natural black olives in brine. These olives are characterized by their fruity and slightly bitter taste and are preserved through natural fermentation in brine (Kaltsa 2010). The olives intended for this commercial type are left on the tree until they reach full ripeness and develop a black-violet or black color (Balatsouras 1995).

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The fermentation process involves soaking the olives in brine, with a salt concentration maintained between 8% and 10%. The debittering occurs naturally during fermentation, without prior alkaline hydrolysis. The reduction in bitterness is achieved through the diffusion of phenolic compounds into the brine (Bouranta, 2022). Table olives are the nutritious fruits of cultivated olive tree varieties (*Olea europaea*), specifically selected for their characteristics that make them ideal for processing. Processing is essential for olives, primarily to degrade the phenolic glycoside oleuropein—a compound responsible for the fruit's natural bitterness, which makes it unpalatable when consumed fresh. Additionally, processing ensures the product's preservation through the action of lactic acid bacteria, which lower the pH, and enhances the final product's quality by improving aroma, taste, texture, and other sensory attributes (Maria et al., 2023). For thousands of years, olive oil and table olives have been integral components of the Mediterranean diet. Globally, the two most commercially significant types of table olives are Spanish-style green olives and black olives (Gomez et al., 2006).

Table olives are renowned for their high nutritional value, containing a variety of nutrients that depend on factors such as the olive variety, the ripening stage of the fruit, growing conditions, and the processing method (Lopez et al., 2008).

The study aims to evaluate the chemical composition, fatty acids, polyphenols, and sensory characteristics of table olives from three cultivars (Giza 102, Giza 92, and Serscola) at two ripening stages (green and black). It also investigates the impact of two processing methods—natural fermentation and Spanish-style—on physical and chemical properties

2. Materials and Methods

Materials

The olive varieties Giza 102, Giza 92, and Serscola (*Olea europaea*) were obtained from the Horticulture Research Institute farm. Sodium hydroxide, sodium chloride, acetic acid, and lactic acid were purchased from a local market in Cairo, Egypt.

Methods

Experimental Design

The experiment was conducted using Giza 102, Giza 92, and Serscola olive varieties (*Olea europaea*). The olive fruits used were fresh, firm to the touch, free from shriveling, and without any visible damage caused by insect bites or stings. The experiment involved green olives from the three cultivars processed using two methods: natural fermentation and the Spanish style. For each processing method, 12 kg of olives per variety was divided into two portions and prepared as follows:

Green Table Olives

Natural Fermentation (6 kg)

Green table olives from the Giza 102, Giza 92, and Serscola cultivars were washed with water to remove dirt, manually sorted to eliminate damaged fruits, and placed in 2-liter plastic containers. The containers were filled with brine (10 g NaCl/100 ml and 0.25% citric acid) with a pH of 3.6. The olives were left to ferment naturally for three months. Samples were taken for analysis after fermentation.

Spanish Style Processing (6 kg)

Olives were hand-picked at the green stage with a normal large size. They were treated with a lye solution (1.5 g NaOH/100 ml) until the NaOH penetrated two-thirds of the flesh thickness (approximately 5 hours). The olives were then washed with fresh water three times to remove excess alkali. The end of the washing process was confirmed using a phenolphthalein indicator. The debittered olives were brined with a 10% NaCl solution, with the total acid content (expressed as citric acid) maintained at 0.25%. Fermentation lasted for one month, after which samples were taken for analysis.

Black Table Olives

Fully ripened black olives were hand-picked and sorted to ensure only healthy and undamaged fruits were used. The fruits were placed in plastic containers with a capacity of 6 kg, containing a 10% NaCl solution and 0.25% lactic acid (pH 3.6). The brine concentration was monitored monthly for three months. Samples were taken for analysis after

three months. Samples were taken for analysis after the fermentation period.

Physical Analyses of Olive Fruit Cultivars

Physical parameters such as fruit weight, pit weight, flesh weight, fruit weight-to-pit weight ratio, flesh weight-to-pit weight ratio, length, and width were measured twice on a batch of 100 randomly chosen olives from each variety. These measurements were based on the ripening index method (Uceda and Frias, 1975), which evaluates olive skin and flesh color. Ripeness index values ranged from 0 (100% intense green skin) to 7 (100% black flesh skin).

Physical and Chemical Parameters

Chemical and physical properties such as moisture, fruit weight, pit weight, length, and width were analyzed according to AOAC (2005). Proximate composition (moisture, crude protein, crude oil, crude fiber, total sugars, and ash) was determined using official AOAC methods (2005).

Phenolic Compounds

Preparation of Extracts

For polyphenol measurement, all samples were treated following the method described by McDonald et al. (2001), with slight modifications. Five grams of dried olives were mixed with 25 ml of methanol and centrifuged at 3000 rpm for 5 minutes (Sigma 2-16 k, Germany). The residue was re-extracted under the same conditions, and the combined extracts were filtered for analysis.

Total Polyphenols Content and Profile

The total polyphenols content of the methanolic extract was determined using the Folin-Ciocalteu reagent, as described by Malik and Bradford (2006). The results were expressed as gallic acid equivalents (GAE, mg/100 g dry weight) based on a calibration curve ($y = 0.0036x$; $R^2 = 0.99$). A qualitative analysis of phenols and phenolic acids was performed using Gas Chromatography-Mass Spectrometry (GC-MS), following the method of Boskou et al. (2006).

Oil Extraction

Three olive cultivars were dried and ground using a laboratory mill, then soaked in n-hexane for 24 hours, repeated twice. The solvent was collected and evaporated under vacuum. The extracted oils were filtered and stored in dark bottles under refrigeration until analysis.

Gas Chromatography Analysis for Fatty Acid Methylation

An aliquot of oil (approximately 10 mg) was dissolved in hexane, followed by the addition of 0.4 ml of 2N KOH in anhydrous methanol (Cossignani et al., 2005). After 3 minutes, 3 ml of water was added. The organic layer was separated, dried over anhydrous sodium sulfate, and concentrated under a nitrogen stream to approximately 0.5 ml for GC analysis of fatty acid methyl esters (FAME).

Identification of Fatty Acid Methyl Esters by GC

The analysis was conducted using an Agilent 6890 series GC system equipped with a DB-23 column (30 m × 0.32 mm × 0.25 µm). Fatty acid methyl esters were directly injected into the GC. Nitrogen was used as the carrier gas at a flow rate of 2 ml/min with a split ratio of 1:100. The injector temperature was set at 250°C, and the FID detector temperature was 270°C. The temperature program started at 150°C, increased to 225°C at a rate of 5°C/min, and was held at 225°C for 20 minutes. Peak identification was achieved by comparing retention times (RT) with standard fatty acids. Peak areas were measured using the Chemstation Program, and the relative areas of the identified fatty acids were recorded.

Sensory Evaluation

Sensory evaluation assessed gustatory attributes (acid, salty, and bitter) and kinesthetic sensations (hardness, fibrousness, and crispness) using a sensory analysis evaluation sheet for table olives, as described by IOC (2021) and Lanza et al. (2010). Eight experienced judges from the Oil and Fat Research Department, Food Technology Research Institute, participated in the evaluation. They assessed defects, gustatory characteristics, and texture attributes of the samples.

Statistical Analysis

Variance analysis (ANOVA) was performed using the general linear model of SPSS software

(version 10). The LSD test ($p < 0.05$) was applied to compare the averages of different parameters.

3. Results and Discussions

Physical Characteristics of Three Olive Cultivars

Consumers prefer olives with high fruit weight and a high flesh-to-pit ratio. Additionally, the price of olives increases proportionally with these values (Nesrin, 2020). Therefore, these attributes should be as high as possible in newly developed cultivars. The fruit and seed size, fruit weight, and flesh-to-pit ratio of fresh olives are presented in Table 1. Statistically significant differences ($P < 0.05$) were observed among the three studied olive cultivars in terms of width, length, fruit weight (FW), pit weight (PW), flesh weight (FlW), FW/PW ratio, and FlW/PW ratio. The highest FW/PW and FlW/PW ratios were recorded in the Giza 102 cultivar at 8.40 and 7.41, respectively. In contrast, the Serscola cultivar exhibited the lowest FW/PW and FlW/PW ratios at 2.99 and 1.99, respectively. The fruit width ranged from 1.90 to 3.10mm, while the length varied between 3.2 and 3.6mm. As shown in Table 1, Giza 102 and Giza 92 had the highest FW values (7.99g and 7.61g, respectively) and FlW values (7.04g and 6.16g, respectively), compared to the Serscola cultivar, which had FW and FlW values of 3.17g and 2.11 g, respectively. Meanwhile, Giza 102 and Serscola were characterized by the lowest PW values (0.95g and 1.06g, respectively), whereas Giza 92 had the highest pit weight at 1.45g.

Table 1. Physical characters of three olive cultivars

Variety	Giza 102	Giza 92	Serscola
Width (mm)	2.5 ± 0.13^{b}	3.10 ± 0.11^{c}	1.90 ± 0.01^{a}
Length (mm)	3.3 ± 0.05^{a}	3.6 ± 0.03^{b}	3.2 ± 0.01^{a}
FW (g)	7.99 ± 0.03^{c}	7.61 ± 0.04^{b}	3.17 ± 0.03^{a}
PW (g)	0.95 ± 0.0^{a}	1.45 ± 0.01^{c}	1.06 ± 0.01^{b}
FW /PW ratio	8.40 ± 0.06^{c}	5.24 ± 0.02^{b}	2.99 ± 0.05^{a}
FlW (g)	7.04 ± 0.05^{c}	6.16 ± 0.07^{b}	2.11 ± 0.02^{a}
FlW/ PW ratio	7.41 ± 0.18^{c}	4.25 ± 0.04^{b}	1.99 ± 0.05^{a}

Different letters in the same row indicate significantly different at $P<0.05$. Each value represents the mean of three determinations (n=3) ± standard deviation. FW: Fruit weight PW: Pit weight FlW: Flesh weight

Serscola Giza 92 Giza 102

Figure 1. Cultivars of table olive

Chemical composition of fresh olives and changes during processing and fermentation in three olive cultivars

The chemical composition of fresh olive fruits from Giza 102, Giza 92, and Serscola cultivars, harvested at two stages (green skin and black skin), as well as changes during processing and fermentation (natural fermentation and the Spanish-style method), are presented in Tables 2 and 3. The results indicate that the moisture content of green fresh olives was 66.10%, 65.40%, and 68.99% for Giza 102, Giza 92, and Serscola, respectively. For ripened black olives, the moisture content was 68.28% for Giza 102 and 66.23% for Serscola. During processing and fermentation, the moisture content of table olives increased compared to fresh olive fruits, regardless of the fermentation method. Similar findings were reported by Balatsouras (1997). Abou-Zaid and Ibraheem (2015) attributed the increase in moisture content to a decrease in total soluble solids during processing and fermentation. Table 2 shows that the crude oil content of green fresh olives was 9.01%, 7.11%, and 9.13% for Giza 102, Giza 92, and Serscola, respectively. For ripened black olives, the crude oil content increased to 9.11% and 10.15% for Giza 102 and Serscola, respectively. The highest crude oil content was observed in black-skinned fresh olives of Giza 102 and Serscola.

Data from Tables 2 and 3 reveal that all treatments (natural fermentation and Spanish-style methods) resulted in a reduction in crude oil content by the end of fermentation, compared to the fresh olives of all three cultivars. Table 3 shows that the Spanish-style method caused the greatest loss of crude oil across all samples, particularly in Giza 92. This may be attributed to the lye treatment, which affects the cell walls of the olives. These findings align with those of Abou-Zaid and Ibraheem (2015). The total sugar content of fresh olives was 7.85%, 7.41%, and 7.11% for Giza 102, Giza 92, and Serscola, respectively. For ripened black olives, the sugar content increased to 8.10% and 9.36% for Giza 102 and Serscola, respectively. However, after processing and fermentation, the total sugar content decreased compared to fresh olives (Tables 2 and 3). These results are consistent with those reported by Hurtado et al. (2008) and Cardoso et al. (2010).

The ash content of olive samples prepared using both natural fermentation and the Spanish-style method increased during processing and at the end of fermentation for all table olive cultivars (Tables 2 and 3). This increase is attributed to the absorption of NaCl from the brine into the olive flesh.

Change in Total Polyphenols

As shown in Table 3, the total polyphenol content in the fruit samples ranged from 379 to 614 mg gallic acid/100g of fresh fruit. The total phenolic content of Giza 92 and Giza 102 fruits was higher than that of Serscola. Additionally, the total polyphenol content in the Giza 102 and Serscola cultivars decreased as the fruit matured (black skin stage). A decrease in total polyphenol content during olive fruit maturation has been reported by Cerretani et al. (2006) and Shibasaki (2005). Furthermore, the results in Table 3 indicate that the polyphenol content decreased during processing and after fermentation in all olive cultivars. These findings are consistent with those reported by Gomez Rico et al. (2008).

Table 2. Chemical composition of fresh olives

	Green olives			Black olives	
Proximate composition	Giza 102	Giza 92	Serscola	Giza 102	Serscola
Moisture %	66.10	65.40	68.99	68.28	66.23
Crude oil %	9.01	7.11	9.13	9.11	10.15
Crude protein %	6.35	6.12	6.21	5.36	6.11
Total sugar %	7.85	7.41	7.11	8.10	9.36
Ash %	3.34	3.91	3.01	3.24	2.90
Crude fiber %	7.35	10.05	5.55	5.91	5.25
Total polyphenols content mg/100g	589	614	454	505	379

Table 3. Change of chemical composition of green and black table olives at the end of fermentation

Proximate composition	Green olives						Black olives	
	Natural fermentation			Spanish style method				
	Giza 102	Giza 92	Serscola	Giza 102	Giza 92	Serscola	Giza 102	Serscola
Moisture %	73.02	74.90	73.98	74.21	75.08	74.15	72.15	70.31
Crude oil %	8.24	6.81	8.25	8.11	5.41	8.11	8.89	10.12
Crude protein%	5.90	4.71	4.66	5.86	5.87	4.98	5.92	5.21
Total sugar %	2.50	2.00	1.83	0.12	0.94	1.28	2.02	2.91
Ash %	4.23	4.64	4.49	4.98	5.22	5.11	4.36	4.10
Crude fiber%	6.11	6.94	6.79	6.72	7.48	6.37	6.66	7.35
Total polyphenols content mg/100g	522	576	385	467	502	312	425	311

Fatty Acid Composition of Fresh Olives

The fatty acid composition of olive oil extracted from three olive fruit cultivars is presented in Table 4. The major fatty acid in all cultivars is oleic acid (C18:1), which ranged from 72.96% to 75.88%. Palmitic acid (C16:0) ranged from 10.22% to 11.12%, linoleic acid (C18:2) ranged from 8.91% to 9.85%, palmitoleic acid (C16:1) ranged from 1.38% to 1.62%, stearic acid (C18:0) ranged from 1.89% to 2.92%, and linolenic acid (C18:3) ranged from 1.01% to 1.12%. The Giza 102 cultivar (green skin) showed the highest amount of oleic acid, followed by Giza 92 (green skin). These findings agree with Xiang et al. (2017), who reported that palmitic acid was the major saturated fatty acid in all cultivars.

Table 4. Fatty acids composition of fresh olives

Fatty acids	Green olives			Black olives	
	Giza 102	Giza 92	Serscola	Giza 102	Sescola
Palmitic acid C16:0	10.22	11.12	10.81	10.81	10.90
Palmitoleic acid C16:1	1.43	1.38	1.62	1.62	1.41
Stearic acid C18:0	1.89	1.92	1.91	2.91	2.92
Oleic acid C18:1	75.88	74.69	73.95	72.96	73.47
Linoleic acid C18:2	8.91	9.15	9.85	9.85	9.55
Linolenic acid C18:3	1.01	1.05	1.12	1.12	1.01
Arachidic acids C20:0	0.41	0.39	0.45	0.42	0.47
Eicoseneoic acid C20:1	0.25	0.30	0.29	0.31	0.27
Total saturated fatty acids	12.52	13.43	13.17	14.14	14.29
Total unsaturated fatty acids	87.48	86.57	86.83	85.86	85.71

Change of fatty acids during processing and fermentation

As shown in Table 5, the oleic acid content decreases during the processing and fermentation of Giza 102, Giza 92, and Serscola (under both natural fermentation and the Spanish-style method) compared to fresh olives. The results also indicate that samples treated using the Spanish-style method had a greater impact on fatty acids than those undergoing natural fermentation. This may be attributed to the higher sensitivity of unsaturated fatty acids to NaOH during processing, while saturated fatty acids are more stable. These findings align with those reported by Salas et al. (2000). Additionally, the results reveal that the total saturated fatty acid content tends to increase, whereas the total unsaturated fatty acid content tends to decrease compared to fresh olives.

Polyphenol Profile and Content (mg/kg) in Fresh Olive Cultivars and After Processing and Fermentation

The amount of phenolic compounds in fresh and processed olives (using both natural fermentation and the Spanish-style method) from three olive cultivars is presented in Table 6. The major polyphenol is oleuropein, which ranged from 19.16 to 74.22mg/kg. Giza 92 fresh olive fruit had the highest amount of oleuropein among all fresh and processed varieties.

This was followed by hydroxytyrosol, which ranged from 9.23mg/kg in Spanishstyle Serscola olives to 46.12mg/kg in Giza 92 fresh olives. Hydroxyphenyl acetic acid ranged from 9.15 mg/kg in Spanish-style Serscola olives to 26.16mg/kg in Giza 92 fresh olives, and tyrosol ranged from 6.15mg/kg in Spanish -style olives to 17.78mg/kg in Giza 92 fresh olives. These results are consistent with those reported by Medina et al. (2017), who identified oleuropein, hydroxytyrosol, hydroxyphenyl acetic acid, and tyrosol as the main phenolic components in fresh olives. Additionally, the results clearly demonstrate that all samples treated with the Spanish-style method showed a more reduction in polyphenols compared to natural fermentation when compared to fresh olives. The results in Table 6 also show that the amounts of all polyphenolic compounds decreased during processing and fermentation. Both natural fermentation and the Spanish-style method were in agreement with the findings of Gomez-Rico et al. (2008), who reported that oleuropein was the most abundant phenolic compound but decreased during processing and fermentation. The content of oleuropein was more significantly affected during processing and fermentation in all samples. Meanwhile, the contents of hydroxyphenyl acetic acid, tyrosol, and hydroxytyrosol were less affected during processing and fermentation, as reported by Abou-Zaid and Ibraheem (2015).

Table 5. Changes of fatty acids composition at the end of fermentation

	Natural fermentation			Spanish style method		
Fatty acids	Giza102	Giza 92	Serscola	Giza 102	Giza 92	Serscola
Palmitic acid C16:0	10.97	12.11	13.00	12.98	13.58	14.12
Palmitoleic acid C16:1	0.83	0.72	0.56	0.81	0.70	0.55
Stearic acid C18:0	1.99	2.11	4.00	3.33	3.90	4.31
Oleic acid C18:1	74.48	73.99	72.32	72.01	70.78	71.51
Linolenic acid C18:2	9.59	9.01	8.40	8.95	9.11	7.73
Linolenic acid C18:3	0.98	1.11	0.99	1.12	1.02	1.01
Arachidic acids C20:0	0.65	0.42	0.25	0.27	0.40	0.33
Eicoseneoic acid C20:1	0.51	0.53	0.48	0.53	0.51	0.44
Total saturated FA	13.61	14.64	17.25	16.58	17.88	18.76
Total unsaturated FA	86.39	85.36	82.75	83.42	82.12	81.24

Table 6. Polyphenols profile and content (mg/kg) in the fresh olive cultivars and at the end of fermentation

Phenolic compounds	Fresh olive			Natural fermentation			Spanish style method		
	Giza 102	Giza 92	Serscola	Giza 102	Giza 92	serscola	Giza 102	Giza 92	Sescola
Cinnamic acid	0.42	0.45	0.31	0.25	0.31	0.22	0.15	0.22	0.13
Hydroxyphenyl acetic acid	19.98	26.16	15.05	16.11	23.15	12.59	13.12	18.30	9.15
Hydroxybenzoic acid	7.02	7.89	4.32	5.80	6.12	3.82	4.02	4.81	2.21
Caffeic acid	0.42	0.48	0.33	0.26	0.33	0.21	0.19	0.22	0.14
Coumaric acid	0.99	2.31	1.25	1.11	0.98	1.02	0.81	1.32	0.16
Vanillic acid	3.76	3.29	3.05	2.88	2.15	2.00	1.89	1.16	1.10
Syringic acid	0.39	0.45	0.31	0.25	0.34	0.22	0.12	0.21	0.15
Hydroxytyrosol	42.69	46.12	39.82	25.12	27.23	26.15	15.15	14.81	9.23
Tyrosol	16.12	17.78	15.28	14.22	14.99	13.33	9.23	10.05	6.15
Taxifolin	0.51	0.62	0.49	0.36	0.38	0.35	0.28	0.22	0.27
Apigenin	2.22	2.36	1.89	1.53	1.89	1.09	1.11	1.23	0.98
Oleuropein	69.18	74.22	66.65	40.16	45.81	41.66	19.16	21.80	22.00
Verbascoside	1.18	1.29	1.09	0.91	1.01	0.89	0.51	0.62	0.43

Sensory Evaluation

The results in Table 7 show the sensory attributes of table olives processed through natural fermentation compared with the Spanish-style method, obtained from three olive cultivars (Giza 102, Giza 92, and Serscola) after processing and 3 months of fermentation. The obtained results are tabulated in Table 7. The findings indicated that the effect of the processing method on the sensory analysis was statistically significant ($P < 0.05$). Spanish-style green table olives from all three cultivars received the lowest score for hardness, but exhibited a higher score for defects. In contrast, naturally fermented green table olives received a higher score for hardness, while showing fewer defects. The results for all three olive cultivars demonstrated good quality in terms of texture and crunchiness, while the bitter, salty, and acidic tastes received medium scores. These results are consistent with those reported by Maria et al. (2010). Regarding black olives (Giza 102 and Serscola), the results in Table 8 show that Giza 102 received the highest scores for bitterness, hardness, crunchiness, and defects. In contrast, Serscola received the lowest scores for bitterness, hardness, crunchiness, and defects.

Table 7. Sensory evaluation of natural fermentation green and Spanish style of Giza 102, Giza 92 and Serscola olives

Attributes	Natural green olive varieties			Spanish style green olive varieties		
	Giza 102	Giza 92	Serscola	Giza 102	Giza 92	Serscola
Soapy	4.20±0.15c	3.80±0.08b	3.60±0.04a	4.00±0.06b	3.00±0.11a	3.00±0.06a
Acid	5.20±0.01b	5.00±0.03a	5.84±0.08c	4.83±0.11a	5.22±0.03b	6.26±0.07c
Salty	4.50±0.08c	4.22±0.31b	3.73±0.07a	5.50±0.03a	5.51±0.22a	6.00±0.01b
Bitter	3.53±0.02b	3.50±0.01b	2.52±0.08a	2.03±0.07a	2.52±0.06b	2.05±0.11a
Fibrousness	5.07±0.01b	5.50±0.06c	4.80±0.02a	4.00±0.11b	4.60±0.08c	3.80±0.023a
Hardness	7.52±0.12b	8.54±0.08c	7.06±0.03a	6.42±0.02b	7.05±0.03c	6.11±0.05a
Crunchiness	3.30±0.11b	3.75±0.05c	2.69±0.07a	2.33±0.03c	2.29±0.05b	2.18±0.04a
Defect	3.30±0.03b	3.50±0.11c	2.90±0.05a	4.20±0.05b	4.50±0.06c	3.80±0.04a

Different letters in the same row indicate significantly different at $P<0.05$. Each value represents the mean of three determinations (n=3) ± standard deviation.

Table 8. Sensory analysis of natural black table olives (Giza 102 and Serscola)

Varieties	Giza 102	Serscola
Acid	3.5±0.04a	4.0±0.08b
Salty	6.0±0.15a	6.5±0.09b
Bitter	4.5±0.06b	3.5±0.11a
Hardness	6.5±0.51b	5.0±0.04a
Crunchiness	3.5±0.22b	2.0±0.5a
Fibrousness	4.8±0.08b	3.2±0.62a
Defect	4.3±0.04b	3.5±0.03a

Different letters in the same row indicate significantly different at $P<0.05$. Each value represents the mean of three determinations (n=3) ± standard deviation.

4. Conclusions

Giza 102 is one of the earliest cultivated fruits used for processing table olives. It offers an ideal balance of taste, flavor, texture, and hardness, making it a high-quality option for table olives that are ready for marketing at the right time. The results of this investigation indicated that the three olive cultivars exhibited different physicochemical characteristics. Giza 102 had the best ratio of flesh-to-pit weight (FlW/PW) and fruit-to-pit weight (FW/PW), along with the highest fruit weight and the lowest pit weight. In terms of chemical composition and sensory attributes, table olives produced from Giza 102 exhibited superior quality compared to those from Giza 92 and Serscola. The fatty acid composition revealed that all examined varieties showed high levels of oleic acid, palmitic acid, and linoleic acid.

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