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Research Article

CONTRIBUTION TO THE STUDY OF A TRADITIONAL OLIVE OIL EXTRACTION PROCESS AS APPLIED IN KABYLIA REGION (NORTHERN ALGERIA)

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ABSTRACT. In some municipalities of Kabylia region (northern Algeria), the traditional olive oil (OO) extraction process includes direct solar drying (DSD) of whole fruits as preliminary operation unit. The present work is a contribution to the study, for the first time to our knowledge, of this traditional process in terms of: i) drying ability of olive fruits evaluated throughout water removal rate (WR, % of initial olive weight (IOW)) and ii) some basic quality characteristics (specific absorbance at 232 nm (K232), free acidity, etc.) of resulting OO. For comparison purposes, solar tent drying (STD) as an attempt to improve the DSD, and hot air drying (HAD) were also considered. The results obtained show that the olives treated by DSD at an average temperature of 34°C and a relative humidity of 13-16% reach a WR of about 40% (against 30% for STD) and give a better oil with a free acidity of 0.74% compared to 1.10 and 2.36% for olives treated by STD (at 46 °C and RH = 10%) and undried olives treated in a modern oil mill, respectively. At last, solar drying makes the extraction process more eco-friendly, considering the low rate (0-0.05 L/kg fresh olive (FO)) of olive vegetable water (OVW) during the OO extraction process. So, it is strongly hoped that this study will contribute to the further development of this research axis.

Keywords: *crushing, extinction, free acidity, peroxide value, pressing*

INTRODUCTION

Traditional foods are defined by several criteria. One of these concerns the production process, the main stages of which must be carried out in a certain area at the national, regional or local scale [1]. Although at one time, such specific foods tended to disappear for various reasons [2], this is clearly not the case in recent years [3]. This said, traditional foods and patterns may be endowed with interesting health properties as is the case with the Mediterranean diet of which OO is one of the essential components [4].

In food technology, drying process is widely applied for preservation and/or formulation purposes. In particular, the solar drying is increasingly adopted due to its positive economical [5,6] and ecological [6,7] implications.

The present work is a contribution to the study of a traditional OO extraction process as applied in some municipalities of Kabylia region (northern Algeria). This procedure includes DSD, which is applied to fresh whole olives as preliminary operation unit. To our knowledge, only one work in the form of a preprint has been devoted to this subject [8].

MATERIALS AND METHODS

Olive fruits

Ripe black olive (*Olea europaea*, variety *Chemlal*) fruits were used. They were supplied by a local farmer and picked in February 2022 at a place called *Azrou-Averkane* (Black Rock), in the district of Bouzeguène, about 50 km southeast of Tizi-Ouzou (capital of the region of the same name, in northern Algeria). For comparison purposes, the same farmer provided us with an OO sample processed in a modern oil mill (MOM-OO) from olive fruits grown in the same olive grove as those used in this work. The olives have the following biometric properties (deduced from 10 olives): weight (9.3 ± 1.7 g), length (13.7 ± 5.3 mm), width (11.4 ± 0.8 mm), kernel weight (4 ± 0 g), kernel length (12.7±1.0) and kernel width (6.3±0.2).

Drying

Since the solar drying of the olives before oil extraction is the main characteristic of the studied process (Fig. 1), the optimal drying conditions, in terms of WR value

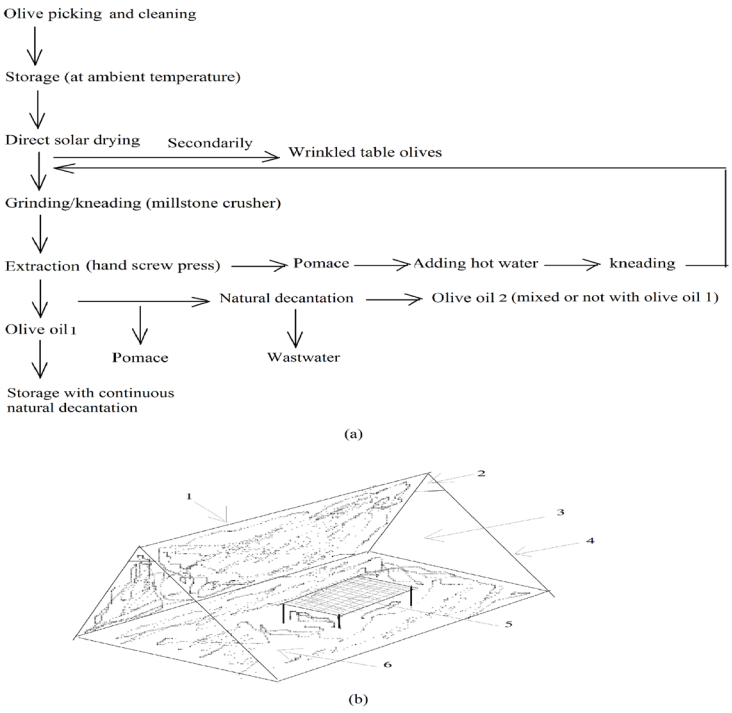


Fig. 1. *Traditional olive oil processing applied in some localities of Kabylie region (northern Algeria) (a), and scheme of solar tent drying (SDT) (b): 1- black plastic tarpaulin(rear face), 2- hot air outlet, 3- transparent plastic tarpaulin (front panel), 4- lateral side covered by the transparent plastic tarpaulin, 5- wire mesh for olive fruits, and 6- floor covered by the black tarpaulin*

that guarantees a maximum olive oil yield (OOY, L/kg FO) and a minimum OWV during OO extraction, were first determined based on local traditional knowledge. According to this latter, the drying is optimal when the texture of dried olives is reminiscent that of dried raisins. This means that olives should wrinkle without the skin sticking to the stone, while the pulp should remain slightly viscous to the touch.

Once the optimal WR was found, two new fresh olive samples were dried by DSD and STD under these conditions before extracting the OO. It must be recalled that the STD was applied as an attempt to improve the DSD from the point of view of hygienic working conditions (protection against dust and other impurities) and acceleration of the water removal process (greenhouse effect) (Figure 1a,b). In fact, traditionally, the olives are exposed to the sun in the open air, by spreading them directly on the ground previously cleaned, on a stone slab, a tarp or other.

For comparison purposes, the HAD at 37 (HAD37), 46 (HAD46) and 55 °C (HAD55) was performed. However, the HAD was applied without ventilation to see the effect of this one on the WR and to compare drying kinetics but not for the study of the olive oil extraction process as it is the case for DSD and STD.

The drying ability was evaluated by following the variation of WR with time and at different conditions. The WR was calculated as follows:

$$WR\ (\%\ IOW) = 100(W_0-W_t)/W_0 \qquad (1)$$

where, W_0 and W_t are the initial and at time t weight (in g) of olive fruit sample, respectively. The W_0 value varied according to the drying procedure: HAD37 (400 g), HAD46 (190 g), HAD55 (25g), DSD at about 34 °C (DSD34) (500 g) and STD43 (300 g).

The drying experiments were performed during February 2022.

OO extraction

The solar-dried olive fruits were divided into batches of about 50 g and each batch was crushed and then pressed separately to extract the OO. Crushing was carried out using a pestle and mortar, while oil extraction was carried out using a manual screw press [8]. Before pressing, the olive paste was piled up in a piece of cloth (instead of traditional pressing mats). Moreover, only one extraction (without addition of water) was applied in this work, unlike the traditional treatment (Fig. 1a).

The extraction process was characterized by determining the OOY and OVW immediately after extraction operation.

OO basic characterization

The extracted OO samples, namely DSD-OO and STD-OO, were characterized for some basic quality characteristics which were determined at Analysis and Quality Control Laboratory (ANALAB) located in the city of Akbou (about 210 km east Algiers): Free acidity (% of oleic acid), peroxide value (meq/kg OO), specific extinction at 232 nm (K_{232}), specific extinction at 270 nm (K_{270}) and variation of specific extinction (ΔK) which was calculated according to International Olive Council (IOC) [9]:

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

For comparison purposes, the MOM- OO sample was also analyzed.

Results are expressed as the mean ± standard deviation. The ANOVA was performed for comparison of means, using free Statistics Kingdom calculator. The differences were considered statistically significant when $p<0.05$. The drying curves and linear regression lines for the constant drying rate phases were obtained using Excel software.

RESULTS AND DISCUSSION

Drying ability of olive fruits

The drying curves obtained by plotting WR versus drying time at different conditions are presented in Fig. 2.

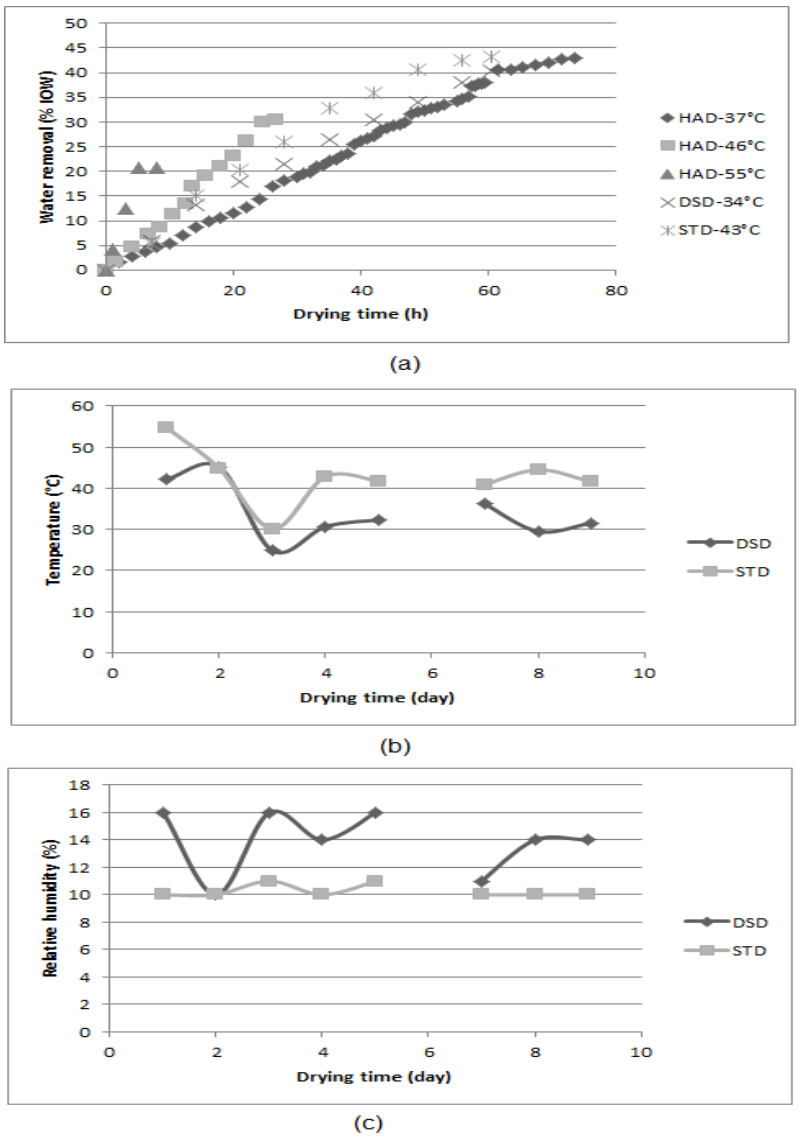


Fig. 2. *Water removal (a), air temperature (b), and air relative humidity (c) versus drying time. HAD = hot air drying without ventilation, DSD =direct solar drying, TSD = tent solar drying*

From the figure 2a, two main drying periods can be globally distinguished for all drying procedures, except for HAD55: i) first drying period at constant speed (corresponding to the elimination of free water) which starts at WR = 0 and ends at critical WR of 20 (HAD55), 30 (HAD46), 35 (STD43) and 40 % (IWO) (HAD37 and DSD34), and ii) drying period at falling speed (corresponding to the elimination of linked water) which starts at critical WR and ends at equilibrium WR. This period was observed only in the case of HAD37, DSD34 and STD43. In the particular case of DSD

and STD, the drying was not prolonged until the equilibrium, because the end of drying is not only determined by the WR value but also by the texture which itself determines the OOY and the rate of OVW rejected during the OO extraction. In the local tradition it is said that the OO "has been stolen by the sun" when it is noticed that the olives are over-dried and the OOY is low.

The absence of the second period for HAD46 and HAD55 could be explained by a loss of permeability to water by fruit skin, phenomenon well described in the literature for various dried food products [10], but not for olive fruits, to our knowledge. We think that a combined effect of a relatively high temperature and a low air velocity could favour an overheating of the olive surface and the loss of its porosity.

From our observations, the desired texture, as defined by the traditional knowledge already outlined above and which indicates the end of the drying process, relates to a critical WR value of about 30 and 40 % IOW for STD and DSD, respectively. The difference in the critical WR values may be due to the non-uniformity of fruit dimensions and drying conditions.

While air temperature (Figure 2b) and relative humidity (Figure 2c) vary throughout the day and from day to day in the case of DSD and STD, the constant drying rate periods are correctly described by the following line equations:

$WR_{DSD} = 5.5t$, $R^2 = 0.98$

$WR_{STD} = 6.6t$, $R^2 = 0.99$

where, t is the drying time (day)

So, the drying rate of the first stage for STD is only 1.2 times higher than that for DSD despite higher temperature and lower relative humidity inside the tent (Figure 2a and b). We believe that outdoor air velocity (~ 3 m/s, according to local meteorological data) promotes DSD and offsets the less favourable effects of temperature and relative humidity.

Technological and chemical characteristics

The determined technological and chemical characteristics are shown are summarized in Table1.

Table 1. *Some technological and chemical characteristics of the extraction process and obtained olive oils. Same lower case letters in the same column indicate no significant difference between values (p>0.05).* *According to[11]*

OO type	OOY (L/Kg FO)	OVW (L/Kg FO)	FA (% OA)	PV (meq/kg OO)	K232 -	K270 -	ΔK -
DSD	0.16±0.05^{a*}	0-0.05	0.74±0.04^{c}	14.99±0.64^{b}	2.32±0.01^{b}	0.20±0.01^{b}	<0.01
TSD	0.17±0.02^{a}	0-0.05	1.10±0.02^{b}	14.13±1.41^{b}	2.36±0.01^{b}	0.24±0.01^{b}	<0.01
MOM	0.16±0.02^{a*}	0.5-0.6**	2.36±0.01^{a}	23.80±0.19^{a}	2.55±0.01^{a}	0.31±0.01^{a}	>0.01

As stated above, the optimal WR value in terms of minimization of the OVW release would be about 30 (for STD) and 40 % (for DSD). However, this target WR value could be impacted by several factors such as olive variety, size uniformity, drying conditions, etc. It should be recalled that in this work, the second extraction with the addition of water to the pomace as usually done (Figure 1a) was not implemented. It was previously established that the OOY could fluctuate within a wide range of values (from below 10% to around 30%) depending on genetic, climatic, maturity and water content factors [12]. Regarding the OVW, the discharge from solar-dried olive fruits is

sometimes almost nil when the drying is optimal. However, this does not rule out the formation of sediments (olive fruit fragments and little water) by natural decantation during oil storage, the fruit fragment release depending mainly on the filtering power of the cloth used as pressing mats. By their nature, these sediments can negatively impact the aesthetic aspect of the product but not the other quality attributes. Locally, they are sometimes used for medicinal purposes. On the other hand, Bubola et al. [13] have found that compared to filtration, natural sedimentation and decantation of OO better improve the sensory profile and the total phenolic compounds. This said, the crushing of the olives under the weight of the millstone and the debris of the progressively crushed cores limits the degree of emulsion and implies more interesting yields and quality of the product [14]. In any case, the OVW remains extremely low compared to the wastewater rejected by modern oil mills (Table 1).

From Table 1, the quality parameters of DSD-OO and STD-OO samples are better than those of MOM-OO sample ($p<0.05$). In accordance with the ICO standards [15], the considered two OO samples can be labelled as extra-vergin from the point of view of K232 and ΔK. The DSD-OO sample can be classified additionally extra vergin from the point of view of both K270 and free acidity. The latter is, moreover, the parameter that differentiates the analyzed oil samples, indicating that STD can improve hygienic working conditions and speed up the drying process but it may negatively impact certain quality attributes of the finished product. The positive effect of solar drying may be explained by two reasons. First, the elimination of water takes place during the drying phase at constant speed during which all the energy induced by the sun's rays is spent for the evaporation of water from the surface of the olives. Therefore, during this period, the temperature on the surface of the fruit remains constant and equal to the temperature of the wet bulb. Second, the absence of any contact between oil and water during the crushing and kneading process favors the prevention of oxidation and hydrolysis reactions of triglycerides. In this regard, it has already been shown that water-rich foods are more vulnerable to fat oxidation and changes in fatty acid composition than dry foods [16].

CONCLUSION

The preliminary results obtained indicate that the basic quality characteristics of DSD-OO and STD-OO samples are better than those of MOM-OO sample ($p\leq0.05$). Moreover, the first two samples differ only by their free acidities (0.74 and 1.1 % oleic acid, respectively) ($p\leq0.05$), indicating that STD can improve hygienic working conditions and speed up the drying process but it may negatively impact certain quality attributes of the finished product. In addition, the solar drying makes the extraction process more eco-friendly, considering the low rate of liquid waste discharged during OO extraction.

Considering these findings, it is strongly hoped that this study will contribute to the further development of this research axis.

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REFERENCES

[1] Reinders, M. J., Banovic, M., Guerrero, L. (2019): Introduction. In: Galanakis, C. M. (eds.) Innovations in traditional foods. Woodhead Publishing-Elsevier. Cambridge, pp. 1-26.

[2] Burton, R. J. F., Riley, M. (2018): Traditional ecological knowledge from the internet? The case of hay meadows in Europe. Land Use Policy 70: 334-346.

[3] García-Barrón, S. E., Guerrero, L., Vázquez-Elorza, A., Lazo, O. (2021): What Turns a Product into a Traditional One? Foods 10 (6): https://doi.org/10.3390/foods10061284.

[4] Tsartsou, E., Proutsos, N., Castanas, E., Kampa, M. (2019): Network meta-analysis of metabolic effects of olive-oil in humans shows the importance of olive oil consumption with moderate polyphenol levels as part of the mediterranean diet. Frontiers in Nutrition 6: https://doi.org/10.3389/fnut.2019.00006

[5] Dissa, A. O., Desmorieux, H., Bathiebo, J., Koulidiati, J. (2011): A comparative study of direct and indirect solar drying of mango. Global Journal of Pure and Applied Sciences 17 (2): 273-294.

[6] Akowuah, J. O., Bart-Plange, A., Komla Agbeko Dzisi A. A. (2021): Thin layer mathematical modelling of white maize in a mobile solar-biomass hybrid dryer. Resaearch in Agricultural Engineering, 67 (2): 74-83. https://doi.org/10.17221/56/2020-RAE

[7] Salazar-Camacho, N.A., Sanchez-Echeverri, L. A., Fonseca, F. J. (2022): Mango (Mangifera indica L.) dehydration as a women entrepreneurship alternative in vulnerable communities. Sustainability 14: 1548: https://doi.org/10.3390/su14031548.

[8] Bennai, D., Taftist, D., Zedek, S., Abdellaoui, R., Boukhiar, A., Benamara, S. (2019): Analyse préliminaire du processus traditionnel de production d'huile d'olives appliqué dans certaines régions de Kabylie (nord algérien). ⟨hal-02271880⟩.

[9] International Olive Council (IOC). (2019a): Spectrophotometric investigation in the ultraviolet, COI/T.20/Doc. No 19/Rev.

[10] Sabarez, H. T. (1998): Chemical and physical changes during dehydration of prunes (prunus domestica). [PhD. Thesis.] University of Wollongong. http://ro.uow.edu.au/theses/1120.

[11] Khdair, A. I., Abu-Rumman, G., Khdair, S. I. (2019): Pollution estimation from olive mills wastewater in Jordan. Heliyon 5: e02386. https://doi.org/10.1016/j.heliyon.2019.e02386.

[12] University of California Cooperative Extension. (2006): Newsletter of olive oil production and evaluation. First Press 2 (1): 1-4. http://cesonoma.ucanr.edu/files/27239.pdf

[13] Bubola, K. B., Lukić, M., Lukić, I., Koprivnjak, O. (2019): Effect of Different Clarification Methods on Volatile Aroma Compound Composition of Virgin Olive Oil. Food Technology & Biotechnology 57(4): 503-512. https://dx.doi.org/10.17113%2Fftb.57.04.19.6401

[14] Article Extraction de l'huile d'olive de Wikipédia en français. nd. https://fr.wikipedia.org/wiki/Extraction_de_l%27huile_d%27olive

[15] International Olive Council (IOC). (2019b): Trade standard on olive oils and olive pomace oils, 2019, COI/T.15/NC No 3/Rev.13.

[16] Al-Bachir M. Sahloul H. (2017): Fatty acid profile of olive oil extracted from irradiated and non-irradiated olive fruits. International Journal of Food Properties 20 (11): 2550-2558. https://doi.org/10.1080/10942912.2016.1243557