

Effect of drying on the properties of pears *cv. D. Joaquina*

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Resumo

O presente trabalho teve como objectivo proceder à secagem, a 60 °C e 70 °C, de peras do cultivar D. Joaquina e avaliar o conteúdo de humidade, a cor, os compostos fenólicos totais e a capacidade antioxidante da pêra em fresco e durante o processo de secagem.

Em relação à cor não se observaram diferenças significativas no valor dos parâmetros da cor da pêra secada a 60 °C e a 70 °C. Por outro lado, a secagem induziu um aumento gradual dos parâmetros a* e b* durante o processo, tornando os frutos mais avermelhados e amarelados do que a pêra em fresco.

A secagem conduziu a uma diminuição aproximadamente igual dos compostos fenólicos totais para a temperatura de 60 °C e 70 °C. Por outro lado, o valor dos compostos fenólicos totais que foram quantificados na fase inicial do processo manteve-se praticamente inalterado até ao fim da secagem.

No que respeita aos compostos antioxidantes observou-se uma diminuição superior a 50 % da quantidade presente nas peras em fresco, independentemente da temperatura.

Palavras chave: pera, secagem, cor, compostos fenólicos totais, capacidade antioxidante

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Abstract

In the present work, pears of the Portuguese cultivar, *cv. D. Joaquina*, were dehydrated by hot air drying at temperatures of 60 °C and 70 °C. Drying properties such as moisture, color, antioxidant activity, and total phenols content were evaluated.

The drying temperature induced the increase of a* and b* colorimetric parameters, due to non-enzimatic browning reaction which turns the dried fruits more reddish and yellow.

The obtained results lead to the conclusion that total phenols content decreased with drying, but the observed values were similar to the pears dried at 60 °C and 70 °C.

Furthermore, the results also indicate that antioxidant compounds might be degraded or modified during the drying process. In addition, a decrease of more of 50 % was observed in the fruits dried at 60 °C and 70 °C.

Keywords: pears, dried, color, phenolic compounds, antioxidant activity.

Introduction

The pear (*Pyrus communis* L.) is a typical fruit of temperate zones and is cultivated in Europe, among other regions. Due to its nutritive properties, good taste and low caloric level, the pear is a much appreciated fruit by the consumers. It has a low content of protein and lipids and is rich in sugars such as fructose, sorbitol, sucrose, and, in lower amount, glucose (Barroca et al., 2006; Senser et al., 1999). These fruits also possess others nutritional components such as vitamins, minerals and antioxidants as

well as bioactive elements, that are important sources of healthy-beneficial compounds (Senser et al., 1999; Silos-Espino et al., 2003). The pear also has a potential source of dietary fibres, and, in particular case of four small varieties of Portuguese pears, the values of dietary fiber ranged between 12 and 15% (dry mass) (Barroca et al., 2006).

The fruits and vegetables are also the major source of phenolic compounds in the human diet that possess a considerable interest due to their antioxidant capacity. The pears are rich in simple polyphenolic structures, among which it is worthwhile to emphasize the presence of arbutin (hydroquinone) and hydroxycinnamic acids with chlorogenic cumaric (esterified with quinic acid) as the prevailing acids. It is also possible to find flavonoids structures composed of flavan-3-ol structures and flavonols with their structurally related glycosides. Thus, (+) catechin and (-) epicatechin were identified by different authors. The flavonoles composition in pear samples includes quercetin, kaempferol, and isorhamnetin glycosides (Escarpa and Gonzalez, 2001; Fu et al., 2011).

Pears are fruits with a low antioxidant capacity compared to pigmented fruits, but they have a higher antioxidant activity than many common vegetables (Kevers et al., 2011; Oms-Oliu et al., 2008). However, the contribution of pears to the intake of antioxidants can be substantial in European countries where the annual consumption per capita is high (Kevers et al., 2011).

Although pears can be consumed fresh they are also commonly submitted to processing techniques such as drying. This process is one of the most important techniques for food preservation because the moisture content is intensively reduced. The water activity strongly influences the type and intensity of the deterioration reactions that may occur in food materials, and, therefore, reducing their water content allows a better preservation, since the material no longer constitutes an appropriate substrate for the growing of bacteria and starches or even for the occurrence of enzymatic modifications.

The tradition in the Beira Alta region of Portugal is to sun-dry a small variety of pears (S. Bartolomeu) resulting in a small sun-dried pear that is very appreciated in Portugal (Guiné and Castro, 2002; Guiné, 2011). Due to the disadvantages of direct sun exposure method Guiné et al. (2011) concluded that others methods of drying, including the convective drying, can be used to produce products with similar properties to the traditional ones. In addition, due to the decrease of production of S. Bartolomeu cultivar, other small pears variety, such as D. Joaquina, among others, are gaining importance on the market and also exhibit good drying features.

The aim of this study was to dehydrate pears (cv. D. Joaquina) at 60 °C and 70 °C, and evaluate properties such as moisture, color, antioxidant activity and total phenols content along the drying process.

Material and Methods

The pears used in this study are a regional variety of a Portuguese cultivar, cv. D. Joaquina. The pears were obtained from a local supermarket and were peeled prior the drying process. The fruits were sliced and the drying process was carried out in a convective drying at temperatures of 60 °C and 70 °C and with air flow of 0.5 m/s. Along drying were evaluated the moisture content, the color, the antioxidant activity, and the total phenols content.

The CIELAB color space was used and the parameters that were measured were L*, a*, and b*. L* is luminosity (0 = black and 100 = white) and the coordinates of opposing color are a*, that assumes negative values for green and positive for red; and b*, which is negative for blue and positive for yellow. For all the determinations a colorimeter chroma meter CR-400 was used.

The phenolic compounds were obtained from fresh and dried pears by successive extractions with methanol (3x1h) and acetone/water (3x1h), performed with the aid of an ultrasonic bath. Total phenolic composition was determined according to the Folin-Ciocalteu method using gallic acid as a standard. The results were expressed as milligrams of gallic acid equivalents (GAE) per gram of dried sample mass.

All extracts were characterized in terms of total phenolic content and antioxidant capacity (ABTS assays) according to Gonçalves et al. (2005).

Results and Discussion

Figure 1 shows the profile of moisture content of the pear slices along the drying at 60 °C and 70 °C. To obtain a very low value of moisture it was necessary a drying time of 3h45min and 6h for 60 °C and 70 °C, respectively.

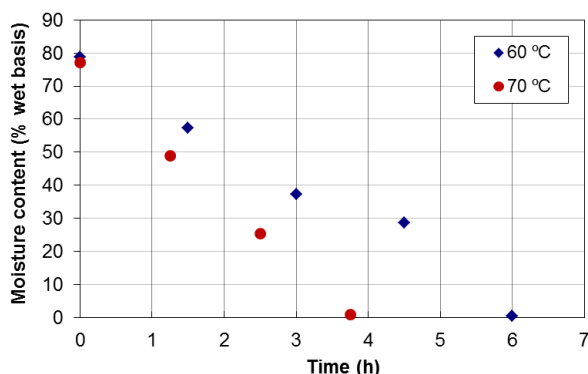


Figure 1. Evolution of moisture profile of pears along drying at 60 °C and 70 °C.

Figure 2 reveals the variation of the color parameters of the pears with time for the drying carried out at 60 °C and 70 °C. As it can be seen, the value of L* (lightness) decreases from 72 (fresh) to 64 (end of drying), showing that the pears become darker with drying but in small extension. The value of a* increases from -1.9 to 6, revealing that a very slight green tone evolves to a red tone. The parameter b* changes from 18 to 30 with drying, highlighting that drying induces an increase in the yellow intensity. The values of the coordinates for the temperature of 70 °C present a similar behavior in relation to the change of color along drying. The conjugation of the red and yellow with the darkness associated to the L* parameter gives place to a reddish-yellow color in the dried pears.

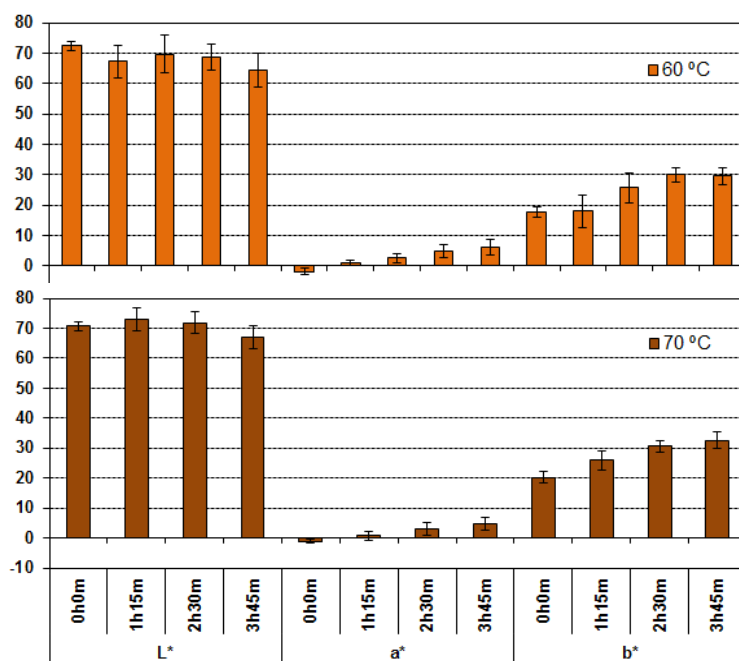


Figure 2. Color coordinates along the drying at 60 °C and 70 °C.

Figure 3 shows the amounts of total phenolic content expressed as milligrams of gallic acid equivalent (GAE) per gram of dry material of D. Joaquina pears (fresh state and dried at 60 °C and 70 °C) to the different extracts of methanol and acetone. The first extract of fresh pear with methanol contains 2.79 ± 0.52 mg GAE/g (d.b.) which corresponds to 75% of the phenolic compounds presented in the three extracts with this solvent. With respect to the extracts with acetone, it is possible to conclude that the phenolic compounds quantified on each extract (E4, E5 and E6) are nearly 33% of the total value in acetone extracts (2.41 mg GAE/g (d.b.)). This value is nearly in accordance with the initial phenolic content of 254.90 ± 9.10 mg GAE/100 g d.b. to fresh pear (cv. Conference) using acetone as solvent (Mrad et al., 2012). The large content of phenolic content in acetone extracts (after three extractions with methanol) reveals that the two solvents dissolve different kind of phenolic compounds presented in the fresh pear. Fu et al. (2011) quantified the total phenolic contents to four different pears (Australian, fragrant, honey and royal) ranged between 11.88 mg GAE/ 100 g wet basis and 68.06 GAE/ 100 g wet basis. Values ranged between 302.3 mg GAE/ 100 g wet basis and 458.2 mg GAE/ 100 g wet basis were found in Conference, Forelle and Peckham's pears cultivars (Imeh and Khokhar, 2002). The total phenolic value in the six extracts to D. Joaquina pears is 185.74 GAE/ 100 g wet basis. The results clearly emphasize the existence of wide variations among the cultivars of pears. After the first hour of drying the phenolic content reduces significantly, but the values remain almost the same at the end of drying, independently of the temperature. This result suggests that compounds might be degraded or modified with temperature. In fact, and according with Martín-Cabrejas et al (2009), the decrease of phenolic compounds during drying can be attributed to the binding of polyphenols with other compounds (proteins) or to alterations in the chemical structure of polyphenols which cannot be extracted or determined by available methods. The degradation of phenolic compounds can be attributed either to the extent of drying time and to the higher temperature. However, the increase of temperature to 70 °C, with the corresponding decrease in drying time, allows total phenolic compounds similar to the ones observed at 60°C.

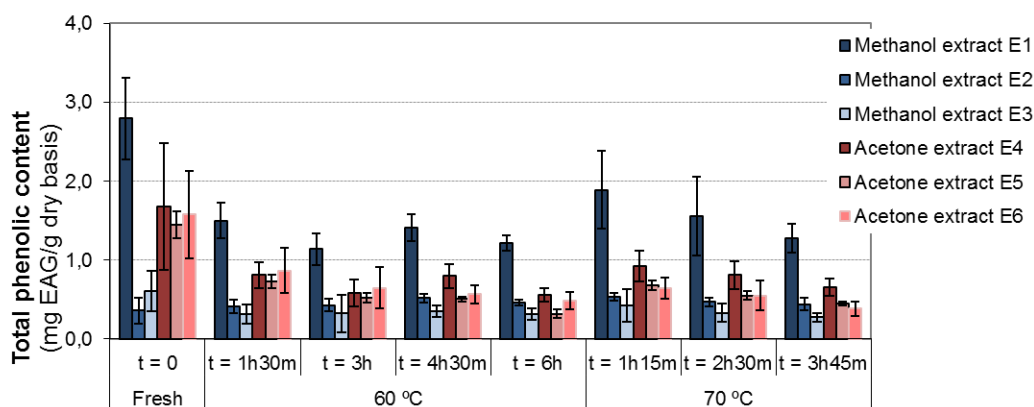


Figure 3. Total phenolic content (mg GAE/g db) in the fresh and dried pears (60 °C and 70 °C).

Trolox equivalent antioxidant capacity (TEAC) assay is based on the ability of the antioxidant to scavenge ABTS radicals and according to Cai et al. (2004), Gan et al. (2010) and Re et al. (1999) it can measure antioxidants capacities of lipophilic and hydrophilic compounds. The antioxidant capacity of the three extracts of methanol and acetone was 12.3 and 11.5 μmol Trolox/g d.b., respectively, which corresponds to values of 2.7 and 2.5 μmol Trolox/g wet basis (Figure 4). This antioxidant capacity in the range of TEAC values varied from 0.84 ± 0.03 to 4.30 ± 0.06 μmol Trolox/g wet weight to four different pears varieties (Fu et al., 2011). Fruits rich in hydroxycinnamate, such as pears, consistently have lower antioxidant activities when compared with fruits and vegetables rich in anthocyanins, flavanones, and flavones (Höner and Cervellati, 2002). In fact, Li et al. (2012) concluded that pears with high total phenolics and total flavonoids contents had significantly higher antioxidant than those of other species and anthocyanins were correlated to antioxidant capacity in

pears. Drying promoted a significant decrease of about 50 % of the antioxidant capacity to both temperatures at the end of the process. In extracts with methanol and acetone, the decrease of this compounds are slightly higher than 50 % and 60 %, respectively, in the end of the process. In addition, the degradation or modification of the antioxidant compounds occurred in the early stages of the drying process at both temperatures. After the first sample of dried pears the antioxidant compounds decreased much more slowly. The results suggest that the antioxidant compounds of the pears have low resistance to heat degradation.

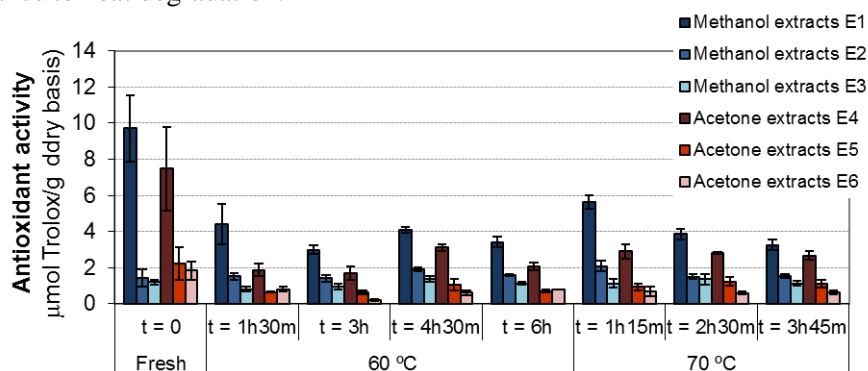


Figure 4. Antioxidant capacity ($\mu\text{mol Trolox/g db}$) in the fresh and dried pears (60 °C and 70 °C).

The correlation between the total antioxidant capacities and the total phenolic content in extracts of methanol (E1+E2+E3) and acetone (E4+E5+E6) is shown in Figure 5. The results reveal a good correlation between TEAC value and the total phenolic compounds in fresh and dried samples suggesting that phenolic compounds could be the main components responsible for free radical scavenging ability of pears.

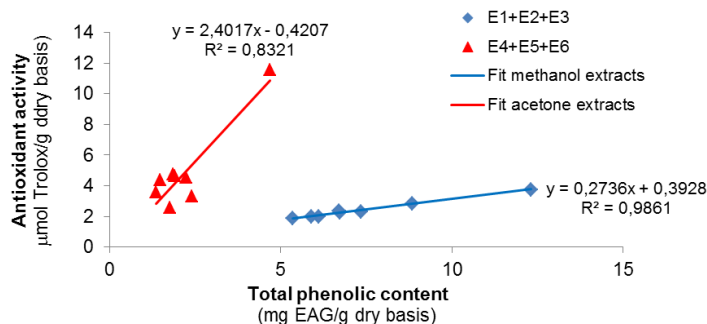


Figure 5. Correlation between the antioxidant capacities and total phenolic content of D. Joaquina pears.

Conclusions

In the present work, pears of the Portuguese cultivar D. Joaquina, were dehydrated by hot air drying at temperatures of 60 °C and 70 °C. Drying properties such as moisture, color, antioxidant activity, and total phenols content were evaluated.

The drying temperature induced the increase of a^* and b^* colorimetric parameters, due to non-enzymatic browning reaction which turns the dried fruits more reddish and yellow.

The obtained results lead to the conclusion that total phenols content decreased with drying, but the observed values were similar for the pears dried at 60 °C and 70 °C.

Furthermore, the results also indicate that antioxidant compounds might be degraded or modified during the drying process. In addition, a decrease of more of 50 % in the antioxidant capacity was observed in the dried fruits at both temperatures (60 °C and 70 °C).

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