PRELIMINARY INVESTIGATION ON TRADITIONAL OLIVE (OLEA EUROPAEA) OIL PROCESSING APPLIED IN KABYLIA REGION (NORTHERN ALGERIA)

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Abstract
The present paper concerns a preliminary investigation on traditional olive (Olea europaea, var. Chemlal) oil (OO) processing applied, although rarely now, in kabylia region (northern Algeria). For this, the traditional procedure, essentially characterized by the use of traditional direct solar drying (TDSD) before oil extraction, was adapted and replicated at laboratory scale, for the first time to our knowledge. Two OO samples were first obtained, using TDSD and indirect solar drying by using a cabinet solar drying (CSD, which is an attempt to improve the TDSD), the manual wringing being applied for oil extraction. Secondly, a third sample was obtained by using CSD and manual screw press for oil extraction. The resulting first two OO samples (TDSD-OO and CSD1-OO) were analyzed for different quality criteria (refractive index, peroxide value (PV), UV absorption, etc.), whereas the third sample (CSD2-OO) was analyzed only for OO yield, released vegetable water, UV absorption and fatty acid composition. Results showed that the SCD1-OO presents the lowest free acidity (<<1%), ΔK (~ 0.001) and PV (~ 7-8 meqO2/Kg OO), values which are characteristic of an extra virgin OO. The third sample highlighted before all the ecological impact of olive fruit drying before OO extraction by reducing almost totally the vegetable waters. However, further studies are needed to better optimize and perfect the entire traditional extraction process, the drying operation in particular.

Keywords: *Extraction, solar drying, quality criteria, UV absorption, vegetable water.*

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1. INTRODUCTION

Among other criteria,traditional foods are defined by the production process, the main stages of which must be carried out in a certain area at the national, regional or local scale (Reinders et al., 2019). In addition, such processes are easy to implement but they require perfection to better meet quality standards (Akeem et al., 2019). Muhialdin et al.(2021) suggest including traditional foodstuffs in the humanitarian food supply chains in the regions prone to disasters and crises, considering moreover the Covid-19 pandemic which reveals the fragility of commercial food supply chains.

OO is considered to be one of the essential components of the Mediterranean diet, which itself is observed as a dietary pattern (Piscopo and Poiana, 2012). The classical OO processing is essentially composed of preliminary treatment stages (reception of fruits, washing / cleaning) and five separate or combined unit operations, namely grinding/kneading, pressing and extraction/separation of OO. In some areas of the Kabylia region, different variants of traditional OO processing are still applied, although rarely now. One of the peculiarities of this process is the use of direct solar drying of olive fruits before oil extraction. Taking into account the fact that the solar dryers are worked by renewable source of energy which does not harm the environment, and consequently promotes sustainable development (Singh and Gaur, 2021).

The present paper concerns a preliminary investigation on traditional olive (*Olea europaea*, *var. Chemlal*) oil (OO) processing applied, although rarely now, in kabylia region (northern Algeria). For this, the traditional procedure, essentially characterized by the use of traditional direct solar drying (TDSD) before oil extraction, was adapted and replicated at laboratory scale, for the first time to our knowledge.

2. MATERIAL AND METHODS

2.1. OO processing

The traditional OO processing applied at the laboratory scale on fully ripe black olive fruits (variety *Chemlal*) was adapted (Fig.1a) from those we have been able to identify in the extreme northwest (Fig.1b) and center (Fig.1c) of Kabylia region (northern Algeria) and which are still applied, although rarely now.

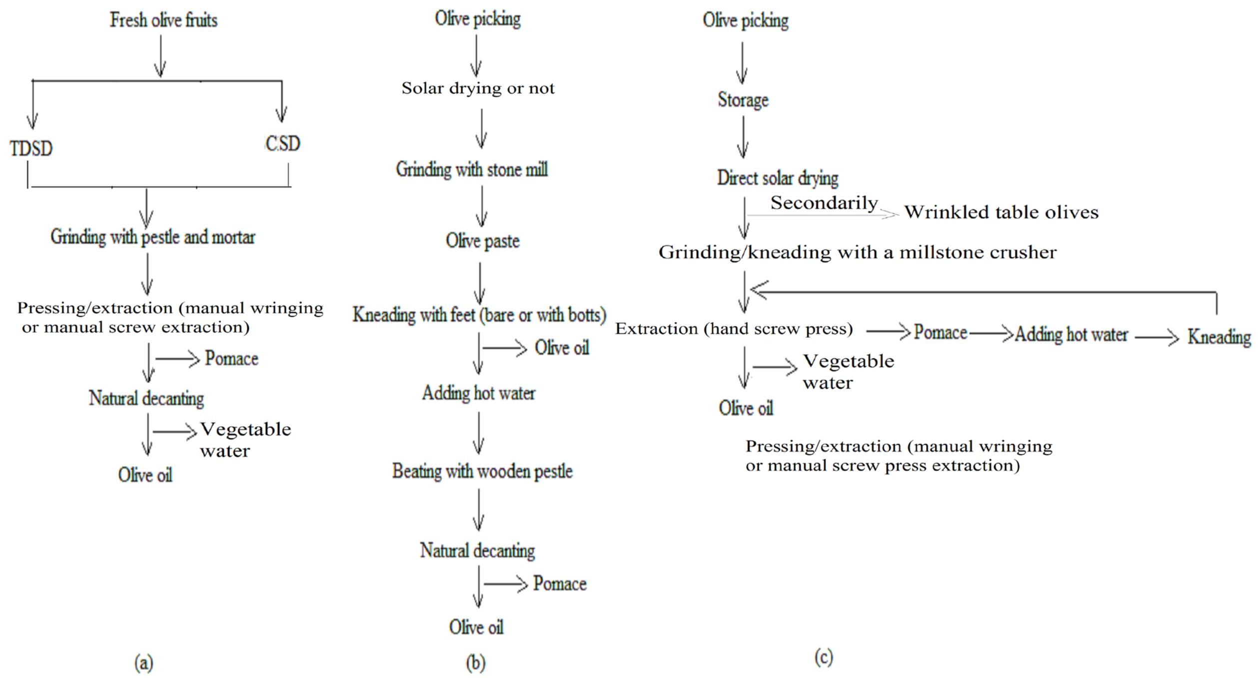

Fig. 1. Olive oil processing applied at laboratory scale (a), and in the extreme northwest of Kabylie region.

The TDSD is to spread the olives in a single layer on a flat surface to expose them directly to the sun's rays. The problems of hygiene, the slowness of the process and the direct contact between solar radiation and the material to be dried represent the main drawback of this method (Sheikh et al., 2018). The indirect solar drying was performed by using SCD. The latter consists mainly of a solar collector (air passage with a black bottom and an upper part covered with glass) that heats the air and a drying cabin that contains the product to be dried thanks to the hot air that rises from the collector, so that the food is not exposed to direct sunlight. The drying process (carried out in February/March 2018) is stopped when the olives become wrinkled but the skin should not stick completely to the stone.

Two OO samples (TDSD-OO and CSD1-OO) were first obtained using manual wringing for oil extraction. Then, a third sample (CSD2-OO) was obtained using CSD and a manual screw extraction (Fig.1a). It may be useful to point out that this press has been specially made for this work (Fig. 2), the test described here being therefore also used to evaluate its performance.

2.2. OO characterization

The TDSD-OO and CSD1-OO were analyzed for the following technological and physicochemical parameters using standard analytical techniques: OO yield, refractive index, free acidity (% oleic acid), peroxide value (PV, in meq active oxygen/kg oil), specific extinction at 232 (K_{232}), 266 (K_{266}), 270 (K_{270}) and 274 (K_{274}) nm and variation of specific extinction (ΔK) (UV/VIS spectrophotometry), chlorophyll (at 630, 670 and 710 nm), carotenoids (at 470 nm) and polyphenols (mg of gallic acid equivalents (GAE), using Folin – Ciocalteu method). ΔK was calculated as follows (IOC, 2019):

$$\Delta K = K_{270} - (K_{266} + K_{274})/2$$

Figure 2: Manual screw press used in this work: 1- clamping bar, 2- screw, 3- wooden plunger, 4- perforated basket containing the olive paste wrapped in a cloth, 5- container- basket support, 6- oil collection vessel

Then, the fatty acid composition was determined by gas chromatography (apparatus of type Chrompack CP 9002). For this, the methyl esters were prepared at room temperature by transmethylation: the upper phase contains the fatty acid esters, whereas the lower phase contains the glycerol fraction and minor constituents of OO. To 0.1 g of OO were added 2 ml of hexane and 0.2 ml of 2N methanolic KOH. The reaction mixture was stirred in a vortex for 2 min. The upper hexane phase thus obtained was removed and then injected into the gas chromatograph equipped with a flame ionization detector (T = 250 ° C) and capillary column of type Cp Sil 8 CB with dimensions 30 m x 32 mm x 0.25 µm. The carrier gas is nitrogen at a flow rate of 1 ml /min and the oven temperature program was 150 to 200 °C (at 4 °C/ min). The peak identification was performed in the presence of controls and the calculation of the different fatty acids was carried out by means of an automatic integrator.

Concerning the CSD1-OO sample obtained with manual screw extraction, only the OO yield, liquid waste , specific extinctions and ΔK were determined.

The experiments were performed,when possible, in triplicate and the results are expressed as the mean ± standard deviation. The ANOVA was performed for comparison of means, using XLSTAT software 2009. The differences were considered statistically significant when $p<0.05$.

3. RESULTS AND DISCUSSION

The technological and physicochemical characteristics of anayzed OO samples are summarized in Table 1. As can be seen, the obtained OOY for TDSD-OO and CSD-OO samples is about 20%, a value which falls within the range of values generally reported in the literature for the variety *Chemlal*. This finding shows that at small scale it is possible to produce olive oil without investing in sophisticated equipment.

However, the manual screw press extraction did not improve the oil yield. We believe that this low yield may be due to the pressing conditions, in particular the compressibility of the paste, the quantity of the olive paste being pressed and imperfections of the press (undersizing). Regarding the vegetable water (intrinsic water of the olive fruit) the amount released (quantified only in the case of CSD-OO2) is almost zero when only one extraction is applied (Figure 1c). But in practice, the pomace from the first extraction is moistened and then kneaded and pressed again to recover the residual oil. It follows that the vegetative water content depends on the level of dehydration of the fruit and the level of moistening of the pomace. In addition to this ecological advantage, drying facilitates the extraction process since only the oil is recovered in its pure state during the first pressing.

Table 1: Physicochemical characteristics of obtained OO samples

Parameter	TDSD-OO	CSD1-OO	CSD2-OO	IOC standards
OOY (%)	19.34±0.07	21.07±0.05	12±2	-
VW (% dried olives)	-	-	~ 0	-
Acidity (%)	1.12± 0.02[a*]	0.84± 0.01[b]	-	≤ 2
PV	12.3±0.02[a]	7.2±0.01[b]	-	< 20
RI	1.469±0.001[a]	1.469±0.01[a]	1.471	1.4677-1.4705
K_{232}	1.501±0.22[a]	1.166±0.09[a]	1.349±0.04	≤ 2.5
K_{270}	0.16±0.01[a]	0.13±0.01[b]	0.39±0.17	≤ 0.22
ΔK	0.01±0.002[a]	0.001±0.0003[b]	0.005 ±0.001	≤ 0.01
PP	155.13±1.79[b]	161.09±2.75[a]	-	-
Chl (mg/kg OO)	1.331	1.3401	-	-
Car (mg/kg OO)	1.394	1.482	-	-
Chl/Car	0.95	0.90	-	-
Palmitic acid (%)	15.76±0.03[a]	15.25±0.11[b]	16.04	7.5-20.0
Oleic acid (%)	64.72±0.40[b]	66.22±0.18[a]	64.70	55.0-83.0
Linoleic acid (%)	13.53±0.01[a]	12.82±0.08[b]	13.8	3.5-21.0

OOY= olive oil yield, VW= vegetable water, PV = peroxide value (meq active oxygen/kg oil), RI = refractive index, K232 = specific absorbance at 232 nm, K270 = specific absorbance at 270 nm, ΔK = variation of specific absorbance, PP = polyphenols (mgGAE/kg OO), Chl = total chlorophyll, Car = caratenoids.

Globally, the physicochemical quality criteria values of considered OO samples are close to those required by the International Olive Council (IOC, 2019). Based on the free acidity (<1%), the CSD-OO could be classified as extra virgin OO. Although the samples analyzed show a PV that meets the requirements for virgin OO (≤20 meq O2/kg) (IOC,2019), the CSD-OO presents the lowest value (~ 7 meqO2/kg) ($p<0.05$). In this context, it is well established that the PV as a measure of primary oxidation products is still the most representative parameter considered to measure oxidation in virgin OO (Longobardi et al., 2021). On the other hand, the ΔK values of CSD-OO, whether it is pressed by spinning or by the screw press, is still extremely low compared to the OIC standards and is 10 (case of manual wringing) and 20 (case of screw press extraction) times lower than that of the TDSD-OO ($p\leq0.05$), indicating especially the favorable effect of indirect drying on OO quality.

Data from Table 1 show a chlorophyll /carotenoid ratio close to 1 for the first two OO samples analyzed, knowing that the stability of this ratio is one of the parameters of authenticity of oils (Roca et al., 2003). More generally, the degradation of chlorophyll (by conversion to pheophytin) and of carotenoids (oxidation and isomerization) depends on many environmental factors such as heat, light and acidity.

The OO fatty acid composition (only palmitic, oleic and linoleic acids are presented here, being the most predominant in the OO) does not appear to be affected by sun drying since for the three analyzed samples it is conform to IOC standards (IOC,2019). The oleic acid of CSD1-OO is

higher than that of TDSD-OO ($p\leq0.05$), indicating the positive impact of improved drying procedures on the OO quality. As highlighted above, the favorable effect of indirect solar drying by using CSD could be explained by its hygienic character (protection against various bugs and dust, among others), by the absence of direct contact between olives and sun's rays, and by the acceleration of the water elimination process due to the high temperature in the drying chamber. In fact, The water removal therefore reduces hydrolysis reactions by reducing contact between water and oil during the milling and mixing operations, the free water influencing drastically such reactions (Adawiyah et al., 2012).

The linoleic acid content of TDSD-OO is greater than that CSD1-OO ($p<0.05$). This might be explained by any chemical and/or enzymatic conversions of oleic acid, themselves influenced by environmental conditions (water content, temperature, light ...) and heterogeneity of processed olive fruits, in terms of dimensions and maturity. It has been already established that during fruit ripening this conversion is catalyzed by the well known natural enzyme desaturase.

4. CONCLUSION

Obtained results show that the efficiency of traditional OO processing as applied in Kabylia region (northern Algeria) can be advantageously improved. Thus, it was shown that the indirect solar drying by using CSD ensures a finished product with the characteristics of an extra virgin oil, in terms of free acidity(<<1%), PV (~ 7-8 meqO2/Kg OO) and ΔK (~ 0.001), among others. Moreover, the ecological impact of the preliminary drying of olive fruits before OO extraction deserves attention since such a process considerably reduces the vegetation water (intrinsic to fresh olives).
However, further studies are needed to better optimize and perfect the entire traditional extraction process, the drying operation in particular.

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