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# CONTEMPORARY STUDIES OF ECOLOGICAL INDICATORS AND BIOLOGICALLY ACTIVE SUBSTANCES IN *OLEA EUROPAEA* L. LEAVES

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*The purpose of the work was to apply some of the final results of three years of scientific research to economics, to summarize them in a comparative manner and in the final results for each year. The leaves contain a large group of phenolic compounds, most represented by flavonoids from the class of anthocyanidins group average 153.6 mg/100g dry weight, flavanones 197.2 mg/100g and flavanols 298.9 mg/100 g. The pelargonidin group is the most represented 184.0 mg/100 g dry weight. High anthocyanin content correlates with a reduced amount of photosynthetic pigments r = 0.7-0.8. Flavonoids changes from 2.5 to 3.4% (average 248.5 mg/100 g dry weight). The remaining classes of flavonoids are distributed evenly in the leaves of Olea europaea L., averaging 35.60 mg/100 g. Only the share of flavonoids of the catechin group accounts for only 1.97 mg/100 g of dry weight.*

***Keywords**: dry arid climate, flavonoids, photosynthetic pigments, phytomass*
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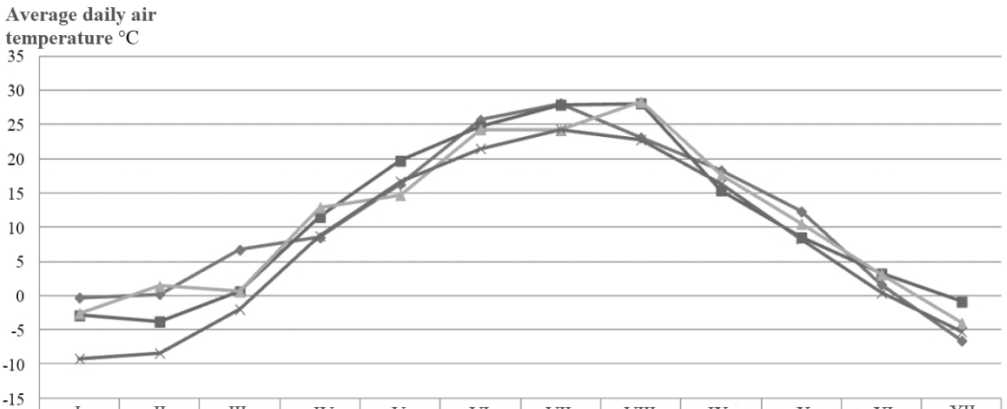
## INTRODUCTION

Modern scientific research has confirmed the effectiveness of using olive leaf extract as an antiviral agent, which also has antibacterial and antifungal effects. There are positive results of using the extract for chronic viral diseases and chronic fatigue syndrome. Evergreen shrub 1-3 m or tree 4-5 (10-12) m tall. The trunk is covered with gray bark, gnarled, twisted, and usually hollow in old age. The branches are gnarled, long, and in some varieties drooping. The leaves are simple, almost sessile, leathery, narrowly lanceolate, entire, gray-green, and silvery below, do not fall off in the winter and are renewed gradually over 2-3 years. Olive trees bloom from late April to early July. The fragrant flowers are very small, 2-4 mm long, whitish, with two stamens, located in the axils of the leaves in the form of paniculate racemes. There are 10-40 flowers in one inflorescence. Olive tree pollen is collected by bees, but wind pollination plays a key role in the reproduction process. The olive fruit is a drupe, most often elongated oval in shape, 0.7-4 cm long and 1-2 cm in diameter, with a pointed or blunt nose, with a fleshy pericarp containing oil. The color of the fruit pulp varies depending on the type of tree, it can be either green, black or dark purple, often with an intense waxy coating. The stone is very dense, with a grooved surface. Fruit ripening occurs 4-5 months after flowering. After planting, the tree usually begins to bear fruit in 4-5 years. Productivity depends on the type of tree and growing conditions; under favorable conditions, the first harvest of up to 40 kg of fruit is harvested from an olive tree, and then in increasing order. For example, a tree 10-15 years old produces more than 100 kg of fruit. Since ancient times, people have eaten olive fruits and made olive oil from them. Recently, research into the biochemical composition of plant materials has become increasingly important. The purpose of such studies is related to determining the nutritional value of certain plants and assessing the possibility of using plant raw materials as a source of antioxidants valuable to humans. In this regard, plants containing a complex of biologically active substances of various natures, polyphenols and alkaloids, are of greater interest. Of particular value is the culture of *Olea europaea* L., the chemical composition of which is quite rich in biologically active substances. In connection with the introduction of various sanctions measures,

the agricultural sector faces the issue of ensuring complete food security of our state more than ever. The medicinal properties of plants are determined not only by their ability to synthesize and accumulate biologically active substances in large quantities, but also to concentrate a number of vital chemical elements. [1, 2, 7]. Olives are rich in fats, proteins, pectins, sugars, vitamins: B, C, E, P, active catechins, contain potassium salts, phosphorus, iron and other elements. The leaves contain organic acids, phytosterol, glycoside oleuropein, resins, flavonoids, lactone elenolide, bitter and tannins, essential oil, which includes ethers, phenols, camphene, eugenol, cineol, citral and alcohols. The leaves contain glycosides, organic acids, bitterness, flavonoids and tannins. Olive fruit oil is the main product for which this crop is mainly cultivated. Provencal olive oil is used in the food industry. The fat content, its chemical and physical properties depend on a complex of factors, soil and climatic conditions of the year, agrotechnical measures, and the pomological variety. Canned olives, dry-salted black olives, and especially stuffed ones, have a piquant taste, are a snack, canned delicacy, complementing the range of food products, and most importantly, have medicinal value. The identification of habitats formed as a result of biotic and abiotic environment components is an integral part of the vegetation cover structure [8, 9].

One of the main tasks in solving this problem is the stable and sustainable development of agricultural production, including all types of grain crops. These cultures can rightly be classified as an olive plant. *Olea europaea* leaves contain a wide range of phenolics compounds, the main phenolic components of olive leaves are secoiridoids, flavonoids and simple phenols such as oleuropein This is a plant that does not shed its leaves in winter, belonging to the *Oleaceae* Lindl. family, genus *Olea* L. 95-100 centners of olives from 1 ha, could get a profit of 1180 USD from this area, the profitability level is 50%. As is known, lipids are one of the main products of plant biosynthesis, which, depending on the composition and structure of the components, have varied biological activity and varying degrees of variability, depending on the systematic and ecological position of the organism. The content of squalene in all studied samples is very low, however, although in insignificant quantities, it is contained in all types. Squalene is a natural unsaturated hydrocarbon of the triterpene series with the formula $C_{30}H_{50}$, and is a colorless viscous liquid. This is a unique substance that is a powerful antitumor agent that prevents the destructive effects of free radicals on cells [10, 14]. This species is one of the most important trees for the agricultural economy of the Mediterranean region with more than 70 % of world olive oil production. Like other cultivated trees, the olive is affected by many pests and diseases, which require direct human control. The olive tree (*Olea europaea* L.) is a small evergreen tree that grows between 8-15 m tall. It is a slow-growing and extremely long-lived species, with a life expectancy up to 1000 years. Selection for productivity in agroecological assessment is carried out against a strict agrotechnical background [11, 12, 13]. Therefore, the varieties were studied against a natural background without the application of fertilizers and without the use of chemicals to protect crops from diseases and pests. Meteorological conditions during the research were varied, which helped to more objectively evaluate the trees under study depending on the prevailing hydrothermal environmental conditions. The period in all years of research was characterized by moderate temperatures, which had a positive effect on the overwintering of plants and contributed to their good preservation (90.7%) by the beginning of the resumption of the growing season in the spring. Average daily air temperatures in the semi-desert zone of Absheron are relatively stable, especially their sums in months with positive air temperatures. The average annual air temperature during the research period annually exceeded the long-term average values by 3.3–3.4 °C (Fig. 1.).

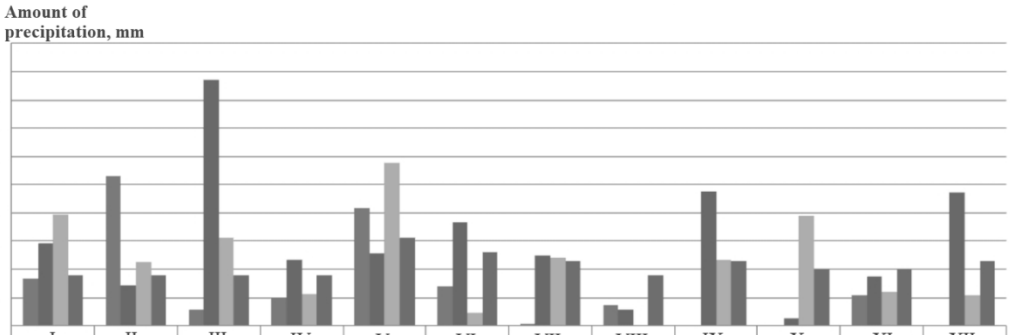



| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | -0,3 | 0,2 | 6,7 | 8,5 | 16,3 | 25,7 | 28,1 | 23,1 | 18,3 | 12,3 | 1,6 | -6,6 |
| 2021 | -2,9 | -3,8 | 0,6 | 11,5 | 19,7 | 24,7 | 27,9 | 28,1 | 15,4 | 8,5 | 3,2 | -0,9 |
| 2022 | -2,6 | 1,4 | 0,6 | 12,9 | 14,7 | 24,3 | 24,2 | 28,3 | 17,6 | 10,5 | 3,1 | -4 |
| Total | -9,2 | -8,4 | -2 | 8,7 | 16,7 | 21,5 | 24,3 | 22,8 | 16,3 | 8,3 | 0,4 | -5,3 |

Source: 2020-2022 years database from National hydrometeorological department

**Fig. 1.** Average daily air temperature during the years of research, °C

In the harsh conditions of a semi-desert, the amount of precipitation during the spring-summer growing season determines not only the amount, but also the very probability of obtaining a harvest of most grain crops. The average annual precipitation rate during the spring-summer active growing season is 75.2 mm. The most moisture-rich year in terms of this indicator was 2021 - 85.7 mm, the driest was 2020 (66.1 mm), and 2022 was distinguished by fairly good moisture with a slight decrease from the long-term average precipitation (73.8 mm) (Fig. 2.).




| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | 16,8 | 53,1 | 5,7 | 9,5 | 41,5 | 14,1 | 0,72 | 7,2 | 0 | 0 | 10,8 | 0,4 |
| 2021 | 29,1 | 14,4 | 87,2 | 23,3 | 25,6 | 36,7 | 24,9 | 5,7 | 47,5 | 2,7 | 17,4 | 47,3 |
| 2022 | 39,4 | 22,5 | 31,3 | 11,1 | 57,9 | 4,7 | 24 | 0,3 | 23,2 | 38,8 | 12 | 10,9 |
| Total | 18 | 18 | 18 | 18 | 31 | 26 | 23 | 18 | 23 | 20 | 20 | 23 |

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Fig. 2.** Amount of atmospheric precipitation during the years of research, mm

## MATERIAL AND METHODS

The leaves were collected from the European olive (*Olea europeae* L.) (Fig, 3 a, b.). The collection of material for research was carried out during the olive fruit harvest period (the second ten days of October). Plants are grown on the territory of Absheron in a dry arid climate. The leaves were dried at room temperature. The component composition of a number of biologically active substances in the leaves of *Olea europaea* L. growing in the Absheron Peninsula was determined spectrophotometrically. The total polyphenol content was determined by spectrophotometric met-

hod using the reagent as a reagent. The method is based on the formation of tungsten blue, which has an absorption band with a maximum of 760 nm. The content of chlorophyll and carotenoids was determined by absorption spectra (wavelengths for chlorophyll a - 662 nm, chlorophyll b - 644 nm, total carotenoids - 440.5 nm) using the calculation formulas of Smith and Benitez (for extraction with 95% ethanol). The amount of flavonoids was assessed in an aqueous-alcoholic extract from dry leaves spectrophotometrically in the wavelength range of short-wave maxima in terms of flavonoid content per rutin [3, 4]. The amount and composition of anthocyanins in a 1% hydrochloric acid aqueous extract; to correct for the content of green pigments, the optical density of the resulting extracts was determined at a wavelength of 657 nm. Anthocyanin content was calculated from cyanidin-3,5-diglycoside and expressed as mg/g dry weight. All experiments were performed in triplicate and results are expressed as mean ± standard deviation [5, 6]. Statistical analysis of the research results was carried out using the statistical software package STATGRAPHICS Centurion XV and the mathematical software package MS Excel using one-way analysis of variance (ANOVA). Differences at $p<0.05$ were considered statistically significant.

**a)** **b)**

**Fig. 3.** a. Old cultivated olive tree for fruit production near Binagadi (Absheron Peninsula, Azerbaijan). b. Ripe fruits: These fleshy drupes turn black when ripe.
(Copyright: R.N. Mammadova)

**RESULTS AND DISCUSSION**

Olive leaves are simple, almost sessile, leathery, narrow-lanceolate, entire, gray-green, silvery underneath. As mentioned earlier, leaves are a by-product obtained from harvesting or pruning. The total polyphenol content averages 538.89 mg/100 g dry weight. Main flavonoids leaves are anthocyanidins, flavanones 198.1 mg/100 g and flavanols 299.9 mg/100 g. The most represented are pelargonidins 192.1 mg/100 g and cyanidins 161.4 mg/100 g, the content of other anthocyanins is at the same level - on average 18.2% of the total anthocyanins

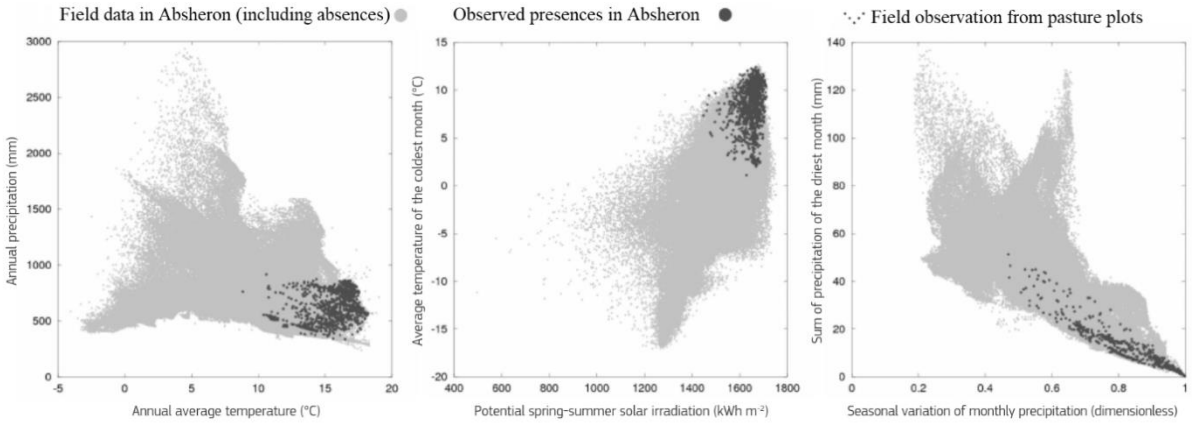
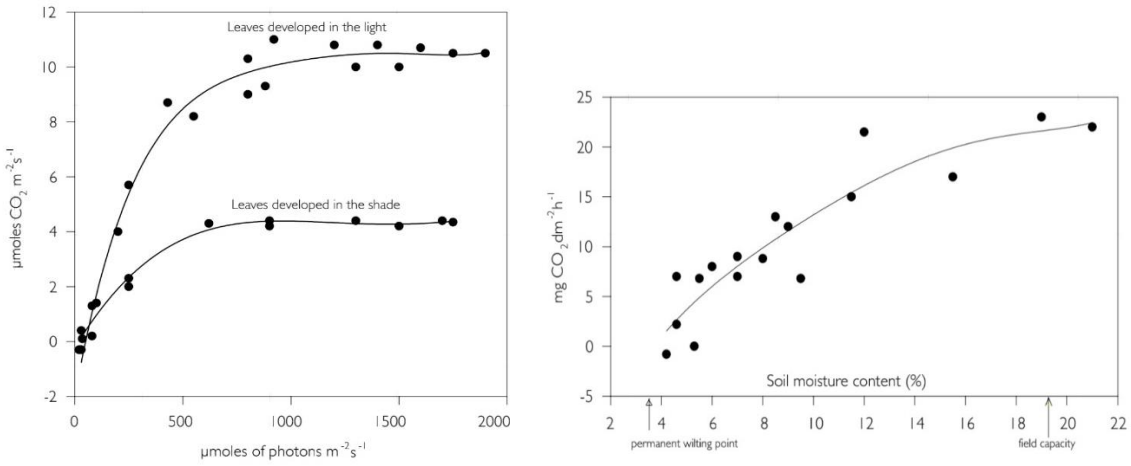



**Fig. 4.** Field data (annual average temperature and precipitation), observed presences (spring-summer solar irradiation of the coldest month) and field observation from pasture plots in Absheron.

The amount of photosynthetic pigments is 0.51±0.03 mg/g chlorophyll b, 1.42±0.08 mg/g chlorophyll a and 0.40±0.03 mg/g total carotenoids. The content of anthocyanidins negatively correlates with the amount of chlorophylls and carotenoids. Analysis and identification biologically research of active substances in the leaves of *Olea europaea* L. will continue, which will allow us to assess the pharmacological significance of this crop in the conditions of Absheron. Field data (annual average temperature and precipitation), observed presences (spring-summer solar irradiation of the coldest month) and field observation from pasture plots in Absheron (Fig. 4.).

Flavones are a common group of flavonoids that have a light yellow or yellow-green color, isoflavones and chalcones. Flavonoids, theaflavins and thearubigins and a large representation of flavonoids from the anthocyanidin group were found in trace quantities. Among flavonoids, the most represented class are flavanols and flavanones, which changes from 2.5 to 3.4% (average 248.5 mg/100 g dry weight). The remaining classes of flavonoids are distributed evenly in the leaves of Olea europaea, averaging 35.60 mg/100 g. Only the share of flavonoids of the catechin group accounts for only 1.97 mg/100 g of dry weight. Another bioactively important group is carotenoids, which belong to tetraterpenes and are a group of natural pigments. Carotenoids in plants occur in the form of three isomers, the most common of which is β-carotene. We have determined that the content of carotenoids in olive leaves averages from 0.38 to 0.47 mg/g dry weight. The total amount of green pigments varied within 1.69±0.10 mg/g dry weight. There is a natural connection between the content of anthocyanins and photosynthetic pigments, which is expressed in the fact that anthocyanins are elements of non-photochemical protection of the photosynthetic apparatus. Anthocyanins protect destroyed chlorophyll from exposure to light rays, limiting the formation of oxygen radicals. The analysis showed that the correlation is quite close r = -0.76, high anthocyanin content is accompanied by a lower amount of carotenoids and correlates with a low level of green pigments r = -0.80.




a) b)

**Fig. 5. a.** Influence of leaf development conditions and light intensity on photosynthesis. **b.** Influence of soil moisture content on olive leaf photosynthesis

Only the leaves on shoots exposed to sunlight (1,610 µmole photons $m^{-2}s^{-1}$), receive a mean light intensity equal to saturation levels (Fig. 5 a.), owing to the effect of the angle and orientation. The photosynthetic balance of leaves shaded inside the canopy and by the canopies of adjacent trees may be negative for a good part of the day. Photosynthesis is limited by water and temperature stress and by attacks from pests and diseases (Fig. 5 b.).

## CONCLUSION

The beneficial properties attributed to composition, especially to their content in phenolic compounds, triterpenic acids, and sugars. The raw material, cultivar, harvesting period or elaboration process have an important role in order to obtain products rich in bioactive compounds. An analysis of biologically active substances in the leaves of *Olea europaea* L., growing in the Absheron Peninsula, was carried out. The leaves contain a large group of phenolic compounds, most represented by flavonoids from the class of anthocyanidins group average 153.6 mg/100g dry weight, flavanones 197.2 mg/100g and flavanols 298.9 mg/100 g. The pelargonidin group is the most represented 184.0 mg/100 g dry weight. High anthocyanin content correlates with a reduced amount of photosynthetic pigments r = 0.7-0.8. Carbohydrate synthesis occurs in the leaves at optimal temperatures of 20-35 °C and at light intensity values ranging between the compensation point, equal to 20-32 μmole photons $m^{-2}s^{-1}$, and 600-1.000 μmoles. Above this last value, photosynthesis remains constant. Olive leaf is highly valued for its numerous bioactive properties and the resulting biological activity it induces. For example, it has been found to have antioxidants through which it exhibits its biological activity. In addition to the antioxidants, the leaf's entire phytochemical profile also enhances its value as a natural resource for improving human health and well-being. Not surprisingly, it is useful against many diseases such as; cancer, anemia, diabetes, inflammatory diseases, microbial infections, etc. The scientific evidence confirms the health advantages of olive consumption, which encourages the opening new marketplaces that use olive waste to meet consumers' health-related needs. According to the data gathered in this review, by-products derived from *O. europaea* L.

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## *OLEA EUROPAEA* L. YAPRAQLARINDA EKOLOJİ GÖSTƏRİCİLƏRİN VƏ BİOLOJİ FƏAL MADDƏLƏRİN MÜASİR TƏDQİQATLARI

**R.N. Məmmədova**

İşin məqsədi üç illik elmi tədqiqatların yekun nəticələrinin iqtisadiyyata tətbiqi, onların müqayisəli şəkildə və hər il üzrə yekun nəticələrində ümumiləşdirilməsi olmuşdur. Yarpaqlarda böyük bir qrup fenolik birləşmələr var ki, onların əksəriyyəti orta hesabla 153,6 mq/100 q quru çəki ilə antosiyanidin sinfindən flavonoidlər, flavanonlar 197,2 mq/100 q və flavanollar 298,9 mq/100 q ilə təmsil olunur, pelarqonid 184,0 mq/100 q quru çəkidə. Yüksək antosiyanin tərkibi fotosintetik piqmentlərin nisbətən azalmış miqdarı ilə əlaqələndirilir r = 0,7-0,8. Flavonoidlərin miqdarı 2,5-3,4% arasında dəyişir (ortalama 248,5 mq/100 q quru çəki). Flavonoidlərin qalan sinifləri Olea europaea L. yarpaqlarında bərabər paylanmışdır, orta hesabla 35,60 mq/100 q. Yalnız katexin qrupunun flavonoidləri yalnız 1,97 mq/100 q quru çəki təşkil edir.

**Açar sözlər:** *quru arid iqlim, flavonoidlər, fotosintetik piqmentlər, fitokütlə*

## СОВРЕМЕННЫЕ ИЗУЧЕНИЯ ЭКОЛОГИЧЕСКИХ ПОКАЗАТЕЛЕЙ И БИОЛОГИЧЕСКИ АКТИВНЫХ ВЕЩЕСТВ В ЛИСТЬЯХ *OLEA EUROPAEA* L.

**Р.Н. Мамедова**

Целью работы было применить некоторые итоговые результаты трехлетних научных исследований к экономике, обобщить их в сравнительном порядке и в окончательных результатах за каждый год. В листьях содержится большая группа фенольных соединений, большая часть которых представлена флавоноидами из класса антоцианидинов в среднем 153,6 мг/100 г сухого веса, флаванонами 197,2 мг/100 г и флаванолами 298,9 мг/100 г. Наиболее представлена группа пеларгонидина – 184,0 мг/100 г сухого веса. Высокое содержание антоцианов коррелирует со сниженным количеством фотосинтетических пигментов r = 0,7-0,8. Содержание флавоноидов изменяется от 2,5 до 3,4% (в среднем 248,5 мг/100 г сухого веса). Остальные классы флавоноидов распределены в листьях Olea europaea L. равномерно, составляя в среднем 35,60 мг/100 г. Лишь на долю флавоноидов группы катехинов приходится всего 1,97 мг/100 г сухого веса.

**Ключевые слова:** *сухой засушливый климат, флавоноиды, фотосинтетические пигменты, фитомасса*