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Characterization of olive oils extracted from the main authoctone cultivars in Albania

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Abstract

The story of the origin of olive oil in Albania has no difference from its spreading path in the Mediterranean region. Albania is a Mediterranean country where it is beleived the olive tree has originated. The Albanian olive production region covers the entire coast from Saranda (South) to Shkodra (North) and inland river valleys in the districts of Peqin/Elbasan, Berat/Skrapar, and Mallakastër/Tepelenë. One of the main factors that affect the productivity and characteristics of olive oil is the type of olive tree cultivar. There are more than 28 varieties of olive cultivars grown all over Albania. In this study there are taken into consideration oils produced from nine most representative autochthone olive cultivars: Kalinjot, Ulliri i bardhë i Tiranës, Mixan, Kotruvs, Ulliri i hollë i Himarës, Frengu, Boci, Karen and Kushan. For each type of cultivar there are presented region of plantation, surface planted, number of trees, typical cultural practices applied, type of processing of olives into oil and yeild of oil production.The extracted oils have distinctive characteristics and tastes. The evaluation of oils characteristics was performed through a huge analytical work of analyses carried out in the samples of the olive oils extracted from the above mentioned nine cultivars, which consist in the definition of: Fatty Acid Composition, Total Polyphenols Content, Free Acidity, Peroxide Number, Jodium Number, Spectrophotometric measurements of K232, K270 and ΔK, Saponification number, Unsaponifiable Matter..

Keywords: autochthone olive cultivar; Olive oil; terroir; distinctive tastes.

1. Introduction

The olive tree, olive fruit and olive oil have been at the core of Mediterranean agriculture and trade since early cultivation times, providing sustenance to various cultures and civilizations of the Mediterranean Basin [1]. The olive and olive oil sector is an important segment of Albanian primary production and agro industry [2]. Albania, situated on the eastern shore of the Adriatic Sea, may be divided into two major regions: a mountainous highland region (north, east, and south) constituting 70% of the land area, and a western coastal lowland region that contains nearly all of the country's agricultural lands and is the most densely populated part of Albania. Due to the mountains landscape and especially because of its many divisions, the climate varies from region to region. It is warmer in the western part of the country which is affected by the warm air masses from the sea (the Adriatic costal region has a typical Mediterranean climate). This climate makes Albania an important producer of olives and olive oil for the region [2]. 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 [3]. As shown in Figure 1, the Albanian olive production zone covers the entire coast from Saranda (South) to Shkodra (North) and inland river valleys in the districts of Peqin/Elbasan, Berat/ Skrapar, and Mallakastër /Tepelenë[4]. By 1990, the number of olive trees increased to 5.9 million covering 45,000 hectares.

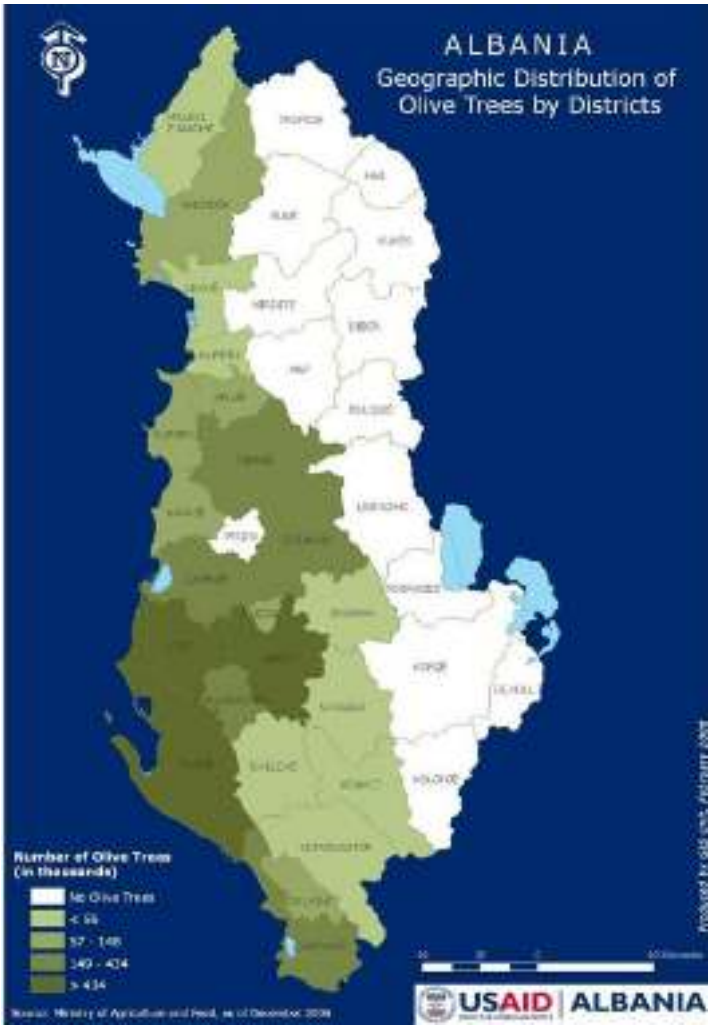

Figure 1. Map of Albania showing olive cultivation area (USAID, 2011)

During this period, large olive plantations were established in Ksamil, Lukova and Borsh (Saranda district); in Jonufer (Vlora district); in Poshnje, Kutalli Malinat (Berat district); in many of the hills in Lushnja, Fier, Tirana; and from coastal Durres up to Ana e Malit (Shkoder district). Recently, according the data on country' olive oil quantity has ranked Albania as 16th in world production [6].

2. Material and Methods

2.1. Characteristics of olive tree production in Albania

Under natural conditions, olive trees have alternate bearing or erratic production – meaning abundant production years are alternated with poor production years. According to available records, 1963 was Albania's highest olive production year with 64,000 tons of olives, followed by 58,700 tons in 2004, with an average range of 30-38 thousand tons per year.The average yield from the olive trees in Albania is estimated at approximately 11.2 kg/tree. This relatively low yield is attributed to the fact that olive trees are grown predominantly in poor soils and in hilly areas with minimal cultural maintenance. However, the yield can easily increase to 35 kg/tree or more with the right combination of pruning, fertilizing and irrigation [4]. The tradition of forgoing commercial fertilizers and pesticides has created interesting opportunities for "clean and green" organic-type products. Some growers take advantage of this tradition of low input usage and a few processors are producing organically certified olive oil, predominantly for export. As shown in Table 1, over one-fifth of the olive trees are 10 years old or younger, indicating a significant resurgence of the olive sector. However, over 50 percent of the olive trees are older than 30 years; the production of older trees is more affected by the problem of alternate bearing [5].

Table 1. Distribution of olive trees by age

Age (Years)	Number of Trees	Percentage %
10 or under	950,000	22
11-20	450,000	11
21 – 30	600,000	14
31 – 50	1,614,000	38
51 or above	650,000	15
Total	4,264,000	100

Source: 2005 Statistical yearbook, Ministry of Agriculture, Food and Consumer Protection

2.2. Selection of olive cultivars under study

The autochthone cultivars considered in this study are:

"KALINJOTI" (Olea europaea L. Subsp sativa)

Origin and Spread: Olive "Kalinjot" is the basic cultivar of the Albanian olives, which occupies over 45% of the planting structure at the national level. It is the main autochthonous olive cultivar of Vlora, Saranda, Delvina, Mallakastra and the Ionian coast. In these areas it occupies over 85% of the structure of the olive orchards. It is a high temperature stable cultivar and has moderate toughness on the cold. It has a scaled maturation and the best harvest time is November. Characteristics of this cultivar is the high periodicity in production, moderately late maturation and the high percentage of the oil content (25-28%) [7]

ULLIRI I BARDHË I TIRANËS (Olea europaea L. Subsp sativa)

Origin and Spread: Autochthonous olive cultivar area of Tirana, more common in Central Albania, mainly in Tirana, Durrës and Krujë and less in Lezha and Shkodra, where it is known by the same name. Cultivar with late maturation. It is less and later infected from the olive fly. It stands well to the prolonged summer droughts and cold of winters. Industrial Extraction Yield in Oil is 24% [8] .

MIXANI (Olea europaea L. Subsp sativa)

Origin and Spread: Autochthonous cultivar and largely cultivated in the areas of Elbasan and Peqin. It is used for oil production. Cultivar very resistant to summer drought and cold of winter, suitable for steep and poor soils. It has a late infection from the olive fly. Industrial Extraction Yield in Oil is 24% [8].

KOTRUVSI (Olea europaea L. Subsp sativa)

Origin and Spread: Autochthonous Cultivar, which has been found in some areas of the Berat and Fier districts. The industrial extraction oil is high: 24-25%. It hasa good resistance to drought, it fits very good even to shallow and poor soils, where other cultivars exhibit growing and production depression[8] .

FRËNGU (Olea europaea L. Subsp sativa)

Origin and Spread: Its denomination can cause confusion about the origin of this cultivar. Century groves with this cultivar can be found exist in the hilly areas between Tirana and Kruja. It is in a localized location and is not spread out of its own area. It has a gradual maturation and moderately constant production. The oil content is high: 28%. It is sensitive to Bractocera oleae and resistant to Pseodomonas sevastanoi. It is resistant to cold and drought[8].

ULLIRI I HOLLË I HIMARËS (Olea europaea L. Subsp sativa)

Origin and Spread: Autochthonous Cultivar of the Himara Coast area. The quality of the oil is very good. Industrial Extraction Yield in oil is no more than 16%. This olive cultivar is particularly well adapted to the skeletal and rocky lands of this area, standing very well during prolonged summer drought, as well to cold

winters. Olive Fruit ripens early, which favors its early touch from the olive fly. Sensitive to Bractocera oleae and Cycloconium oleaginum [8].

BOÇI (Olea europaea L. Subsp sativa)

Origin and Spread: This Cultivar is spread in Tirana area and has a late maturity period.late. It has an average periodic production. Average oil content 21-22%. Very susceptible to Cycloconium oleaginum. Sensitive to Bractocera oleae. It is Resistant to cold and drought [8].

KUSHAN (Olea europaea L. Subsp sativa)

Origin and Spread: It is an Autochthonous cultivar originating from Preza villages and up to Fushë-Kruja. It is localized and not spread out of this area. It has a Medium and periodical production with an oil content of 28-29%. Resistant to cold and drought. Sensitive to Bractocera oleae, Cycloconium oleaginum and Pseodomonas sevastanoi (8).

KAREN (Olea europaea L. Subsp sativa)

Origin and Spread: It is a cultivar originating in Tirana area, actually widespread in Kavaja and Tirana. Cultivar with gradual and and late maturity. It has an early introduction to production after planting. High oil content of 26%. Sensitive to Cycloconium, Bractocera oleae and resistant to Pseodomonas sevastanoi, resistant to cold and drought [8].

In TABLE 2 are shown the autochthonous cultivars from which oil is extracted, the area where they situated, the planted surface in Ha, the number of trees and the maximum oil industrial yield.

Table 2. Varieties of olive trees in albania

No.	Varieties	Region	Surface Ha	Number of Trees	Maximum Oil Yield Industrial Production (% of weight)
1.	**KALINJOT**	Vlore, Sarande, Delvine, Mallakaster	18.000	2.340.000	25
2.	**ULLI I BARDHE I TIRANES**	Tirane, Durres, Kruje, Lezhe , Shkoder	1500	200.000	24
3.	**MIXAN**	Elbasan, Peqin	3780	430.000	24
4.	**KOTRUVS**	Berat, Fier	1400		24
5.	**FRENG**	Tirane, Kruje	900		24
6.	**ULLIRI I HOLLE I HIMARES**	Himare	800	70.000	16
7.	**BOC**	Tirane	600	55.000	18
8.	**KUSHAN**	Preze, Fushe Kruje	800	70.000	24
9.	**KAREN**	Kavaje, Karen	920	81.000	22

Source: 2010 Statistical yearbook, Ministry of Agriculture, Food and Consumer Protection

2.3. Typical cultural practices

Albanian olive groves are located mostly on slopes and hills with the density ranging from 5 to 25 trees per 1,000 square meters. The trees are totally rain fed. The application of cultural practices varies greatly from one location to another. Below are the percentages of the olive plantations with regard to the use of specific cultural practices [4].

1. Pruning:

- once per year (15%)
- once every 2-4 years (40 %)
- 5-7 years (15%)
- never (30%)

2. Fertilization:

- none applied (77 %)
- organic manure (15%)
- conventional fertilizers (8%)

3. Ploughing:

- none applied (67%)
- once (22%)
- twice (11 %)

4. Pesticide application

- none (82%)
- fungicides (5%)
- insecticides for olive fruit fly (12%)
- pheromen traps (0.5%)

5. Harvesting:

- hand picking (27 %)
- stick shaking (72%)
- mechanical harvester (1%)

2.4. Processing Olives into Oil

The extraction of oils has been carried out at the Center of Agricultural Technology Transfer in Vlora city. The pilot equipment used was a two-phase processing line, with a capacity of 30-50 kg olives/hour. The olive processing was performed within 24 hours of olives sample collection. This plant was automatic and realized a continuous processing by transferring the mass of olives firstly to a disc mill crusher, a homogenizer and a continuous decanter which separated the two phases: oil and wet husk. The oil was cold extracted, in 250C. The homogenizing of the crushed olive mass was conducted for 90 minutes. The full removal of water from oil was done by passing the obtained oil in a centrifugal separator.

2.5. Sensory Evaluation of Oils

One of the objectives in olive oil sensory evaluation in this study was to determine whether the oils contained defects from improper fruit storage, handling, pest infestation, oil storage, or processing problems [9]. The oils didn't have any vinegary or fermented odor or flavor. The oils produced were also not rancid or have any other off flavor that is essentially not of the olive. Human sensory evaluation is much more accurate (100 times) than laboratory equipment for certain olive oil characteristics. Aroma and taste are very complex and cannot be determined in the laboratory. The tongue can also detect texture differences difficult to measure analytically. The second objective of oil sensory evaluation in the study was to describe the positive characteristics of the oil in relation to its intensity of olive–fruity character. All oil produced had a fruity olive flavor that was characteristic of the respective variety of olive fruit. Bitterness and pungency were often present in the olive oils, this due especially to the fact they were newly extracted. They are not defects and will mellow as the oils age [10, 11, 12, 13, 14].

2.6. Evaluation of physical and chemical characteristics of olive oils from olive autochthonic cultivars

The definition of the physical-chemical characteristics of olive oils was carried out according to the analytical methods defined in Regulation 2568/91 of the European Union. Two oil samples were taken for each variety directly from production (stored in dark glass bottles at 12-140C), by processing olives from all regions where the autochthone varieties grow, such as Tirana, Vlora, Fier, Elbasan, Berat, Kruja and Mallakastra. The physical-chemical analysis of the oils were performedwithin 1-2 days, at the Oil Technology Laboratory, at the Faculty of Biotechnology and Food -Agricultural University of Tirana, at the General Chemistry Laboratory at Vlora University as well as at the Department of Chemistry of the University of Ioannina. The physical-chemical analyzes carried out in Albania were the determination of: Free Acidity, Peroxide Number, Absorption Ultraviolet (UV) Coefficients, K270, K232 and ΔK, Iodine Number, Saponification Number, Unsaponifiable Matter and Total Content of Polyphenols in oil. The determination of fatty acid content was performed by gas chromatography at the Department of Chemistry, Department of Industrial Chemistry and Food, University of Ioannina.

3. Results and Discussion

Table 3. Physical and chemical characteristics of oils extracted from autochtonus cultivars

Cultivar	Free Acidity %Oleic Acid	pH	Peroxide Number	Saponification Number	Jodium Number	K232	K270	Δk	Unsaponifiable Matter
Kalinjot	0.55	4.92	4.9	181	78.8	1.698	0.102	-0.001	1.14
Mixan	0.89	5.02	5.6	181	79.9	1.676	0.106	0.001	1.19
UBT	1.13	5.11	4.2	176	79.6	1.67	0.123	-0.001	1.02
U.H.H	0.58	4.95	4.6	180	79	1.489	0.101	-0.001	1.32
Kushan	0.79	5.51	4	177	78.8	1.711	0.1	-0.001	1.25
Frëng	0.91	4.91	4.1	188	78.9	1.655	0.111	0	1.27
Kotruvs	1	5.07	8.4	178	79	1.347	0.176	0.001	0.77
Boç	1.31	4.93	8.8	177	79.1	1.3	0.167	0.003	0.59
Karen	1.11	4.95	4.5	189	78	1.651	0.107	0.002	0.88

Table 4. Polyphenol content in oils extracted from autochtonus cultivars

Cultivar	Polyphenols content in Galic acid (mg/kg)
Kalinjot	223
Mixan	142
Ulliri i Bardhe i Tiranes	117
Ulliri i Holle i Himares	218
Kushan	130
Frëng	192
Kotruvs	174
Boç	205
Karen	121

Table 5. Fatty acid composition of the oils extracted from autochtonus cultivars

Cultivar	Palmitic Acid %	Palmitoleic Acid %	Oleic Acid %	Linoleic Acid %	Linolenik Acid %	Stearic Acid %
Kalinjot	7.88	0.39	77.9	7.32	0.44	2.99
Mixan	6.91	0.40	75.7	6.65	0.37	3.39
Ulliri i Bardhe i Tiranes	6.99	0.66	75.67	9.89	0.60	3.43
Ulliri i holle i Himares	4.33	0.13	77.3	4.55	0.27	3.01
Kushan	5.55	0.32	75.68	7.88	0.33	3.31
Freng	5.33	0.23	76.88	7.07	0.34	3.13
Kotruvs	7.71	0.94	68.3	12.12	0.88	2.67
Boç	8.99	1.46	59.3	17.2	1.02	2.23
Karen	8.44	1.03	70.02	11.7	0.66	1.93

- Free acidity (% oleic acid) is the basic criterion for the classification of olive oil and the quality index of the rawmaterial (olives), as well as processing storage conditions. As the results of Table III show, the free acidity (% oleic acid) for the analyzed olive samples varies from 0.58% to 1.31%, with "Boç" cultivar presenting the highest acidity, while "Kalinjot" cultivar oil resulting with the lowest free acidity value.
- Peroxide Number is an indicator of the primary oxidation stage that occurs in oils, forming peroxide compounds. It is worth mentioning that this parameter was immediately analyzed in the laboratory, and the conditions of sample analysis were unchanged. Standards determine the norm of this indicator, for virgin olive oils suitable for consumption, value ≤ 20 mecs O2 kg oil (VKM, 2013). The low peroxide numbers show that the oil is not oxidized as a result of maintaining the appropriate conditions of processing and storage. The peroxide numberss in the analyzed samples resulted within the allowed values for extra virgin and virgin olive oils, ranging between 4.1 mec O2 / kg and 8.8 mec O2 / kg (TABLE III).
- Naturalness criterion of olive oils is mainly tested (Decision of the Council of Ministers, 2003), through the measurements of Ultraviolet Absorption Coefficients K232, K270 and ΔK, as well as Iodine Number (olive oil 75-92). Results presented in TABLE III, show that samples of autochthon olive oils are found to conform to the highest category of "extra virgin olive oil" and are clear in terms of the naturalness criterion and purity.
- All samples of olive oils from all the cultivars under this study present a Number of Saponification and Unsaponifiable Matter in Ether petrol values, which confirm their “extra virgin” category. The standard for the Unsaponifiable Matter allowed for extra virgin olive oil is ≤ 15 g/kg. According to the data in Table III, the values of this parameter fluctuate from 0.59 to 1.32 g/kg. So, from the results obtained these indicators result conforming to the standard, which shows that the samples from the production are original, "extra virgin olive oil".
- The total content of polyphenols in the olive oils obtained from autochthonous cultivars (expressed as gallic acid) ranges from 117 to 223 mg/kg. The total content of polyphenols expressed as gallic acid in the "Kalinjot" sample showed to have the highest value (223 mg/kg) followed by the "Himara Slim Olive (Ulliri I Holle I Himares)" cultivar with 218 mg/kg. While the "White Olive of Tirana (Ulliri i Bardhe i Tiranes)" resulted with the lowest value of polyphenol content (117 mg /kg).
- Definition of fatty acid profile is important for assessing the authenticity of olive oil, its nutritional value and its stability. In the framework of this study, fatty acid profiles were analyzed at the Department of Chemistry, Section of Industrial Chemistry and Food, at the University of Ioannina, Greece. There were observed high content of oleic acid and minimum levels of linoleic and linolenic acids. Results obtained from the analysis of fatty acid content for olive oil samples obtained from autochthonous cultivars are presented in TABLE V. As seen, the "Kalinjot" sample contains the highest percentage of oleic acid (77.9%), while the "Boç" sample

has the lowest percentage (59.3%). Oleic acid is followed by palmitic acid (4.33% to 8.99%), linoleic acid (4.55% - 17.2%), stearic acid (1.93% - 3.43%), linolenic acid (0.27% -1.02%) and palmitolic acid % - 1.46%).

4. Conclusions

1. The free acidity values of the oils obtained from selected autochthonous cultivars are accepted values for extra virgin olive oils (compared to the limits according to IOC, 0.8 g per 100 g). All results obtained from the physico-chemical evaluation (TABLE III) indicate that the oils produced fall in the category of original, "extra virgin olive oil".
2. The highest content of oleic acid was found in the samples "Kalinjot" (77.9%) and Ulliri i Holle i Himares (77.3%). High content of oleic acid and lower linoleic and linolenic acid than other vegetable oils, indicate that the olive oils obtained contain more fatty acids with a double bond, so olive oil will be more resistant to the oxidation. In general, for all olive oil samples obtained from autochthonous cultivars, the content of fatty acids (TABLE V) results within the COOI / EU (COI, 2006, EEC, 1991) and Albanian legislation (VKM, 2013), for the category "extra virgin olive oil".
3. "Extra virgin olive oil" from autochthone cultivars was found to contain significant amounts of phenols, which are natural antioxidants and very important from the nutritional point of view. The total content of phenols, in addition to the nutritional value, also affects the oxidative stability of olive oils. Autochthonous cultivars mainly result in average phenol content. This is explained by the fact that the oils are fresh and produced from the collected olives in optimal times.
4. Based on the above results for all parameters analyzed we can say that autochthonous cultivars represent good quality in terms of physic-chemical parameters

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