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Research Article

Monitoring of Some Chemical Changes in Turkish Uslu Monocultivar EVOO During 12 Months of Storage

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ABSTRACT

In this research, a Turkish olive cultivar named as "Uslu" locally grown in Akhisar was used for production of monocultivar extra virgin olive oil (EVOO) by using Mobile Olive Oil Processing Unit" (TEM Oliomio 500-2GV, Italy). Olive oil samples were bottled and stored up to 12 months. Some chemical properties such as free fatty acid content, peroxide value, moisture content and UV absorbance value, minor and major components (tocopherols, total phenol compounds and phenolic composition), were determined during storage for 12 months. Chemical parameters such as free fatty acid content, peroxide value of "Uslu" olive oil samples were in agreement with the trade standards of International Olive Council (IOC). Results showed that color values of EVOO changed from green to yellow. UV absorbance values altered during storage. EVOO samples had very low free fatty acidity (0.2%) values which are unusual for commercial olive oils at the end of storage time. Uslu EVOO samples had high content of total phenols (359.33 ppm) and α-tocopherol (265.80 ppm). These values decreased approximately 25.37-15.48 % at the end of storage, respectively. Luteolin was the most abundant phenolic compound and its concentration decreased from 289.54 to 257.00ppm during storage. Results showed that tocopherol isomers, total phenols and phenolic compounds content decreased during 12 months storing.

Keywords: Olive oil, Uslu, Phenolic Compounds, Tocopherol, Storage.

1. Introduction

Olive is one of the most important plant in Mediterranean countries, especially Spain, Italy, Greece and Turkey. Akhisar is one of the districts of Manisa Province, located in Aegean Region. The origin of «Uslu» olive cultivar is Akhisar-Manisa. Because of bright black color, aroma and taste of fruit it is used for black table olive. Fruit skin is very soft so cannot transport to far away. Fruit flesh ratio is 85% and its oil ratio is 22% (Anonymous, 2010; Ozkaya, 2016). An abundance of oleic acid, a monounsaturated fatty acid, linoleic and linolenic acids as polyunsaturated fatty acids, are the characteristics that sets olive oil apart from other vegetable oils. From the ancient times, people of Mediterranean countries consume extra virgin olive oil (EVOO), because olive oil is unique oil among all edible oils due to high amounts of phenolics, vitamins, oleic acid and other minor compounds. The chemical composition varies depending on the genetic, geographic, agronomic processing and storage conditions. Its shelf life longer than other edible oils, because of presence of antioxidants such as mainly polar phenols and α-tocopherol. Other factors such as free fatty acids, unsaturated hydrocarbons, enzymes, and trace metals are affected oxidative stability negatively. Pigments have negative effect on oxidative stability. EVOO's major and minor components as well as oxidation indices of virgin olive oil were changed during storage. Oxidative stability parameters such as, free fatty acidy, peroxide value and oxidative rancidity increased during storing time. Total poly phenols declined up to73%, and this decrease was remarkable

higher in samples whose initial phenol contents were greater. Another important factor in olive oil quality is storage conditions. Storage at room temperatures led to no change in the amount of some phenolics such as tyrosol and hydroxy tyrosol. Storage of olive oil under nitrogen pressure in a dark place at room temperature (25-30°C or lower) increases shelf life (Boskou., 2006). There was no change in aromatic hydrocarbons of freezed samples up to 12 months (Mulinacci et al., 2013). Important reduction (79%) was observed in the amounts of α-tocopherol (Vitamin E) in four months, whereas <45% of the phenols were lost under diffused light during storage (Okogeri and Tasioula-Margari, 2002). A positive correlation was observed between the age of the oils and the tyrosol to total phenols ratio (Cinquanta et al., 1997). EVOO protects its premium quality after 240 days of storage at 40 °C due to high antioxidant content (Lavelli et al., 2006). A decrease in chlorophyll and carotenoid contents and an increase of oleic acid percentage were also reported. (Morelló et al., 2004). Psomiadou et al.(2000) suggested a good handling is quite important for retaining high α-tocopherol levels of Greek VOO under domestic conditions up to two years. Although some physicochemical characteristics of Uslu EVOO such as free fatty acid, iodine value, peroxide value, saponification, unsaponifiable matter, refractive index and specific gravity values were reported earlier (Tanilgan et al., 2007), this is the first report on monitoring the changes of Uslu EVOO quality during shelf life in details. A mobile olive oil processing unit (MOOPU) was designed to produce "monovarietal virgin olive oil" with premium quality. MOOPU was transferred into the orchard located in Manisa district of the Middle Aegean zone. Therefore it was possible to process Uslu olives at optimum conditions within two hours after harvest. Olive oils were packaged and quality parameters were monitored during storage monthly for 12 months.

2. Methods and Materials

2.1. Production of Extra Virgin Olive Oil (EVOO)

A "Mobile Olive Oil Processing Unit" (MOOPU) with state-of-the art Olemio equipment was designed in order to produce VOO. A special container was constructed and equipped with a knife crusher and a two-phase horizontal decanter (Oliomio D500, Italy). The mobile unit is an articulated lorry with a special semi-trailer measuring 2438 x 12 192 x 2896 mm which is divided into three separate sections. First section is olive accepting unit including; bunker, leaf removers, washer and crusher units of the system. Second section is processing unit including malaxer, decanter, filter and bag-in-box filling machine. Third section is support unit placed a power plant and a water supply tank. Processing unit was equipped by an air conditioner, isolation and filter ventilation systems and protected for temperature changes, dust and odor. MOOPU carried by a trailer truck to orchards in 2015-2016 season. Olive fruits were harvested by hand picking in the early harvest period and processed to "cold press" VOO in the MOOPU in a few hours. Olive paste was prepared after crushing by a hammer mill and the paste was mixed in the malaxer at 27°C for 15 min (Cold press). After decantation VOO was filtered and filled in 250 ml amber glass bottles (headspace: 4cm) by nitrogen gas. The bottles were stored at room temperature (18-24 °C) up to 12 months.

2.2. Chemical analyses

Chemical analysis including, free fatty acid content, peroxide value, moisture content (MC) was performed according to the EC 2598/91, AOCS Cd 8-53 methods, and ISO 662 respectively. Color values (*L*, *a*, *b* values) were measured by spectrophotometer (Minolta, CM-3600d, Japan). *L* (lightness), *b* (yellowness), and *a* (redness) values were determined. UV absorbance was performed according the IOC method COI/T.20/Doc. No 19/Rev. 3. UV absorbance was collected in 232, 266, 270 and 274 nm by using UV Spectrophotometer (Agilent 8453, USA). Δ K values were calculated with the following formula:

$$\Delta K = K_{270} - [(K_{266}+K_{274})/2]$$

2.3. Total Phenolic Content

Polar fraction was extracted and used for total phenolic and phenolic composition analyses. Olive oil sample (2.5 g) was weighed into a falcon tube. Hexane (6 ml) was added and shaken for 1 min. This solution was filtered through solid phase extraction (SPE) cartridge (Superclean LC-Diol, USA) and collected in a glass tube. Then hexane (6 mL) and 4 mL hexane: ethyl acetate (85:15, v/v) were passed through the SPE cartridge, respectively. The cartridge was washed with of methanol: deionized water solution (1:1 v/v). The phenolic extract was evaporated (UniEquip Univapo 100 ECH, Canada). After addition of 2 mL methanol:deionized water solution (1:1 v /v) the tubes vortexed for 30 second. For determination of total phenols Folin & Ciocalteu method was used and the results were expressed in terms of gallic acid equivalent (mg gallic acid/kg oil) (Omani et al., 2007; Inarejos-Garcia et al., 2009).

2.4. Phenolic Composition

Ultra high performance liquid chromatography (UHPLC, Thermo Scientific Dionex Ultimate 3000, USA) and C18 column (4.6 mm inner diameter x 250 mm length and 5 mm particle diameter; Thermo scientific acclaim 120) was used for determination of phenolic

profile. Prepared phenolic extract (1 mL) for total phenolic content was passed through 0.45 µm microfilter (Merck, PVDF, Millipore Millex-HV, Germany) and poured in to an amber vial. Column temperature was fixed at 30°C and acetic acid: deionized water (1:1) (A), methanol (B), acetonitril (C) were used in a gradient flow program as mobile phase. In the gradient program eluents were 2.5 % B, 2.5 % C, and 95% A solution up to 60 min. Flow rate was 1mL/min and diode array detector (DAD) detector was set in 280 nm, 320 nm and 335 nm. Apigenin, cafeic acid, gallic acid, luteolin, m-cumaric acid, p-coumaric acid, oleuropein, syringic acid, trans-ferulic acid, vanilic acid, vanillin, tyrosol, 3-hydroxy tyrosol, 3.4-dihydroxy benzoic acid, 4-hydroxy benzoic acid, 4-hydroxy phenyl acetic acid were purchased from Sigma-Aldrich Co. (Germany) and used as phenolic standards.

2.5. Tocopherol Composition

Tocopherol composition was performed using AOCS Official Method Ce 8-89, 1997 (AOCS, 1997). 2 g EVOO sample was weighed into a 25 ml volumetric flask. After dissolving oil by a quantity of hexane, flask was made up to volume. Solution was passed from syringe filter (0.45 µm) (PVDF, Millipore Millex-HV) in to the HPLC vial. The samples (20 µl) injected to HPLC (UHPLC: Ultra High Performance Liquid Chromatography (Dionex Ultimate 3000). LiChrosorb SI 60-5 column (4.6 mm I.D × 250 mm length and 5 µm particle size) was used for analysis. Column temperature was fixed at 30°C during process. Flow rate of analysis was 1 ml/min. Isopropanol: hexane (0.5 :99.5, v/v) isocratic mix was used for mobile phase, and chromatograms were obtained at 292 nm wavelength. Analysis time and injection volume were 30 min and 100 µl, respectively. Tocopherol standards were purchased from Sigma-Aldrich and used for determination of α, β, ɣ and Δ tocopherols contents.

2.6. Sensory Evaluation

Every month olive oil samples were transferred to Ayvalık Olive Oil Tasting Laboratory accredited by International Olive Council and TURKAK (Turkish Accreditation Agency). Method for the organoleptic assessment of virgin olive oil (COI/T.20/Doc. No. 15/Rev. 8, November 2015) was used. Eight trained tasting panels were able to assess the oils to determine the levels of positive attributes, such as fruitiness, bitterness and pungency. Negative attributes arising due to poor quality fruit, incorrect processing or storaging, such as rancidity, musty and fusty, were determined by sensory panels. Descriptors were evaluated on a 0–10 intensity scale (a number between 0 and 10). Oils were served in coloured tasting glasses.

2.7. Statistical Analysis

Statistical analysis was performed by SPSS 17 (SPSS Inc.Chicago, IL) statistical software and using One-way Anova method. All analyses were performed at least duplicate. and differences among all groups were determined by Duncan test.

3. Results

3.1. Chemical Analyses

Free acidity, peroxide and UV absorbance values of the olive oils extracted from Uslu variety in the Mobile Olive Oil Processing Unit (MOOPU) were shown in Table1. Although a slight increase were observed in the free fatty acid values during storage, all samples could be classified as extra virgin olive oils (<0.8 %) according to International Olive Oil Council (IOC) standards. Some researchers showed that free acidity increased with storage depending on the packaging material, storage conditions and time (Mendez et al., 2006; Clodoveo et al., 2007). On the other hand, free fatty acidity value increased slowly after eight years of storage time (Baiano et al., 2014; Abdalla et al., 2014; Lavelli et al., 2006). Peroxide values (PV) of EVOO samples had increasing trend up to eighth month of storage (Table 1). The PV reached to maximum values in eighth month. From ninth month to end of the storage time, PV had decline trend. The PV reached to minimum level at the end of storage time. Significant increases were reported on the PV of olive oil samples during short term (30 days) and long term (sixth years) of storage in different packaging materials at different conditions (Abdalla et al., 2014; Lavelli et al., 2006; Okogeri and Tasioula-Margari, 2002).

UV absorbance values (K232 and K270) which are indicator of oxidation changed during storage significantly. K232 value of Uslu (Manisa) EVOO decreased up to third month. There was an increase in fourth. The minimum level of K232 value obtained in second month. It was reached to maximum level in eighth and tenth months. This value had stable condition near the of the storage time. K232 values of EVOO samples were under the IOC limitation (<2.5). According to the IOC standard K270 must be <0.22 for EVOO. This value was upper than IOC limitation in third month of storage period (0.34). Uslu (Manisa) EVOO had the highest and the lowest values of K270 values in third and second months, respectively (Table 1). ΔK values of EVOO samples were zero or below zero (results are not shown). These results are in agreement in the related literature (Mendez and Falque , 2007; Baiano et al., 2014; Lavelli et al., 2006;Okogeri and Tasioula-Margari, 2002; Capino et al.,2005; Gómez-

Table 1. Oxidative stability parameters and color valuse of Uslu extra virgin olive oils during 12 months storage

STORAGE PERIOD (Month)	Free Fatty Acid Content (%)	Peroxide Value ($meqO_2$/kg yağ)	K232	K270	*L value*	*a value*	*b value*
0	0.1±0.00^{b}	8.70±0.268^{i}	1.5±0.00^{f}	0.09±0.00^{f}	35.93±0.064^{a}	-.0.09±0.018^{a}	12.86±0.000^{a}
1	0.2±0.04^{a}	13.18±0.065^{g}	0.4±0.00^{h}	-0.15±0.00^{j}	34.33±0.912^{a}	-0.08±0.021^{a}	12.56±0.424^{a}
2	0.2±0.00^{a}	13.57±0.035^{f}	0.3±0.00^{i}	-0.17±0.00^{k}	36.82±0.035^{a}	-0.35±0.011^{abc}	13.34±0.099^{a}
3	0.2±0.00^{a}	14.00±0.029^{e}	0.4±0.00^{h}	0.34±0.00^{a}	36.70±0.021^{a}	-0.29±0.004^{abc}	13.12±0.014^{a}
4	0.2±0.00^{a}	14.40±0.090^{d}	1.9±0.00^{b}	0.09±0.00^{f}	36.61±0.000^{a}	-0.49±0.011^{c}	12.82±0.141^{a}
5	0.2±0.00^{a}	14.42±0.000^{d}	0.5±0.00^{g}	0.15±0.00^{c}	36.64±0.014^{a}	-0.44±0.007^{bc}	13.05±0.035^{a}
6	0.2±0.00^{a}	14.53±0.001^{c}	1.7±0.00^{e}	0.10±0.00^{e}	35.82±2.517^{a}	-0.14±0.049^{ab}	12.82±2.857^{a}
7	0.2±0.00^{a}	14.61±0.099^{b}	1.9±0.00^{b}	0.06±0.00^{i}	37.59±0.170^{a}	-0.23±0.014^{abc}	14.84±0.212^{a}
8	0.2±0.00^{a}	14.76±0.063^{a}	2.0±0.00^{a}	0.10±0.00^{e}	26.51±0.735^{b}	-0.05±0.007^{a}	14.97±1.167^{a}
9	0.2±0.00^{a}	10.52±0.024^{h}	1.7±0.00^{e}	0.19±0.00^{b}	37.41±0.297^{a}	-0.36±0.000^{abc}	14.36±0.389^{a}
10	0.2±0.00^{a}	8.70±0.038^{i}	2.0±0.00^{a}	0.12±0.00^{d}	33.79±5.848^{a}	-0.20±0.205^{abc}	14.53±0.460^{a}
11	0.2±0.00^{a}	8.70±0.018^{i}	1.8±0.00^{c}	0.08±0.00^{h}	36.66±0.679^{a}	-0.11±0.074^{a}	13.29±0.976^{a}
12	0.2±0.00^{a}	8.35±0.021^{j}	1.7±0.00^{d}	0.08±0.00^{g}	35.66±1.054^{a}	-0.10±0.032^{a}	12.74±0.226^{a}

*Different superscript letters in the same column indicate significant difference between mean values (P < 0.01).

Table 2. Tocopherol Content of Uslu (Manisa) monocultivar during 12 months' storage (ppm).

STORAGE PERIOD (Month)	α -Tocopherol	β-Tocopherol	ɣ-Tocopherol
0	265.80±5.527^{a}	0.86±0.010^{a}	0.85±0.016
3	247.68±5.970^{b}	0.77±0.022^{b}	ND
6	239.95±0.720^{bc}	0.71±0.010^{b}	ND
12	224.63±3.545^{c}	0.62±0.020^{c}	ND

*Different superscript letters in the same column indicate significant difference between mean values (P < 0.01).

Alonso et al., 2007; Del Caro et al., 2006). Baiano et al. (2014) reported that K232 value of Coratina olive oil increased up to sixth year, then it decreased, at the end of storage time an increase was observed.Gutierrez and Fernandez (2002) showed that only two quality indices (K270 and sensory evaluation) Picual and Hojiblanca olive oils decreased during storage at 2°C in darkness and 30°C in illimunation. Quality deterioration resulted in downgraded olive oils which was no longer extra virgin olive oils during storage and there was an excellent correlation between initial stability and the time to reach the limit of K270 > 0.25.

3.2. Color Analysis

In spite of the fact that color is not regarded as an important quality characteristic for extra virgin olive oils, it has a great effect on consumer acceptance. Color of virgin olive oils is related to olive maturity and process conditions. Analysis of color (*L* and *a* values) showed that color of olive oil samples altered significantly during storage (Table 1). It has been atrributed that decomposition of color pigments such as chlorophylls, pheophytins, xanthophylls and carotenes (Boskou et al., 2006) . The lowest *L* values (lightness) were seen in eighth month. Fluctuations were observed in *a* (redness) values of all samples during storage. The highest and lowest *a* value was seen in eighth and fourth months, respectively. There was no significant difference among *b* values of EVOO samples during 12 months storage time.

3.3. Tocopherol Profile

Tocopherol (α, β, ɣ) profile of Uslu EVOO were determined during storage (Table 2). The results showed that tocopherol contents (α, β, ɣ) decreased with increasing storage time as expected. The lowest tocopherol contents were obtained after a year of storage. It means that 15.48 % of α-tocopherol, 27.90 % of β-tocopherol and 100 % of ɣ-tocopherol contents were decomposed in EVOO samples during storage. These results were in agreement with other researcher results (Psomiadou et al., 2000; Baiano et al., 2014; Okogeri and Tasioula-Margari, 2002; Rastrelli et al., 2002).

Table 3. Changes in Total phenols of Uslu (Manisa) EVOOs during12 months of storage (ppm)

Storage Period (Month)	SAMPLE NAME
0	359.33±0.401[a]
3	330.22±0.904[b]
6	304.08±0.779[c]
9	281.26±0.415[d]
12	268.14±0.245[e]

*Different superscript letters in the same column indicate significant difference between mean values (P < 0.01).

Table 4. Changes in phenolic compounds of Uslu (Manisa) during 12 months of storage time (ppm)

Phenolic Compounds	Month		
	0	6	12
3,4-dihydroxy benzoic acid	3.58±0.035[a]	2.80±0.041[b]	2.05±0.010[c]
4-hydroxy benzoic acid	1.17±0.034[a]	0.85±0.040[b]	0.47±0.018[c]
m-coumaric acid	1.05±0.028[a]	0.84±0.050[b]	0.41±0.069[c]
luteolin	289.54±0.654[a]	266.41±0.933[b]	257.00±1.387[c]
apigenin	8.00±0.043[a]	6.16±0.124[b]	3.09±0.661[c]

*Different superscript letters in the same raw indicate significant difference between mean values (P < 0.01).

3.4. Total Polyphenol

Total polyphenols contents of the samples were presented in Table 3. The highest total polyphenol values were determined at fresh oils and its amount decreased with time. But the decreases were not dramatic, after a year 25.37 % of total polyphenols were decomposed in EVOO samples. After a short term or long term storage significant decreases in total polyphenols were reported for monocultivar and commercial olive oils by Clodoveo et al. (2007); Morelló et al. (2004) Abdalla et al. and Baiano et al. (2014).

3.5. Phenolic Profiles

Phenolic profiles of Uslu (Manisa) EVOOs were determined during a year storage time (Table 4). There are several papers on determination of Turkish olive oils in literature, this is the especial report related to effect of storage time on phenolic compounds of Uslu (Manisa) monocultivar extra virgin olive samples. Concentration of 3,4-dihydroxy benzoic acid was decreased from 3.58 to 2.05 ppm during a year storing. Initial concentration of 4-hydroxy benzoic acid was 1.17 ppm. This value received to 0.47 ppm after 12 months. m-coumaric acid content was 1.05 ppm in zeroth month. This value decreased by time. The final concentration of m-coumaric acid was 0.41 ppm. Luteolin had the highest amount among phenolic compound that were identified in Uslu (Manisa) EVOO samples. Amount of this polyphenol was 289.54 ppm in zeroth month and this value decreased to 257.00 after 12 months storing. Apigenin content of Uslu (Manisa) EVOO was 8.00 ppm in zeroth month. Amount of apigenin was decreased to 3.09 ppm at the end of storage time. These results suggested that storage caused to change phenolic profile confirmed by literature. It is widely recognized that the simple phenols, tyrosol and hydroxytyrosol, increase over time due to hydrolytic processes of the secoiridoidic derivatives representing their linked forms (Mulinacci et al., 2013). Yorulmaz (2009) reported that luteolin was the most abundant phenolic compound following trans-cinnamic acid and luteolin-7-glucoside. They also quantified tyrosol, syringic acid, p-coumaric acid, luteolin-7-glucoside, trans cinnamic acid, luteolin and apigenin in Turkish olive oils extracted from different olive varieties. Montedoro and Servili (1992) reported that 3,4-DHPEA, *p*-HPEA, vanilic acid, cafeic acid, 3,4-DHPEA-EDA, 3,4-DHPEA-EA had been identified in olive oils. Morelló et al. (2004) suggested that although storage did not appear to have any effect on vanilic acid or vanillin, which were present at low concentration there was a significant decrease in the concentration of the rest of the quantified phenolic compounds. That reduction was more marked in the secoiridoid derivatives such as 3,4-DHPEA-EDA, p-HPEA-EDA and 3,4-DHPEA-EA indicating a more active participation in the oxidative processes as they were more easily oxidized. Among the most representative phenolic compounds in olive oil, lignans seem to be the most stable during oil storage. Mulinacci et al. (2013), and García et al. (2003) showed an increase tyrosol and hydroxytyrosol contents over time due to hydrolytic processes of the secoiridoidic derivatives.

Gómez-Alonso et al. (2007) stated that the main phenols were the dialdehydic form of elenolic acid linked to tyrosol (p-HPEA-EDA), oleuropein aglycon , and the dialdehydic form of elenolic acid linked to hydroxytyrosol (3,4-DHPEA-EDA). Baiano et al. (2014) reported that there were increasing and decreasing trends in phenolic compounds (3,4-DHPEA, *p*-HPEA, vanillin, *p*-coumaric acid, 3,4-DHPEA-AC, 3,4-DHPEA-EDA, *p*-HPEA-AC, *p*-HPEA-EDA, 1-acetoxipinoresinol + *trans*-cinnamic acid, *p*-HPEA-EA) content.

3.6. Sensory Evaluation

Results of sensory evaluation are shown in figure 1. Uslu olive cvs has very nice flavor. Pungency was higher than fruitness and bitterness. The difference between 0 to 12 month is about 2 points for pungency and bitterness but 1 point for fruitiness. This variety has stable olive oil so the flavor is protected whole year even in the room temperature. Bitterness decreased from 5 to 3.2 score after 12 months. Fruitness score changed from 4 to 3.5 during storage time.

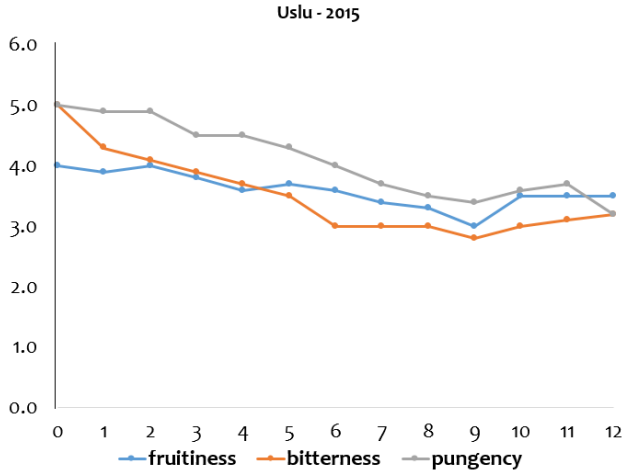

Figure 1. Sensory evaluation of Uslu EVOO during 12 months' storage

4. Conlucsion

There is some limited research paper about Uslu EVOO in the literature, therefore this project can be useful for determination of its physical and chemical properties. On the hand, present study will be also useful for enrichment of Turkish olive oil database for better programming Republic of Turkey, Ministry of Food, Agriculture and Livestock. The effects of storage time for 12 months on the chemical properties such as free acidity, peroxide value, color, UV absorbance, tocopherol content, total phenols, and phenolic compounds of monocultivar Extra Virgin Olive Oils (EVOOs) extracted from some Uslu (Manisa) produced in a mobile olive oil processing unit were investigated in present project. According to the results, Free fatty acid content of Uslu increased a little after 12 months of storage. This trend was observed in peroxide value of Uslu (Manisa) EVOOs. Color of Uslu (Manisa) EVOO altered from green to yellow during a year storage. Results showed that total phenol, phenolic compounds, and tocopherol isomers of Uslu (Manisa) monocultivar EVOOs were decreased in EVOO samples by storage time. The results showed that it is possible to produce excellent olive oils from Uslu variety. Uslu (Manisa) showed good oxidative stability during storage time because of high content of phenolic compounds and α-tocopherol. Present research, disclose some important and effective properties of Uslu EVOO for improving of Olive oil production and programming in Turkey. Uslu also could be candidate to apply for geographic indication among minor varieties locally grown in Turkey.

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