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Dritan TOPI,
Fadil THOMAJ, Eltion HALIMI [1]

VIRGIN OLIVE OIL PRODUCTION FROM THE MAJOR OLIVE VARIETIES IN ALBANIA

SUMMARY

The implementation of a sustainable economy has gained momentum around the world. Limited resources for development in small and developing countries have forced them to address this new focus in areas that show considerable possibilities. The Republic of Albania has put into place a national scheme to increase the olive plantations and olive oil production. The commercial potential of Olive Oil from the main autochthonous olive varieties shows promise for the near future. Olive culture is one of the most viable agricultural activities in remote arid areas such as the Southern and Interior Regions. Improving the quality of the product is imperative and requires the governmental implementation of the Good Agriculture Practices as well as the Good Manufacture Practices. This can be done through appropriate oleo culture, i.e. the cultivation of autochthonous cultivars. Efforts to develop commercial products from the varieties '*Kalinjoti*', '*Ulli i bardhë Tirana'* (UBT) could increase the income for the rural economy and moreso for the national economy. The study on these cultivars covers the oil content, the fatty acid composition, the antioxidant capacity, and the total polyphenol content.

The Kalinjoti cultivar is the most abundant, comprising 50% of all Albanian olive trees, while *Ulli i bardhë Tirana* covers only a small area. The oleic acid content varies from 74.59% (Kalinjoti) to 75.62% (Ulli bardhë Tirana). The content of the palmitic acid is relatively low to Kalinjoti (9.41%) and UBT (10.71%). The levels of linoleic acid are considered relatively low in UBT (6.99%) and higher in Kalinjoti (9.80%). The total phenol contents expressed through gallic acid equivalents (GAE) in the studied olive cultivars varies from 421.30±3.27 GAE mg/kg oil (UBT) and 216.63 ±10.76 GAE mg/kg oil (Kalinjoti).

The results achieved indicate the quality of the mono-varietal Virgin Olive Oils from these varieties.

Keywords: Virgin Olive Oil, Native Cultivar, Kalinjoti, Ulliri bardhë Tirana, Sustainable Agriculture.

INTRODUCTION

The implementation of sustainable and green economies has gained momentum around the world. Limited resources for development in small and developing countries have forced them to address this new focus in areas that

[1] Dritan TOPI (corresponding author: dritan.topi@unitir.edu.al), Eltion HALIMI, University of Tirana, Faculty of Natural Sciences, Boulevard Zogu 1, 1010, Tirana, Albania, Fadil THOMAJ, Agriculture University of Tirana, Faculty of Agriculture and Environment, Kamez, 1007, Tirana, Albania

show genuine possibilities. Albania, as a Mediterranean country, owns a number of olive plantations and is actually running a national scheme to increase olive oil production. Olive cultivation is mainly present in Western Albania and penetrates the interior through the river valleys. Annual production, depending on the On-Off years, has varied by 50,000 tonnes of fruit, though the olive production for the harvesting year 2010-2011 resulted in 70,000 tonnes (FAOSTAT, 2011). The plantations now cover approximately 41,000 ha, or 6.3% of the available arable land. Ownership of these plantations is totally private and is distributed among 90,000 small farms (MBUMK, 2009). Olive revenues have reached 50 million Euros, and rank the country in twentieth place (FAOSTAT, 2011).

The economic potential of the 'Olive Oil' commodity resulting from the main autochthonous olive variety is a positive possibility for the near future. Olive culture is one of the most viable agricultural activities in remote arid regions such as the Southern and Interior Regions of Albania (MBUMK, 2009). Improving the quality of the product is essential and requires the implementation of the state-sponsored Good Agriculture Practices and the Good Manufacture Practices. Such quality improvement can be done through the cultivation of autochthonous cultivars with high efficiency. Efforts to develop commercial products from the '*Kalinjoti*' and '*Ulli i bardhë Tirana'* (UBT) varieties are an opportunity for further growth. Scientific studies have concluded that there are 22 autochthonous cultivars, usually grouped into main cultivars and secondary cultivars according to their distribution and number (Thomaj and Panajoti, 2005).

Olive oil is consumed without a refining process, unlike other vegetable oils (2568/91; Boskou, 2006). Virgin Olive Oil (VOO) is well known for its benefits to human health, and is an integral part of the Mediterranean Diet (Montedoro et al., 1992). Its health effects are linked to its chemical composition – 98% fatty acids and 2% sterols, tochoferols, pigments and phenolic compounds (Boskou, 2006). VOO shows very interesting nutritional properties due to its composition of fatty acids and natural antioxidants, potentially providing many advantages to human health (Visioli and Galli, 1998).

Composition of the olive oil is related to a number of factors, such as variety, climate, cultivation, and ripening, as well as the quality of the extraction systems. Analysis of fatty acid profiles helps in determining a characterisation of the different cultivars and is proposed as a means of differentiating the product based on the cultivar's geographical origin (Mannina et al., 2003).

This study makes a presentation of the main constituent profiles for two main cultivars: *Kalinjoti* and *Ulliri bardhë Tirana* (UBT), including phenolic content and total antioxidant capacity. The importance of these olive cultivars is not linked only to their region of cultivation, but the years it has taken on a national level of importance. In their cultivation region they are identified as main cultivars, i.e. the *Kalinjoti* cultivar in the Vlora Region and *UbT* to the Tirana region. Kalinjoti counts for 50% of the total number of Albanian olives, while UbT counts for 4% (MBUMK, 2009).

Potential area for PDO olive oil products

The potential of olive oil production in Albania is very high, considering the climate and relief. However, some organisation problems in the extraction sector and the implementation of Good Agriculture Practices are evident. Production of olive oil and PDO table olives in Albania may be accomplished in a number of regions. The following elements must be taken into consideration: a) specific regions with specific pedo-climatic characteristics; b) use of limited olive cultivars; c) special product characteristics; and d) tradition of production.

Some native cultivars do constitute a great potential for the production of PGI for both categories of 'Olive Oil' and 'Table olives.'

Figure 1: Geographical areas where the study is conducted

They are classified in two groups: I) main cultivar; and II) secondary cultivar. They are referred to by the cultivar domination in a special region. Six main cultivars are identified for each region: 1. 'Kalinjoti' (Vlora); 2. 'Kokërrmadh Berati' (Berat); 3. 'Mixan' (Elbasani); 4. 'Ulliri i Bardhë of Tirana' (Tirana); 5. 'Krypsi of Kruja' (Kruja) and 6. 'Kallmet' Lezhë.

European Union Legislation for the protection of agricultural commodities and food processed foods, including the VOO with 'Product of Designated of Origin' Law No 2081/92 ((EEC) No 2081/92) states that:

a) '*Designation of Origin'* addresses the region name and state to prescribe a processed agro-food product. Individual quality or characteristics are exclusively linked to geography and the environment with natural and human factors.

b) *'Geographical Indication'* addresses the name of the region used to prescribe an agricultural or processed food commodity.

MATERIAL AND METHODS

1. Sample collection

Olive oil samples for both the 'Kalinjoti' and 'Ulliri Bardhë of Tirana' cultivars are extracted from olive fruit harvested from the regions described in Table 1. Olive oil samples from Tre Vllazer (Vlora), and Marikaj (Tirana) were obtained from olive mills and subsequently analysed, according to the methodology of sample collection. The period of sampling (Table 3) was the same as that of extracting olive fruit in the Laboratory.

Table 3: Variety, harvesting period, extraction date

Cultivar	Harvesting date	Extraction date	Region
Kalinjoti	25/11/2010	27/11	Vlora
Kalinjoti	13/11/2010	16/11	Marikaj (Tirana)
Ulli Bardhe Tirana	20/11/2010	21/11	Priska (Tirana)
Ulli Bardhe Tirana	20/10/2010	20/10	Marikaj (Tirana)

Olive samples and extraction

Samples of Kalinjoti and Ulliri bardhë Tirana were harvested at in November of 2010. Identical amounts of the olive fruits were harvested and evaluated according to their maturity index. Oil extraction was carried out using extraction conditions similar to those used on an industrial scale, using a SPREM Oliva Press (Italy) in a laboratory. The oil was separated by decanting, transferred into dark glass bottles, and stored in the darkness at $4^{\circ}C$ to await further analysis.

Analytical methods

Fatty acid methyl esters (FAME) were prepared through direct acidic transesterification, as originally proposed by Lepage and Roy (1984) and later modified by using pentadecanoic acid as an internal standard. The assay of FAME was carried out with a HP-6890 Gas chromatograph, equipped with a Flame Ionization Detector (GC-FID). Calculations were performed according to AOCS Official Method Ce 1b-89. The identification of fatty acids was undertaken using pure standards (Sigma-Aldrich, Supelco), based on the comparison of retention times. Fatty acids were calculated as the percentage of the total fatty acids. Each sample was analyzed in triplicate.

Total polyphenolic content (TPC) was measured by a colorimetric method proposed by Kalantzakis et al (2006). Samples were dissolved in n-hexane (Sigma, Germany) and extracted with a methanol/water mixture (60:40, vol vol^{-1}). The insoluble fraction (non-polar) in methanol/water fraction was removed, whereas the polar fraction was allowed to remain, for the sake of further analysis. The absorbance of mixture was measured in UV-VIS Mini-1240

Spectrophotometer (Shimadzu) at 725 nm. Results were expressed as gallic acid equivalent (mg kg^{-1} olive oil), calculated from the following calibration curve, determined by linear regression, where [GA] is the concentration of gallic acid, expressed as mg kg^{-1} olive oil: A_{725}= 3.015 [GA] + 0.005 (r^2=0.999). Each sample was measured in triplicate.

2. Physico-chemical quality parameters

Physico-chemical quality parameters (free acidity, Peroxide Value, K_{270} and K_{232}), were conducted according to analytical methods prescribed in Regulation 2568/91 (EEC, 1991).

Statistical analysis

The complete data were evaluated by a randomized block design, with three replicates from fatty acid analysis and duplicates for TPC values. Results were displayed as mean values and standard error (n=3). The significance of the differences among the values was determined by Analysis of Variance using the One-way ANOVA test, with a level of significance at $P<0.05$.

RESULTS AND DISCUSSION

The main effects of micro-nutrients and bio-fertilizer inoculation were significant, and a significant variety of micro-nutrient interaction was obtained for a chlorophyll index (Table 2). The highest chlorophyll index was recorded in plants that had received Fe, as their chlorophyll index was 26 % higher.

In Table 4, the physico-chemical indicators for the studied samples of two cultivars from the different regions are presented.

The olive oils show low values for the studied values (Acidity $\leq$ 0.8; Peroxide Value $\leq$ 20 meq O_2/kg; $K_{270} \leq 0.22$; $K_{232} \leq 2.5$) with the result that they can be classified in the group of 'Extra Virgin Olive Oils' (EVOO). These results are most pertinent in the time of ripening, harvesting and extraction.

Fatty acid profiles (Table 5) suggest that these cultivars, despite the fact that they come from different geographic regions and from different extraction techniques, should be classified in the EVOO group. The palmitic acid content results higher in Kalinjoti than in the UBT olive cultivar. The stearic acid level was below 3%. For the same cultivars, the values of different regions, Vlora and Marikaj have different results.

There are higher levels of palmitoleic and margaroleic acids in Kalinjoti than in the UBT cultivar.

Comparing the two cultivars through different regions indicates that oleic and linoleic acids are the cause of differentiation between the studied cultivars. The oleic acid content was higher in UBT, while the linoleic acid was higher in Kalinjoti.

Analysis of the olive oil samples from three-phase olive mills are presented in Table 9. They indicate that the physico-chemical parameters are lower by classifying them as EVOO.

Table 4: The Kalinjot and UBT cultivar analysis of physico-chemical parameters for different region origins

Phisico-chemical parameters	**Cultivar**	**Region**	**Mean ± StDev**	EEC 2568/91
Free acidity (g/100g)	Kalinjoti	Vlora	0.16 ± 0.06	≤1
		Marikaj (Tirana)	0.15 ± 0.03	
	U.B.Tirana	Marikaj	0.20 ± 0.06	
Peroxid value (meq/kg)	Kalinjoti	Vlora	4.34 ± 1.12	≤ 20
		Marikaj (Tirana)	4.21 ± 1.12	
	UBTirana	Marikaj	5.21 ± 1.12	
K_{270}	Kalinjoti	Vlora	0.13 ± 0.12	≤ 2.5
		Marikaj (Tirana)	0.12± 0.03	
	UBTirana	Marikaj	0.12 ± 1.12	
K_{232}	Kalinjoti	Vlora	1.59± 0.13	≤ 0.22
		Marikaj (Tirana)	1.53±0.09	
	UBTirana	Marikaj	1.61±0.13	

Table 5: Fatty acid composition of two cultivars: Kalinjoti and Ulliri i Bardhë Tirana (Mean ± StDev)

Fatty acid	**Kalinjoti**			**Ulli i Bardhe Tirane**	
	Mechanic pressing		**Three-phase extraction**	**Mechanic pressing**	
	Vlorë	**Marikaj**	**Tre-Vllezër**	**Priskë**	**Marikaj**
14:0	0.00±0.00	0.00±0.00	0.000±0.00	0.00±0.00	0.00±0.00
16:0	9.57±0.01	9.41±0.00	8.941±0.00	10.71±0.01	10.88±0.01
16:1(n-9)	0.14±0.00	0.10±0.00	0.137±0.00	0.08±0.00	0.07±0.00
16:1(n-7)	0.26±0.00	0.26±0.00	0.218±0.00	0.37±0.00	0.35±0.01
17:0	0.10±0.00	0.13±0.00	0.144±0.00	0.12±0.01	0.13±0.00
17:1 (n-7)	0.15±0.00	0.18±0.00	0.201±0.00	0.18±0.00	0.19±0.00
18:0	3.02±0.00	2.99±0.01	3.273±0.01	3.23±0.00	2.83±0.01
18:1(n-9)t	0.00±0.00	0.00±0.00	0.000±0.00	0.00±0.00	0.00±0.00
18:1(n-9)c	73.61±0.02	74.59±0.01	75.413±0.01	75.62±0.01	74.61±0.06
18:1(n-7)	1.48±0.00	1.30±0.00	1.277±0.00	1.49±0.01	1.53±0.00
18:2(n-6)t	0.00±0.00	0.00±0.00	0.000±0.00	0.00±0.00	0.00±0.00
18:2 (n-6)c	10.11±0.01	9.80±0.01	8.854±0.00	6.99±0.01	8.00±0.07
20:0	0.46±0.01	0.40±0.01	0.484±0.00	0.50±0.01	0.43±0.01
18:3 (n-3)	0.75±0.01	0.56±0.00	0.719±0.00	0.48±0.00	0.58±0.01
20:1 (n-9)	0.34±0.01	0.29±0.01	0.340±0.01	0.24±0.00	0.28±0.01
22:0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.07±0.00

Analysis of the mono-unsaturated and poly-unsaturated fatty acid speaks to the stability of the product. Different authors have proposed 18:1/C18:2 as a value for assessing the stability of the olive oil. To ensure the stability of the product, that value must be > 7 (Kiritsakis et al. 2002).

Table 1: Oxidative stability of the olive oils for two cultivars

	Kalinjoti		U.B.Tirane		
Formula	**Vlorë**	**Mallakastra**	**Marikaj**	**Priskë**	**Marikaj**
n-6/n-3	13.57	10.47	17.64	14.41	13.75
SFA	13.15	13.36	12.92	14.56	14.34
MUFA	75.99	78.01	76.72	77.96	77.05
PUFA	10.86	8.29	10.36	7.47	8.59
Oleic/Linoleic	7.28	9.93	7.61	10.82	9.33
MUFAs/SFAs	5.78	5.84	5.94	5.35	5.37
MUFAs/PUFAs	7.00	9.42	7.41	10.43	8.97

The total phenol content expressed in gallic acid equivalents (GAE) in studied olive cultivars varies from 421.30±3.27 GAE mg/kg oil (UBT) and 216.63 ±10.76 GAE mg/kg oil (Kalinjoti).

CONCLUSIONS

These results clarify the fact that the Kabuli chickpea is a highly responsive crop to micro-nutrient fertilizers in general and Zn and Fe in particular and their scarcities may be one of the major reasons for poor yield in a semi-arid region: high bicarbonate and pH in soils. The utilization of micro-nutrient fertilizers in the appropriate amount and time along with the application of bio-fertilizers can be considered a reasonable solution to the performance problems of the chickpea under semi-arid conditions.

The olive industry in Albania is likely to experience a boom in the near future. Cooperation among academia and producers will help both to achieve their goals. Scientific studies in applicative sciences hold great promise for developing countries. It will help in increasing expertise in the local scientists while helping the private sector. Monovarietal olive oils native to Albania need to be studied in greater detail. Competitiveness with big producers is not easy for many reasons, so the production of PDO Olive Oils is probably the wisest course. The Kalinjoti cultivar has proved to be very compatible with the climate in Southern Albania, so it is important to cultivate it in this area. Recently the Ulli bardhë of Tirana cultivar has been distinguished among other cultivars. It is time to ensure the sustainable development of rural areas, and one of mostly like ways to do this is the cultivation of the olive.

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Dritan TOPI,
Fadil THOMAJ, Eltion HALIMI

PROIZVODNJA DJEVIČANSKOG MASLINOVOG ULJA IZ GLAVNIH SORTI MASLINA U ALBANIJI

SAŽETAK

Implementacija održive ekonomije sada dobija novi zamah širom svijeta. Postojanje ograničenih resursa razvoja u malim i zemljama u razvoju utiče na pomjeranje fokusa ka oblastima koje pokazuju značajne mogućnosti. Republika Albanija trenutno realizuje nacionalni plan za proširenje plantaža maslina i povećanje proizvodnje maslinovog ulja. Komercijalni potencijal maslinovog ulja iz glavnih autohtonih sorti maslina je pozitivna premisa za blisku budućnost. Uzgoj masline je jedna od najvažnijih poljoprivrednih aktivnosti u udaljenim sušnim regijama, kao što su južna i središnja regija. Poboljšanje kvaliteta proizvoda je imperativ i zahtijeva sprovođenje dobre poljoprivredne prakse, kao i dobre proizvodne prakse. Ovo je moguće ostvariti razvojem odgovarajuće uljne kulture, odnosno uzgajanjem autohtonih sorti. Napori da se razviju komercijalni proizvodi od sorti *Kalinjoti* , *Ulli i bardhë Tirana'* (UBT) mogu uticati na rast prihoda ruralne ekonomije, ali i nacionalne privrede. Istraživanje o ovim sortama obuhvata sadržaj ulja, sadržaj masnih kiselina, kapacitet antioksidanata i ukupan sadržaj polifenola.

Sorta *Kalinjoti* je zapravo najrasprostranjenija jer je zastupljena sa 50% od ukupnog broja stabala masline, dok *Ulli i bardhë Tirana* pokriva malu oblast zasađenu maslinom. Sadržaj oleinske kiseline varira od 74,59% (Kalinjoti) do 75.62% (Ulli bardhë Tirana). Sadržaj palmitinske kiseline je relativno nizak i kod sorte Kalinjoti (9,41%) i kod sorte UBT (10.71%). Nivo linolne kiseline smatra se relativno niskim kod sorte UBT (6.99%) i nešto višim kod sorte Kalinjoti (9,80%). Ukupan sadržaj fenola, izražen ekvivalentnom galskom kiselinom (GAE), u ispitivanim sortama maslina varira od 421,30 ± 3,27 GAE mg/kg ulja (UBT) i 216,63 ± 10,76 GAE mg/kg ulja (Kalinjoti).

Ostvareni rezultati ukazuju na kvalitetet jednosortnog djevičanskog maslinovog ulja dobijenog iz ovih sorti.

Ključne riječi: djevičansko maslinovo ulje, domaća sorta, Kalinjoti, Ulliri bardhë Tirana, održiva poljoprivreda