DRYING KINETICS OF OLIVE POMACE FROM EXTRA VIRGIN OLIVE OILS PRODUCED IN SOUTHEASTERN BRAZIL

Raquel Guidetti Vendruscolo[1]; Bruna Sanches Silva[1]; Edneia Correia de Souza[1]; Marcio Schmiele[1]

[1]Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM)

ABSTRACT

This study aimed to perform the drying of olive pomace cultivated from southeastern Brazil after extraction of extra virgin olive oil at three different temperatures and to evaluate the drying kinetics. Drying was carried out in a conventional oven with renewal and constant air circulation equal to 1 m s^{-1} at three temperature levels: 40, 60, and 80 ºC. The results showed that the increase in drying air temperature favored the water removal from the samples. The temperature equal to 80 ºC resulted in lower values of final moisture of bagasse in the same drying period and higher drying speeds, being considered the most suitable drying temperature. The lipid content also had an influence on the drying process.

INTRODUCTION

A few decades ago olive cultivation was restricted to countries in the Mediterranean basin, such as Spain, Italy, and Greece. However, the production of olives has gone through a process of expansion, currently being produced in countries like New Zealand, Australia, Argentina, Chile, Uruguay, and Brazil. Of the Brazilian states, Minas Gerais, São Paulo, and Rio Grande do Sul stand out in terms of olive production; It is worth noting that this production is destined almost exclusively for olive oil extraction (1). The cultivar and genotype, as well as the region, climate, soil quality and agricultural practices directly influence the characteristics of the olives, oil obtained and by-products such as pomace; therefore, it is important to study matrices obtained in different production sites (2).

Olive pomace is the residue generated after the extraction of oil composed of the pulp and epicarp, as well as parts of the seed and a residual lipid fraction. Pomace composition is variable due to several factors such as olive composition and residual water and oil contents (3). A large part of the phenolic compounds (hydroxytyrosol and hydrophilic compounds) remains in the pomace, which can be a natural and low-cost source for use in the food industry as a source of bioactive compounds with antioxidant properties (4).

The technological application of olive pomace requires it to be dehydrated before application in the food matrix to avoid the deterioration of the product by bacteria and fungi and to reduce the amount of water between 5 and 6% (on a dry basis), to achieve the ideal water activity for product conservation (5). Among the most common drying techniques used for this purpose, hot air drying stands out. This type of drying allows better control of process variables and the low temperatures operated are a way of protecting bioactive compounds against degradation processes (6).

OBJECTIVE

To investigate the drying kinetics of pomace from four olive varieties cultivated in southeastern Brazil at three drying temperatures (40, 60, and 80 ºC). As well as determining drying speed and content of moisture and residual lipid.

MATERIAL AND METHODS

2.1. Obtaining samples

The olive pomace (Arbequina – AR, Koroneiki – KO, Barnea – BA, and Grappolo – GR) came from the extraction of extra virgin olive oil by cold processing at the Universidade Federal dos Vales do Jequitinhonha e Mucuri, Campus JK, in Diamantina, Minas Gerais, Brazil (18° 12′ 3″ S, 43° 34′ 31″ W).

2.2. Moisture and ethereal extract

Moisture and ethereal extract determinations were performed according to the Association of Official Analytical Chemists (7), methods No. 920.151 and No. 948.22, respectively.

2.3. Bagasse drying

The drying tests were carried out using the TE-394/1 air circulation and renewal oven (Tecnal, Piracicaba, Brazil), with a constant air circulation speed equal to 1 m s^{-1} and temperatures defined by a completely randomized design, equal to 40, 60, and 80 ºC. The samples (mass of 70 g and thickness of 1 cm) were arranged in rectangular aluminum shapes measuring 200 mm in length and 60 mm in width, resulting in a surface area of 0.012 m^2. The average ambient air temperature ranged from 19 to 21 ºC and the relative humidity of 70% during the drying period. The samples were removed from the oven to check the mass, at 5-minute intervals during the first hour and every 15 minutes during the two subsequent hours, totaling 3 hours of drying. Dryings were performed in three replications.

2.4. Drying kinetics

The drying kinetics was calculated from the experimental data obtained in the drying process as described by Montero et al. (8).

2.5. Average drying speed

The average drying speed (R) was determined according to Foust (9).

2.6. Statistical analysis

Analysis of variance (ANOVA) and the Scott-Knott mean test were used to compare the experimental data and determine the existence of significance between the different means ($p<0.05$).

RESULTS AND DISCUSSION

The changes in the experimental values of the moisture ratio as a function of drying time for the four olive pomace samples at the three temperatures used (40, 60 and 80 ºC) were plotted and are shown in Figure 3.1.

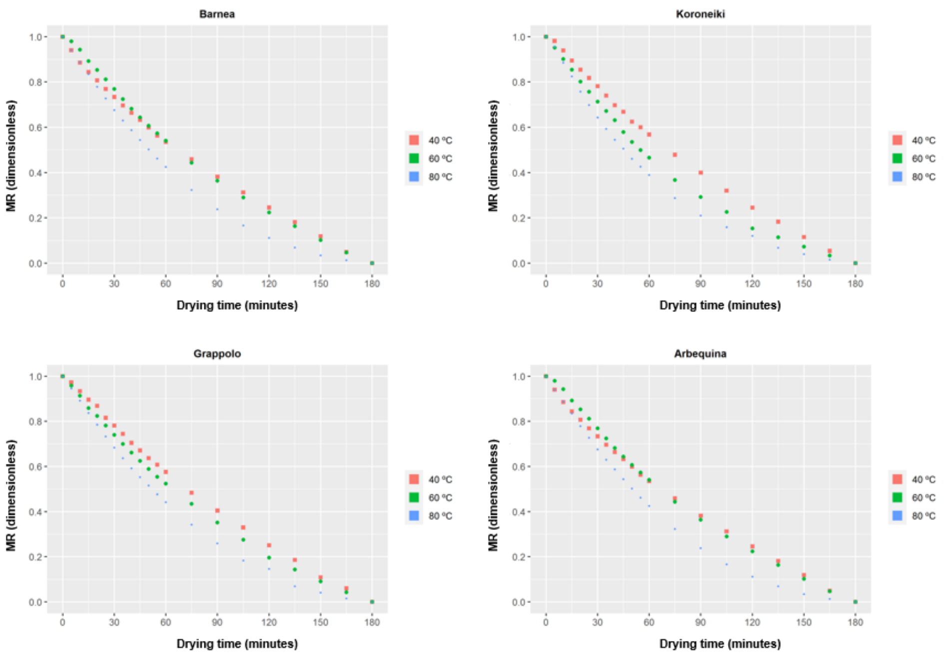

Figure 3.1. Moisture ratio (MR) as a function of drying time for olive pomace varieties.

As seen in Figure 3.1., the moisture content continuously decreases as a function of drying time and the total drying period decreases with increasing temperature. Similar effects of the effect of temperature on drying kinetics were reported by Mphahlele, Pathare, and Opara (10) (pomegranate peel), Goula et al. (11) (olive pomace), Prithani and Dash (12) (kiwi), Goula, Thymiatis and Kaderides (13) (grape pomace).
Figure 3.2. presents the drying rate as a function of the moisture ratio present in the samples. These diagrams demonstrate the periods present during the drying process. A typical drying kinetics profile can present three characteristic periods (9): non-permanent regime period, constant rate period, and decreasing rate period.

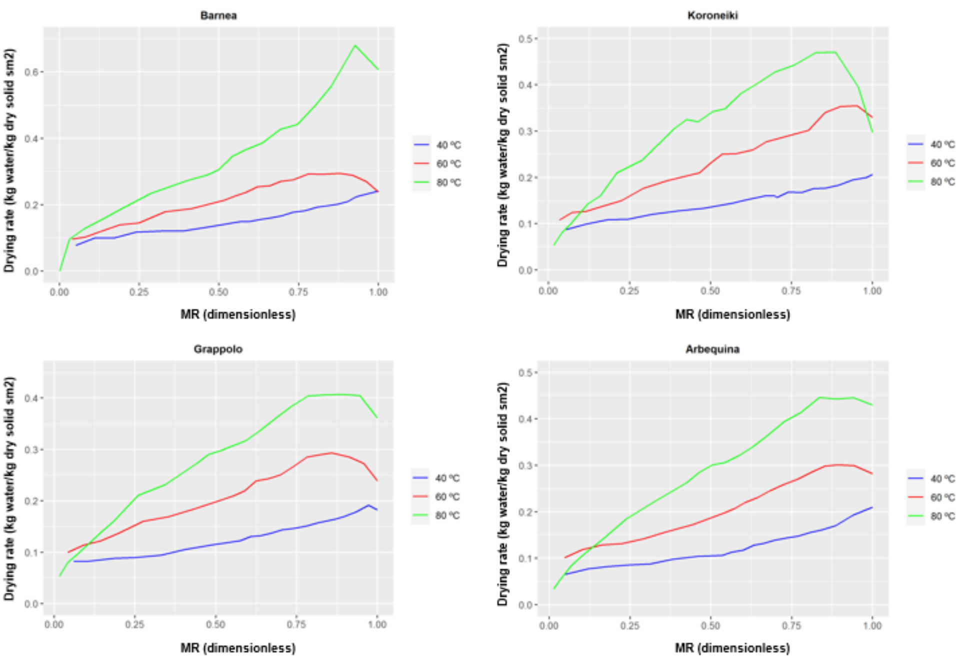

Figure 3.2. Drying rate curves as a function of moisture ratio (MR) at air-drying temperatures of 40, 60 and 80 ºC.

For the analyzed samples, it was possible to identify an initial period of drying with a non-permanent regime and a decreasing rate period. The constant rate period was short or imperceptible for all varieties and at the three drying temperatures used. For all samples, the decreasing rate period started with moisture ratios greater than 0.75.

Regarding the average drying speed during the decreasing period, as expected, higher drying air temperatures are related to higher drying speeds. With increasing temperature, it was possible to double the drying rate. At 40 °C the speeds varied from 20.44 to 25.70 kg/h.m², at 60 °C from 32.49 to 34.27 kg/h.m² and at 80 °C from 39.36 to 41.92 kg/h.m², among the different cultivars.

Temperature significantly influenced the moisture decrease in all olive pomace varieties ($p<0.05$). The drying temperature equal to 80 ºC was the one that decreased the moisture contents most intensely for all samples, as can be seen in Table 3.1. The drying time equal to 180 minutes resulted in moisture values equal to 0.67, 6.24, 0.68, and 4.53 %, on a wet basis, for the Arbequina, Koroneiki, Barnea, and Grappolo varieties, respectively.

Table 3.1. Initial and final moisture and lipid content of olive pomace.

Variety	Arbequina	Koroneiki	Barnea	Grappolo
Initial Moisture (%)	35,34±0,74	41,24±0,10	37,49±0,71	39,39±1,72
Lipids (% db)	16,09±0,42	19,49±1,38	11,88±0,58	15,06±1,83
Temperature (ºC)	Final Moisture (% wb) after 180 minutes			
40	21,34±1,44[a]	24,78±3,87[a]	17,17±1,75[a]	25,24±1,99[a]
60	8,82±2,36[b]	11,79±5,26[b]	3,72±1,31[b]	12,87±1,21[b]
80	0,67±0,51[c]	6,24±0,58[b]	0,68±0,68[c]	4,53±0,60[c]

* Results expressed as mean ± standard deviation (n=3). db: dry base. wb: wet base. Different lowercase letters superscript in the column indicate a significant difference between the temperatures by the Scott-Knott test ($p<0.05$).

The reduction in moisture is also influenced by the amount of lipids remaining in the pomace; because they have a hydrophobic character and change the sorption and desorption capacity of foods. The lower the lipid content, the easier it is for the product to lose water. The existing hydrophobic interaction between the lipid components forms a barrier that hinders the migration of water from the interior to the surface of the material (14; 15).

This is probably the reason why the olive pomace from the Barnea and Grappolo samples, which have the lowest residual lipid values (11.88 and 15.06 %, respectively) (Table 3.1.), reached the equilibrium moisture value at 150 minutes of drying for a temperature equal to 80 ºC (Figure 3.1.). Therefore, due to the lower final moisture values reached and higher drying speeds, the temperature of 80 ºC was defined as the most suitable drying temperature for the process.

CONCLUSION

The results showed that the moisture content of the four varieties studied decreased significantly with increasing drying temperature. The temperature equal to 80 ºC resulted in lower values of final moisture of bagasse in the same drying period and higher drying speeds, being considered the most suitable drying temperature. The lipid content also had an influence on the drying process.

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