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Comparative study of physical and chemical propriety of the oil of some varieties of olive trees

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ABSTRACT: Edible oils are an important constituent of human diet because they provide desirable nutritional properties, flavor and texture of food. Olive oil is one of the most frequently used edible oils. Therefore knowledge of its physicochemical properties is indispensable to assess its quality. In fact, there are many factors having an influence on the chemical and physical characteristics of olive oil, such as the climatic conditions, the agronomic and genetic factors.

In Morocco, different varieties have been developed in order to improve the yield and oil quality. But few comparative studies were made between the different product varieties. The aim of this study was to characterize the olive oils from five olive varieties most cultivated in Morocco. Then compare them by using the physic-chemical parameters with storage conditions (darkness and sunlight). Several parameters were studied, namely, quality indices defined by the International Olive Oil Council (IOOC): The acid value "Av", the peroxide value "Pv" and the specific extinctions "K_{232} / K_{270}". The results of different analyses show significant differences between these five varieties, and demonstrate that the Picholine de Languedoc variety is the most efficient in term of quality for the consumer.

KEYWORDS: Olive oil; Olive varieties; Acid value; Peroxide value, K_{232}, K_{270}.

1 INTRODUCTION

The olive tree (Olea europaea) has an important social and economical significance in the Mediterranean basin, which occupies 98% of the world's cultivated olive trees [1]. The virgin olive oil is a product with high added value. Land suitable for the cultivation of olive trees, favorable climate and ancient olive traditions are important competitive advantages for Moroccan olive oil sector [2].

Extra-virgin olive oil, especially consumed in the raw form, keeps all its vitamins, essential fatty acids and other nutrients including powerful antioxidants. For this reason, it is recognized as one of the best food for its capacity to prevent some pathology, such as cancer and cardiovascular diseases, and to reduce their incidence in the western population [3]. Numerous studies show that olive oil reduces cholesterol, lowers blood pressure and the incidence of breast cancer and inhibits platelet aggregation [4], [5]. Because of the high antioxidants content, olive oil appears to reduce dramatically the oxidation of low-density lipoprotein (LDL) cholesterol, thus preventing heart disease. These same antioxidants also increase the stability, shelf life, and flavor of the oil. On the other hand, cell membranes contain fatty acids that are highly susceptible to free radical damage, producing lipid peroxides that can kill the cell.Consequently, the interest of many researches is focused on the controls of degradation of the olive oil during storage processes and on the methods to avoid it [6], [7].

The aim of this work is to evaluate the effects of storage conditions such as darkness and sunlight on the stability of physic-chemical properties of the olive oils from the following varieties: Moroccan picholine, Menara, Haouzia, Dahbia, Picholine de Languedoc and Manzanille.

2 MATERIALS AND METHODS

2.1 OLIVE SAMPLES AND OIL EXTRACTION

Olive fruits of five varieties: Picholine Marocaine (P), Picholine de Languedoc (La), Manzanille (M), Dahbia (D), Haouzia (Ha) and Menara (Ma), were collected in the same farm in Beni-Mellal and benefited from the same cultural practices. All olive samples of each variety were picked by hand at an optimal stage of maturity, and cultivars during 2010 season. After cleaning, fruits from each variety were triturated in our laboratory under the same conditions. The molding was carried out by traditional methods: Manual grinding using a grinding wheel, a Kneading (the dough with 50 % of weight in hot water) to prevent oxidation of the olive paste, in a closed room, not exceeding 45 min [8]. Then the obtained paste was filtered, and finally centrifuged for 11 min to remove water and keep the oil phase. All oil samples were stored in glass bottles prior to analyses.

2.2 ANALYTICAL METHODS

The acid value (Av), expressed as percent of oleic acid, peroxide value (Pv), given as milliequivalents of active oxygen per kilogram of oil and UV absorption characteristics (K_{232} and K_{270}) were determined following the analytical methods described in the standards of the International Olive Oil Council (IOOC) [9].

The acid and peroxide values were determined by volumetric method. Specific extinction coefficient at 232 and 270 nm (K_{232} and K_{270}) were determined using a JASCO spectrophotometer (V-630).

2.3 MONITORING OLIVE OIL SAMPLES

To study the influence of each storage condition (darkness and sunlight) on the stability of olive oil parameters, we follow the steps: A first batch of samples was placed in an enclosed space, protected from light and at room temperature. A second batch of sample was placed in a transparent box, and left in direct contact with sunlight. Analysis period consists of 1 month time intervals during 7 months.

3 RESULTS AND DISCUSSION

The determination of different quality indices (physic-chemical parameters) was made from five times, and that for the duration of storage of the studied olive oils. The medians were calculated and reported as parameters result.

It can be seen in **Table 1** that oils extracted from different olive varieties have an acid value less than 0.8%, Pv < 20 méq O_2.Kg-1, $K_{232} \leq 2.6$ and $K_{270} \leq 0.25$. The evaluation for initial quality of the oils studied allowed classifying them all in extra virgin olive oil [9].

The **Table 1** shows that olive oils extracted from five varieties, are very little oxidized because they have a peroxide value very low compared to other large studies [10], [11]. Thus, we notice that is almost the same for all the oils obtained. This can be explained by the fact that extraction was conducted under conditions strictly controlled and identical.

Also, the acid value is low, which can be attributed to the state of optimal maturity olives. In 2004, Dugo et al. showed that the early harvest produced olive oils with acidity less than 1% [12].

The evolution of the different parameters studied during storage of oils from the varieties described above is plotted against time in graphical form. **Fig.1**, **2** and **3** illustrate the results and represent the evolution of physic-chemical properties of olive oil over time and storage conditions.

To determine the relationship between the quality parameters in question, and the storage time in months, and the other, to evaluate the stability of these parameters for each variety of olive oil according to the storage conditions studied, we have tried to establish a linear equation for each case. Different equations obtained in both storage conditions are summarized in **Tables 2**, **3**, **4** and **5.**

3.1 CHEMICAL ANALYSIS

3.1.1 ACID VALUE

The acid value, expressed as oleic acid, is a factor of quality olive oil [9], which provides information on the deterioration of the oil by hydrolysis. **Fig.1** shows a linearly changing insignificant, especially when exposed to sunlight, depending on the duration of storage of oils.

Analysis of the variance values of acidity (**Table.2**) shows an effect of the variety and storage conditions on this parameter. The Av has increased significantly, during exposure to sunlight over the storage in the dark. The greatest variation is observed in oil from Manzanille with 0.41%, while the lowest was noticed in oils from Menara and Haouzia with only 0.05%, when exposed to sunlight.

3.1.2 PEROXIDE VALUE

The peroxide value is an important quality parameter of edible oils [9]. The initial PVs of all samples were within the legal limit of 20 meq. O_2 kg^{-1}. The evolution of the peroxide value during storage is shown in **Fig.2**. When exposed to sunlight, there is usually an increase in peroxide value for all samples, indicating that light has a negative effect on olive oil. In fact solar radiation promotes self-oxidation of olive oil. Olive oil from Dahbia had the highest and olive oil from Picholine de Languedoc had the lowest Pv among the olive oil samples monitored (**Table.3**). Also, the peroxide value varies between 6.25 and 10.62 meq O2/kg for all oils. These low values of the peroxide confirm that the oil was extracted quickly after harvesting the olives. Moreover, this suggests that the oil does not oxidize rapidly, therefore, it will retain over time. Thus ensures that the extraction was carried out on healthy and fully ripe olives. In addition, according Nouros, a peroxide value, more than 10 meq O2/kg may mean that olive oil is less stable with a shorter life [13].

3.2 PHYSICAL ANALYSIS

The specific extinction oil is an important parameter of quality of oils. The absorbance of the oil at 232nm (K_{232}) gives an idea on the evolution in the oxidation process and the formation of linoleic hydro peroxide, whereas, the absorbance at 270nm (K_{270}) gives informations on the concentration of secondary oxidation product such as ketones and aldehydes [14], [15].

3.2.1 SPECIFIC EXTINCTION COEFFICIENT AT 232 (K_{232})

The evolution of the specific extinction at 232 nm is shown in **Fig.3**. The results show that, there is a variation of this parameter between the samples stored in the dark and samples subjected to sunlight, increasing the parameter of the specific extinction at 270 nm, has been outstanding after two months of exposure to sunlight. **Table.4** shows that the greater variation is observed in oils from Dahbia and Manzanille. The smallest change is known in oil from Haouzia.

3.2.2 SPECIFIC EXTINCTION COEFFICIENT AT 270 (K_{270})

Examination of the **Fig.4** reveals that the specific extinction coefficient at 270 nm evolves very weakly during storage for oils studied. This phenomenon could be explained by a slow processing of primary products into secondary oxidation products i.e at this moment it is the stage of the formation of hydroperoxides which is in action.

Also, **Table.5** shows that the greater variation is observed in olive oil from Dahbia and Manzanille. The smallest change is known in oil from Picholine de Languedoc.

In the end, the results found in the physical analysis coincide with the peroxide values which tend to increase slightly during the storage period in both conditions. This could mean that the spread of oxidation of olive oil has not reached its final stage: decomposition of hydroperoxides.

In fact, the oxidation resistance may be due to the storage conditions, especially in the dark, since the mechanism of the photo-oxidation is much faster than that of autoxydation. Caponio et al., showed that for olive oil stored in the dark, there is the formation of hydroperoxides, as evidenced by the extinction coefficient K_{232}. While in exposure to sunlight is the secondary oxidation compounds predominate, as evidenced by the extinction coefficient K_{270} [16].

4 Tables and Figures

4.1 Tables

Table 1. The initial physic-chemical parameters of monovarietal olive oil samples (average of 5 tests).

Olive varieties	*Acid value (%)*	*Peroxide value (méq O_2.Kg^{-1})*	K_{232}	K_{270}
Menara	0.11	1.25	0.18	0.02
Picholine de Languedoc	0.68	1.23	0.27	0.04
Manzanille	0.65	1.25	0.08	0.01
Haouzia	0.13	1.27	0.4	0.01
Dahbia	0.38	1.26	0.18	0.01
Picholine Marocaine	0.39	1.2	0.17	0.01

Table 2. Evolution of the acid value over time "Av % = f (t)" in the olive oil varieties in both storage conditions.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 0.0085t + 0.0987	Y= 0.0197t + 0.0917
Picholine de Languedoc	Y= 0.0451t + 0.5993	Y= 0.0761t + 0.564
Manzanille	Y= 0.1001t + 0.5147	Y= 0.1283t + 0.4865
Haouzia	Y= 0.0127t + 0.1128	Y= 0.0197t + 0.1058
Dahbia	Y= 0.0592t + 0.3102	Y= 0.062t + 0.3102
Picholine Marocaine	Y= 0.0818t + 0.2679	Y= 0.1213t + 0.2538

Table 3. Evolution of the peroxide over time "Pv (méq.O_2 Kg^{-1}) = f (t)" in the olive varieties in both conditions of storage oils.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 3.125t – 2.0833	Y= 4.0625t – 3.125
Picholine de Languedoc	Y= 1.25t	Y= 2.5t – 1.25
Manzanille	Y= 1.875t – 0.4167	Y= 3.75t – 2.7083
Haouzia	Y= 3.4375t – 2.0833	Y= 4.7125t – 3.6083
Dahbia	Y= 2.1875t – 1.25	Y= 6.25t – 5.8333
Picholine Marocaine	Y= 1.875t – 0.8333	Y= 3.75t – 3.125

Table 4. Evolution of specific K_{232} extinction coefficient over time "K_{232} = f (t)" in the olive varieties in both conditions of storage oils.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 0.2832t + 0.0055	Y= 0.2903t + 0.0444
Picholine de Languedoc	Y= 0.2092t + 0.0188	Y= 0.3039t – 0.082
Manzanille	Y= 0.3008t – 0.187	Y= 0.3114t – 0.1976
Haouzia	Y= 0.2263t + 0.3135	Y= 0.2194t + 0.3059
Dahbia	Y= 0.3192t + 0.0004	Y= 0.3081t + 0.0322
Picholine Marocaine	Y= 0.2665t + 0.0218	Y= 0.2872t + 0.0504

Table 5. Evolution of specific K_{270} extinction coefficient over time "$K_{270} = f(t)$" in the olive varieties in both conditions of storage oils.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 0.0267t - 0.0054	Y= 0.0366t – 0.0167
Picholine de Languedoc	Y= 0.0239t + 0.0154	Y= 0.0278t + 0.0144
Manzanille	Y= 0.0509t – 0.0399	Y= 0.0477t – 0.0345
Haouzia	Y= 0.0406t – 0.0313	Y= 0.0466t -0.0255
Dahbia	Y= 0.0474t – 0.0329	Y= 0.0524t – 0.0374
Picholine Marocaine	Y= 0.0448t – 0.0334	Y= 0.0404t – 0.0265

4.2 Figures

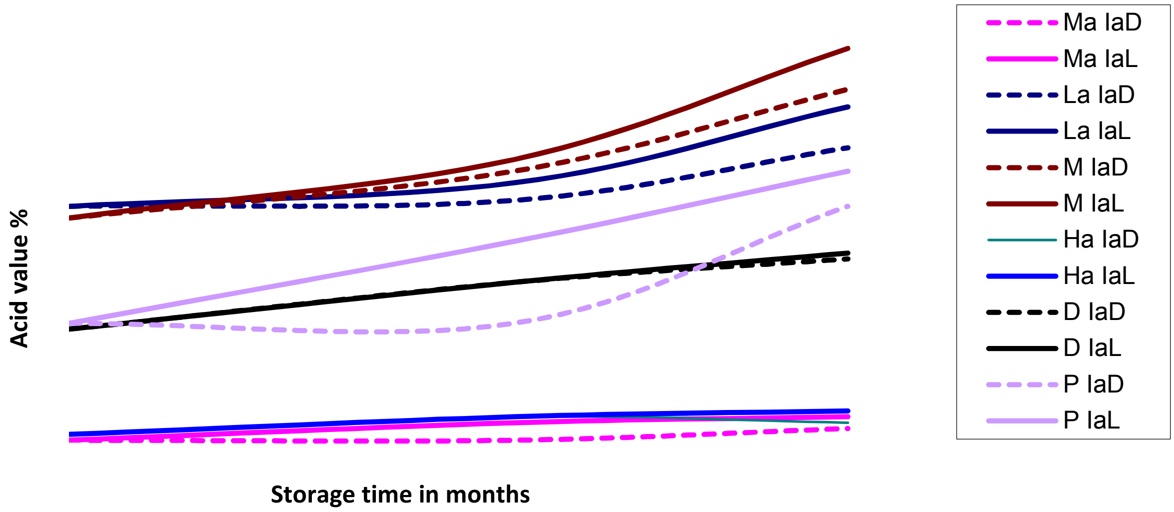

Fig. 1. Changes in the acid values of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

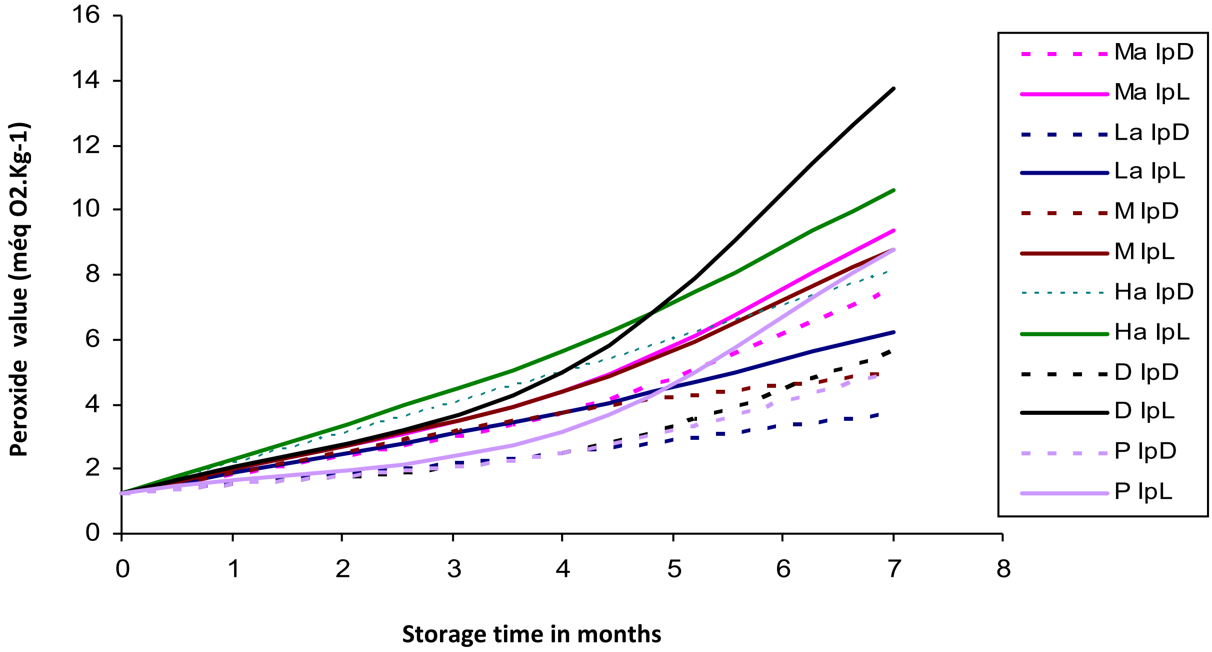

Fig. 2. Changes in the peroxide values of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

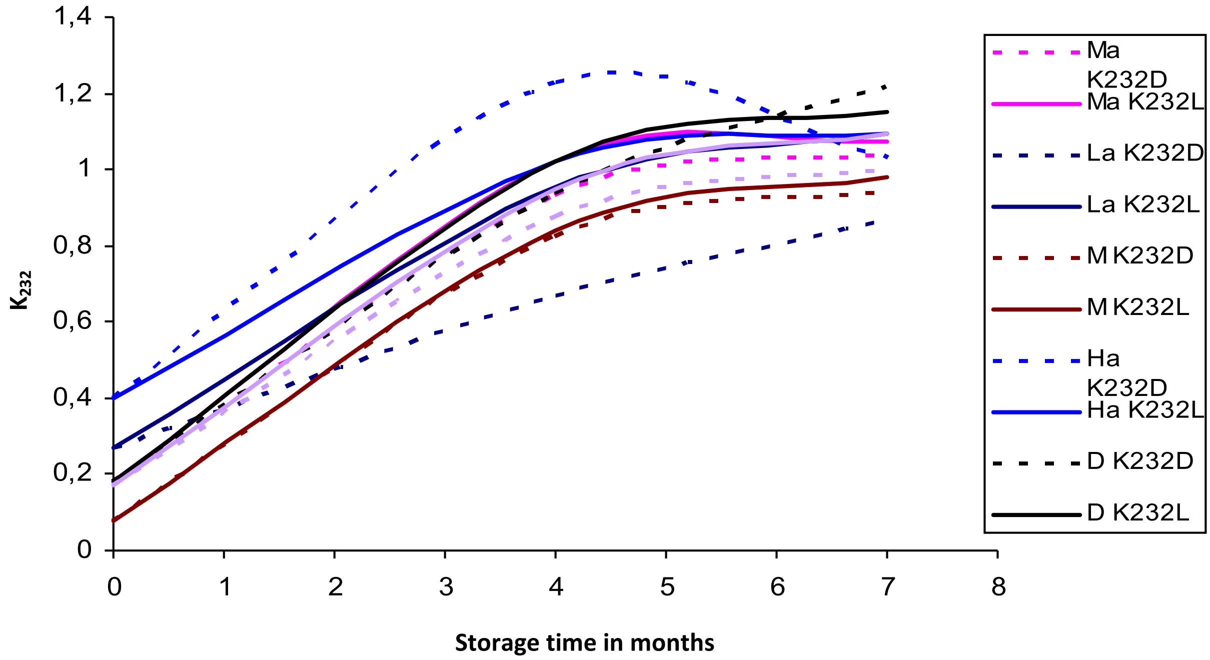

Fig. 3. Changes in the K_{232} of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

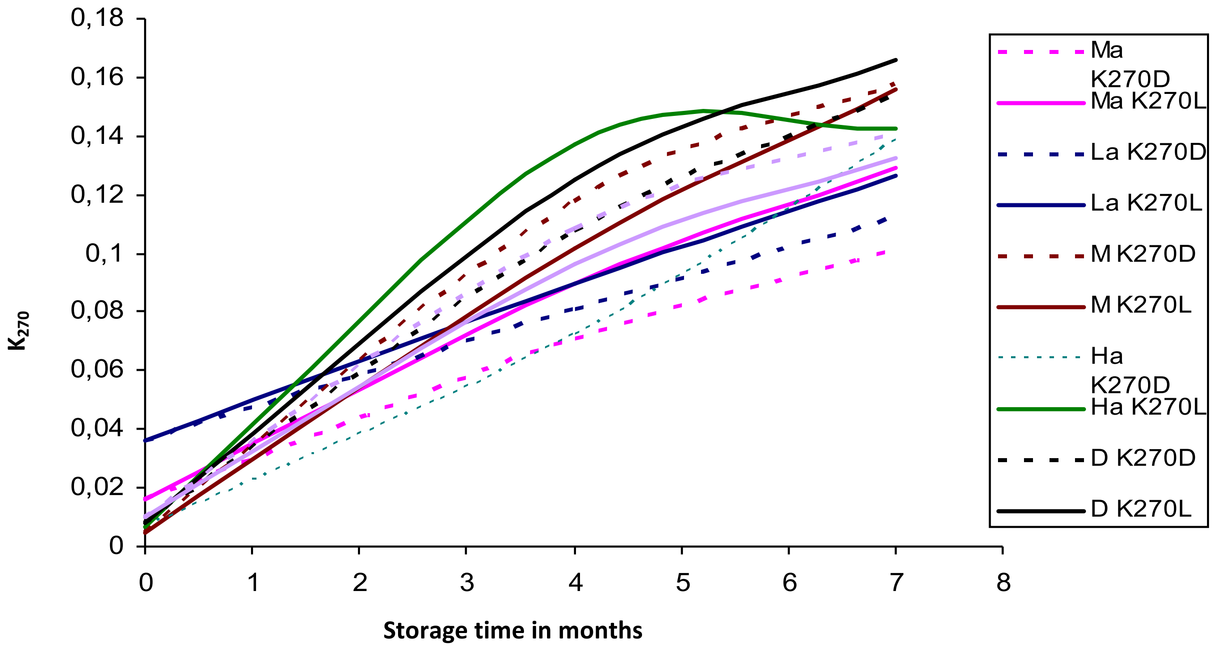

Fig. 4. Changes in the K_{270} of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

5 CONCLUSION

This study shows a significant effect of variety on the physic-chemical properties of the studied oils. Also, the sunlight has a more or less significant to the stability of physic-chemical properties of olive oil according to the variety. The acid value varies remarkably in olive oil from Manzanille, and therefore the appearance of a characteristic flavor 'rancid' which modify the marketability of the oil. The peroxide value varies significantly in olive oil from Dahbia. This will result in a rapid augmentation of rancidity. K_{232} and K_{270} extinctions vary greatly in olive oils from Dahbia and Manzanille. While olive oil Moroccan Picholine has moderate physicochemical stability. Which was not the case during its comparison with the Arbequina variety in other studies [17], [18].Then, we can say that these oils will be enriched by quickly oxidation products and then have a low storability. In short, these changes negatively affect the life span, sensory quality, nutritional and food security of olive oil.

From the above results it could be mentioned that acid value, peroxide value, K_{232} and K_{270} values were lower in extracted oil from Picholine de Languedoc. The physic-chemical properties of this olive oil, showed good stability when exposed to sunlight. Thus, it's the most recommended for use due to its high resistance to deterioration during storage.

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