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SENSOR TO SAFEGUARD QUALITY IN THE CONSERVATION OF SICIIAN EXTRA VIRGIN OLIVE OIL

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***Abstract* – The production of olive oil in Sicily, in recent decades, has implemented the use of technologies that have as their main objective the sustainable safeguarding of food quality.**
Food quality both from the point of view of the transformation process, and from the point of view of product conservation, from olive oil is not a simple condiment but involves important nutritional attentions with health implications.
The preservation of bottled olive oil is fundamental in order to improve the life cycle of the product after its transformation, in shelf life.
The parameters observed during the observed conservation and storage period; temperature and relative humidity.
The information collected is transmitted via data logger for the storage of data, entered and processed, in order to identify particular details and therefore to intervene in the thermoconditioning system.
During the conservation period, the main qualitative parameters of the bottled extra virgin olive oil are analyzed by means of chemical analyzes from monovarietals.

I. INTRODUCTION

The olive tree (*Olea europea* L.) is among the fruit species cultivated for the longest time in the Mediterranean basin and is certainly among the first to have been domesticated [1].
The plant of the olive tree, whose botanical name is "olea europea sativa", oleaceous family, exists in numerous varieties, with more than 700 local types, "cultivar", spread in an area that extends between the 35- and the 45. parallel of north latitude, a temperate climate band that well meets its requirements in terms of maximum and minimum temperature.
Currently the interest in olive growing is widening more and more, due to a wide recognition of the health and nutritional qualities of olive oil and its election as the "prince" of dietary fats in the Mediterranean diet, has led to an increase and a geographical widening of demand.
Global consumption is estimated to increase to 3 million tons in 2018/2019, compared to 3 million the previous year (COI).
The scenario inherent in the world market of olive oil, refers to the past olive-growing campaign, in fact, presents some particularly relevant notes that mainly affect countries outside the Mediterranean area, however still distant from European production realities, even if in a positive trend for several years.
Production increases in Australia, Chile, South Africa, USA, Japan and China, and the entry into the Brazilian market with significant increases in olive groves are highlighted. However, 75% of production remains concentrated in the Mediterranean countries and, in particular, in Spain (57%), Italy (23%), Greece (15%), Tunisia, Morocco, Turkey and Syria.
Italian production touched 600000 tons of olive oil on a total area of 1 million hectares. In particular, the most productive regions were Calabria (33%), Puglia (31%) and Sicily (10%), followed by Campania, Lazio and Tuscany.
The fruit is a drupe formed, from the outside towards the inside, by epicarp, mesocarp and endocarp.
The epicarp or peel, represents the 1% of the fruit, is formed by cells having the outer wall covered by a thick cuticle covering the enire surface.The mesocarp, or pulp, is the median part of the drupe.
It makes up 70% of the fruit. It's the part that contains the oil. The endocarp, or core, is the woody envelope that forms the outer part of the core. It makes up 29% of the fruit. It encloses the seed containing the embryo. [7].
Olive oil is the product obtain from olives either mechanically or by other physical processes, under thermal conditions which do not alter them and which have non undergone any treatment other than washing, decating, centifugation or filtration.
Like all fats, about 99% of olive oil is made up of fatty acids and the remaining 1% from the unsaponifiable fraction. Fatty acids are present in the oil essentially as constituents of triglycerides, glycerol esters (Very few are the free fatty acids: which, on the other hand, when present in large quantities involve an increase in the value of acidity, therefore the possibility of the oils to oxidize).
Fatty acids are formed by molecules containing carbon atoms bound together by simple bonds (saturated, palmitic acid, stearic acid) or one or more double bonds (monounsaturated, oleic acid, and polyunsaturated, linoleic acid, and others).
Unsaponifiable fraction consists of alcohols, sterols, polyphenols, minor polar compounds, hydrocarbons, fat-soluble vitamins, chlorophylls, aromatic substances). These substances are responsible for the organoleptic properties such as aromas (fruity), smells (apple, artichoke, almond, pine nuts, grass, leaf), typical tastes (bitter, spicy, sweet), biological properties such as antioxidant preserving and healthy properties. Antioxidant substances such as polyphenols have the capacity of an oil to resist oxidation (rancidity).
Their effect is to oxidize instead of fats by consuming over time; they therefore have protective action; their quantity is an indication of the degree of aging of an oil and its shelf-life.
The amount of antioxidants also depends on the type of cultivar and the harvesting period (higher in green olives, decrease with maturation).
Chlorophylls give the color green. In the presence of light they degrade, changing the color of the oil to yellow, and have a harmful effect on fatty acids allowing oxidation; in the absence of light instead they behave as antioxidants along with polyphenols.
Given its composition (low content of polyunsaturated glycerides

and the presence of numerous compounds with antioxidant action) is the oil that least of all degrades when subjected to the action of high temperature in cooking and frying: Heated to 200'C still retains all its features.[6].

Among the factors influencing the quality of virgin olive oil, both from the chemical-physical aspect of the components and from the organoleptic point of view can be counted: the cultivar (variety of cultivated olive trees); the geographical area of cultivation; climatic conditions; the degree of ripeness of the olives; the harvesting methods;times and places of preservation of the olives;processing technology; preservation of the oil; general hygiene and cleaning; time and temperature of kneading; treatments to the plant and the soil.

The fruit of the oil is a drupe called olive from which, through physical means, olive oil is obtained which is classified according to quality classes, olive oil has a significant economic, nutritional and health interest [2].

In fact, the concept of quality referring to a food cannot be dynamic, as it tends to evolve over time according to the changing needs of the consumer, increasingly looking for products that respond to healthy, qualitative and nutritional parameters [3]. Ultimately, the quality of olive oil is expected from a synergy of aspects, among which the technological and technological ones that exert their influence on the various chemical components have a significant weight. [8].

The aim of the work is to relate the control via wireless sensors of parameters such as temperature in conservation. The monovarietal Sicilian extra virgin olive oil samples, consisting of a single cultivar, come from the GDO, [16].all the samples were kept anonymous during the chemical-physical analysis, in order to use the instruction staff unconditionally.

The samples are placed in 1 liter dark glass bottles with an airtight cap, and stored in the dark, in storage rooms at different temperatures, listed below; with thermo-conditioning parameters selected to maintain the temperature of 10 °C, 20 °C and ambient temperature, with a commercial temperature sensor. [10].

How the temperature and humidity sensors work, the temperature and humidity sensors detect the measurement and convert them into an analog or digital signal, so as to signal their value.[18].

The temperature coating, measures the kinetic energy of the particles that make up the different substances, is a physical quantity, with their movement, they generate heat. [11]. Humidity, on the other hand, is defined as the quantity of water vapor in the atmosphere and can be distinguished in two forms: absolute humidity, the quantity of water vapor contained in a known volume which increases with increasing temperature, and relative humidity. The latter, in particular, represents an extremely important value and is defined by the percentage ratio between absolute humidity and saturation humidity, the maximum amount of water vapor that the air mass considered can contain, equal to 100% at the temperature of dew.

II. MATERIALS AND METHODS

The analyzes were conducted in 2019 on 18 olive oil samples produced in the 2017/2018 olive year. Each sample was subjected to chemical-physical analyzes in accordance with the official analysis methods according to EC Reg. 1989/2003 [4], in particular, the parameters subjected to verification, in order to assess the quality, were the following: free acidity, number of peroxides, spectrophotometric indexes in UV, chlorophyll and carotenes and phenolic analyzes.

The free acidity expressed in oleic acid, which currently must be at most 0.8% in order to classify an oil as extra virgin, is a parameter that can be easily exceeded if during the entire production chain practices are adopted that are not suitable for quality production.

It is essential that the raw material (olives) is of excellent quality, that is, healthy, harvested to the right degree of ripeness, and above all preserved in fenestrate crates and kept as little as possible in the farm and at the mill.

For the determination, approximately 2 g of oil should be weighed in a 250 ml flask and 50 ml of alcohol-ether mixture prepared in the cylinder.

Transfer the mixture into the Erlenmeyer flask, neutralise the acidity of the mixture by adding 0,1M Naoh drop by drop to a pale pink colour. Add the ether-alcohol mixture to the oil, shake in a rotary direction and titrate with NaOH until pink. .[13].

The number of peroxides indicates the potential degree of oxidation of the oil, it is necessary to refer to the same practices described for free acidity, in this case the chemical process responsible for this alteration is rancidity or beta oxidation which causes a progressive oxidation of the produced by mainly unsaturated fatty acids of which olive oil is very rich. [14].

The peroxide numbers are determined by weighing in the flask, using the technical balance, about 2 g of oil, add 30 ml of acetic acid: chloroform 3:2 mixture and 1 ml of KI in saturated solution to the flask, shake gently for 1 minute in rotational direction and place 5 minutes in the dark. .[12].

Determination, a burette must be prepared with the 0.1N thiosulfate solution, after 5 minutes add 100 ml of double distilled water and 1 ml of solid starch to the flask, the solution will become purplish, titrate with 0.1N thiosulphate up to complete discoloration. The white is prepared following the protocol but without the presence of oil. It is then calculated. The determination of ultraviolet in oil is a type of analysis is expressed by the coefficients "K" which represent the absorption by the exposure of ultraviolet light in particular conditions.[17]. The molar extinction coefficient at the wavelength, respectively 230 nm and 270 nm, indicates the oxidative state of the oil, as conjugated dienes and trienes can be formed during the oxidation of the product. .[15]

They are determined by weighing about 0.12 g of your oil sample in 25 ml flasks and making up to volume with isoctane and taking the reading on the spectrophotometer

The determination of chlorophyll and carotenes must be weighed about 5 g of your oil sample in 25 ml flasks and made up to the mark with hexane.

Readings are taken at 476 nm and 670 nm with respective factors of 407.7 and 95.41 to obtain the results.

Polyphenols are antioxidant substances and if present in high concentration they are a value for the oil. The analysis is performed with the UV spectrophotometer based essentially on the formation of a blue compound between polyphenols and the Folin-Ciocalteu reagent.

15 g of oil is weighed in centrifuge tubes and added with 15 ml of methanol-chloroform mixture (95:5) and 0,8 ml of Tween 20. It homogenizes for 2 minutes at medium speed with ultraturax then moves to the centrifuge for 15 minutes at 1800 rpm. The supernatant shall be taken and extraction repeated twice more with the methanol-chloroform mixture. The organic phases are collected in a 50 ml flask which, after being made up to the mark with the methanol-chloroform mixture, is placed in the freezer for at least 12 hours after which it is filtered with paper filters and left in the freezer.

1 ml of filtrate is placed in a 20 ml flask and added with 5 ml of the Folin-Ciocalteu solution and two-distilled water (1:5) after 5 minutes, 6 ml of saturated sodium carbonate solution is added.

Allow to react between 30 and 90 minutes and then make up to the volume with double distilled water then centrifuge for 15 minutes at 1800 rpm.

At this point the spectrometer is read against a blank, from the calibration curve, built using gallic acid, we go back to the concentration of total polyphenols.

The analyzes were carried out at monthly intervals for one semester.

They are types of flexible thermocouples with type K TC temperature sensor, connected with data loggers, which function as transducers: they are composed of materials sensitive to a given stimulus (humidity/temperature), and then generate a corresponding electrical signal. In particular: humidity is measured thanks to the presence of a hydrophilic polymer, therefore having a tendency to interact with the water molecules with which it comes into contact.

The higher the degree of humidity, the more proportionally the number of bound molecules acquired and, as a consequence, the output signal will be higher. The temperature, on the other hand, is detected thanks to metal elements that are sensitive to heat. The sensors are placed at a distance of two meters from the samples.

III. RESULTS

The analyzes conducted at the Food Technologies section of the Department of Agricultural, Food and Forestry Sciences of the University of Palermo.

The free acidity in the analyzed samples (Tab. 1) found values lower than the limits set by the EC Reg. 1989/2003 [4] and are optimal for the storage temperature at 10 °C good for temperature at 20 °C and moderate at temperature environment.

The same goes for the results regarding the number of peroxides including 4.10 meq O_2/kg of the Nocellara belice at room temperature and 5.71 meq O_2/kg of the Tonda iblea always at room temperature.

The extinction values K232, K270 and ΔK were within the limits set for the category of extra virgin olive oils.

Ultimately, all the parameters analyzed highlight the absence of oxidative degradation phenomena.

(Tab. 1 Composition of free acidity, number of peroxides, k factors)

Sample	Acidity (%)	Peroxides number (O_2/Kg)	K_{232}	K_{270}	Δ K
Biancolilla 10°C	0,23	4,81	2,12	0,12	0,01
Biancolilla 20°C	0,26	4,97	2,34	0,23	0,01
Biancolilla TA	0,29	5,15	2,05	0,14	0,01
Nocellara Belice 10°C	0,21	4,51	2,46	0,20	0,01
Nocellara Belice 20°C	0,25	4,88	2,18	0,22	0,01
Nocellara Belice TA	0,27	4,10	2,00	0,10	0,01
Cerasuola 10°C	0,30	4,33	2,25	0,12	0,01
Cerasuola 20°C	0,38	4,30	2,50	0,24	0,01
Cerasuola TA	0,40	5,04	2,50	0,24	0,01
Tonda iblea 10°C	0,33	5,11	2,19	0,12	0,01
Tonda iblea 20°C	0,36	5,59	2,27	0,12	0,00
Tonda iblea TA	0,45	5,71	2,18	0,11	0,01
Giarraffa 10°C	0,21	4,05	0,25	0,14	0,01
Giarraffa 20°C	0,29	4,29	2,06	0,14	0,01
Giarraffa TA	0,33	4,73	2,40	0,21	0,01
Ogliarola messinese 10°C	0,34	4,33	2,97	0,22	0,01
Ogliarola messinese 20°C	0,33	4,46	1,15	0,25	0,01
Ogliarola messinese TA	0,36	4,91	1,93	0,03	0,00

TA = room temperature

With regard to the total polyphenols of the analyzed samples (Table 2), the measured values showed a strong influence [5] of the varietal component on the aspect in question.

The quantities of polyphenols controlled by 132 ppm in the Giarraffa sample kept at room temperature at 407 ppm in the Biancolilla at 10 °C.

The values of chlorophyll and carotenoids are normal for all theses, such as the content of total polyphenols.

Table 2 - Analytical indices of chlorophyll, carotenoids and total polyphenols.

Sample	Chlorophyll (ppm)	Carotenoids (ppm)	Total polyphenols (ppm)
Biancolilla 10°C	5,33	3,00	407
Biancolilla 20°C	4,76	2,31	397
Biancolilla TA	3,45	8,47	400
Nocellara Belice 10°C	4,02	2,80	370
Nocellara Belice 20°C	3,84	5,61	383
Nocellara Belice TA	4,43	5,56	332
Cerasuola 10°C	3,50	3,31	387
Cerasuola 20°C	2,45	3,36	363
Cerasuola TA	3,36	4,22	329
Tonda iblea 10°C	2,38	1,64	203
Tonda iblea 20°C	2,10	1,39	231
Tonda iblea TA	4,62	2,35	194
Giarraffa	7,17	3,43	147

10°C			
Giarraffa 20°C	6,51	3,76	150
Giarraffa TA	4,26	3,94	132
Ogliarola messinese 10°C	4,00	4,45	382
Ogliarola messinese 20°C	4,11	4,91	357
Ogliarola messinese TA	5,93	5,87	305

TA = room temperature.

The temperature control through the sensor to keep the optimum storage temperature, is very efficient also and especially with the values expressed for chlorophyll and carotenes.
All the parameters chemically analyzed gave an excellent qualitative result.
This factor therefore highlights the importance in the conservation of olive oil of a precise and regular temperature control.

IV. CONCLUSION

Concluding the importance of bio-agronomic and morphological variability is a peculiar characteristic of the Sicilian varietal platform, in synergy with the genetic polymorphism it is the first responsible for the variability that affects all aspects of oil production: yield, chemical-organic and organoleptic characteristics. In fact, among the factors that contribute to the definition of the characteristics of an oil, the genetic component has primary importance: the cultivar is responsible, in fact, for the specific imprint on the oil product through particular chemical-physical characteristics and sensory note, which differentiate one oil from another. The survey conducted showed that all oils comply with the European legal parameters, that real-time temperature analysis is fundamental for the quality of the product for immediate control. In conclusion, the quality of an olive oil is obtained not only by an optimal transformation practice but it is essential to carry out a conservation. Given the previous bio-morphological and genetic studies that have allowed an exact description of the different olive cultivars, to date are less known aspects related to the quality of the oil obtainable from them.
Among the factors, which contribute to the definition of the characteristics of an oil, the genetic (and therefore varietal) component is of primary importance: the cultivar is responsible, in fact, for the specific imprinting of the oily product through particular chemical-physical characteristics and sensory notes, which differentiate one oil from another.
Free acidity and the number of peroxides were optimal, as well as the other components.
At the same time, the contributing cause of the measured quality can be sought in the genetic aspect, as can be deduced from the study of the chemical composition.
At the same time, the contributing cause of the measured quality can be sought in the genetic aspect, as can be deduced from the study of the chemical composition.
In conclusion, the quality of an olive oil is obtained only by adopting rational criteria throughout the production chain, from the planting of the olive grove (genetic aspect) to harvesting and finally to the transformation and conservation processes (technological aspects). Conservation is certainly a fundamental point for safeguarding the quality of the oil, such results can be obtained by combining a control using sensors that record and report any anomalies.

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