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Properties of pears dried with different drying processes

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Abstract: Pears of S. Bartolomeu variety have been used over the years in Portugal to produce a traditional dried pear using the cheapest practice with environmental friendly characteristics: open-sun drying. However, the obvious disadvantages concerning the drying efficiency and safety of the dried product have been an incentive to design or improve solar drying methods as an alternative to the traditional one.

The present work has tested three types of drying processes, namely solar stove, solar drying and tunnel drying. In addition, the efficiency of drying and the properties of the dried pears were compared with the traditional dried fruits. The results of the tests have allowed us to conclude that all methods have lead to a considerable reduction in drying time as compared to open-sun drying. Indeed, the drying time for the solar stove and the solar dryer showed a reduction of 40% while in the drying tunnel this reduction increased to 60%. In addition, it was also possible to conclude that the properties of the dried pears obtained by the three processes correspond to a dried fruit similar to the traditional dried pears.

Thus, based on these results, it can be inferred that the traditional sun drying at open-air can be replaced by either of the processes tested in the present study, which, allow a higher drying efficiency associated to a higher safety of the dried food, while maintains the properties of the traditional food product.

Keywords: dried pear, solar drying, solar stove, tunnel drying, chemical properties.

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 well appreciated fruit by the consumers. Although pears can be consumed fresh, they are also commonly submitted to processing techniques as the conserves in syrup, purées for use in nectars, yogurts and drying (1).

The tradition in the centre of Portugal is to sun-dry a S. Bartolomeu variety, resulting in a small sun-dried pear that is very appreciated in this country. The traditional solar drying method, which is based on an open-air exposure, provokes changes in taste, colour, flavour and texture which results in a reddish brown pear that looses its pronounced astringency and gets distinctive organoleptic characteristics in terms of texture, taste, colour and flavor (2). Additionally, this variety of pears constitutes a potential source of dietary fibre since it has 12% of total dietary fibre (3).

The traditional solar drying consists in leaving the uncut and peeled pears at direct exposure in open fields (5-6 days) followed by a period of 2 days where they are taken out of the sun at the hottest hour of the day and muffled in barrels or baskets. Next, the pears are flatted by a compression on both sides changing their spherical shape to flat-pressing form. After this, they are left again in direct sun exposure for 2-3 days (4). Despite the scarcity of equipment used within this method the labour that is involved is quite considerable.

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Nowadays, the open-air drying method is being substituted by drying in solar stoves, taking advantage of the lack of cost of solar energy. At the same time, such method allows the production of dried fruits of higher safety since the problems associated to lack of hygiene are minimized. Additionally, there has been an increasing interest to develop industrial or semi-industrial driers, which allow an important reduction in the drying time, while maintaining all the advantages discussed above.

The purpose of the present work was to study alternatives to the traditional air drying of pears and to analyse their effect on the reduction of drying time and on the chemical and physical properties of the dried pears. The pears were dried in three different drying systems beyond the traditional open-air drying: (i) solar stove (length=3.2 m, with=1.9 m, height=2m in the center and 1.3 at the sides) with convective air drying promoted by a fan. The structure is aluminium and is completely enclosed in 3 mm greenhouse glass. A hygrometer was placed inside the stove to register the temperature and relative humidity at 10 minutes intervals; (ii) solar dryer with natural ventilation and with dimension structure of 990×595×375 mm enclosed with glass. The system is equipped with two trays at 5 cm and 20 cm of the bottom, with thermocouple and online weight data acquisition; and (iii) tunnel drying with a net dimension of 40×60cm, equipped with two trays of polyethylene and a balance to measure continuously the weight of the batch of pears. The air is heated by an efficient design of a low-cost solar collector and the temperature was controlled to 40 ºC and air velocity of 1.1 ms^{-1}

Materials and Methods

Pears of the S. Bartolomeu variety were purchased to a farmer in Venda de Galizes, being harvested on a ripening stage previously defined by other studies (5). The ripening of the fruits was periodically controlled by moisture, acidity, total soluble solids (TSS), and hardness. The fresh pears used in this study have the following properties: moisture (wet basis) = 81 %; acidity = 20.9 cm^3 NaOH/ 100 g dry solids; total soluble solids = 50.6 g/100 g dry solids, and hardness = 74.1 N. These results were obtained by a sample with 20 fresh pears. The size of the fresh pears presents some variability and therefore the pears under study were selected to have a medium diameter of approximately 4-5 cm and a mass in the range of 40-60g.

The drying process carried out in the three drying systems began at the same time and the peeled and uncut pears were left over nylon nets placed 50 cm above the bottom on the solar stove, and on the trays inside the solar drier and tunnel drier. The drying was undertaken with approximately 200, 50 and 120 fresh pears, respectively for the solar stove, solar dried and tunnel drier.

Periodically, two pears from each drying process were taken randomly to analyze their properties. The drying process was finished when the final water content of the pears reached approximately 20% (wet basis), since this is the value that allows good preservation characteristics. The dried pears were then stored in plastic bags and refrigerated at 4 ºC.

Moisture content of the pear pulp was quantified with a Halogen Moisture Analyzer (Mettler Toledo HG53). Total soluble solids and acidity were estimated according to previous established methodologies (6). The hardness of the peeled fresh pears was determined by a presser tester with 8 mm of diameter. All the properties were determined in duplicate both to fresh and dried products.

Results and Discussion

Figure 1 presents the profile of moisture (wet basis) of the pears along drying in the solar stove, solar drier and tunnel drying. The results show that the method of drying under solar radiation (solar stove and solar drier) do not follow a monotonously behavior as the drying on tunnel with controlled conditions of temperature and air velocity. In fact, the evolution of moisture of the pears dried under incidence of solar radiation can be justified by the changes of climatic conditions along drying. The larger dimensions of the solar stove, when compared with the solar drier, can also lead to more pronounced variations in the moisture of pears during drying.

The methods with direct incidence of sun on glass allow a decrease in drying time of up to 4 days whereas in the tunnel drying that decrease is of 6 days, when compared with the drying time of open sun drying, which is of approximately 10 days. The faster drying of pears inside the tunnel dried is due to the fact that the temperature is maintained constant at 40 ºC along drying while the temperature inside the solar stove or solar drying is dependent of the hour of the day, and temperatures higher 40 ºC are reached only at few hours of the day.

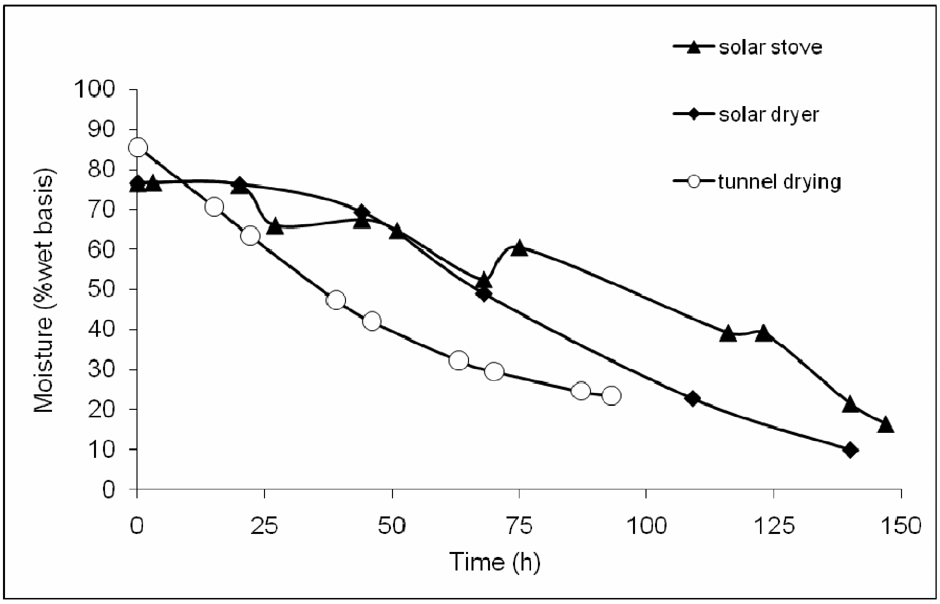

Figure 1 – Profile of moisture for the different drying processes.

Figure 2 shows how the relation TSS/Acidity changes along drying in the three processes. The TSS/Acidity along drying presents some variability, which is a result of the heterogeneity in the fresh pears, as it is typical in agricultural foods. Due to the longer drying time, the final dried pears from the solar stove and the solar drier show a higher TSS/Acidity reason.

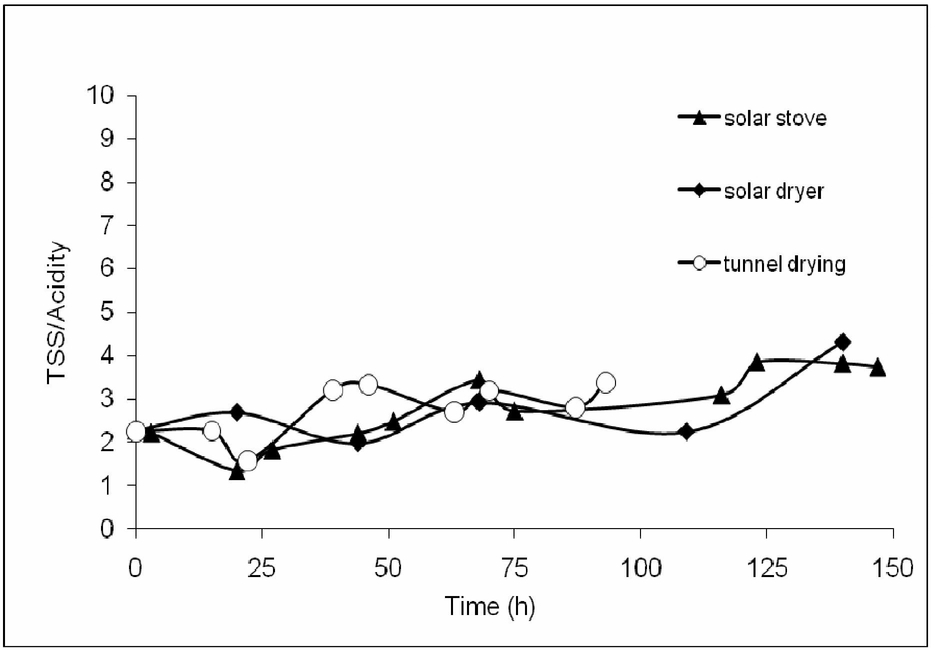

Figure 2 – TSS/Acidity ratio along the pears drying in solar stove, solar drier and drying tunnel.

As referred, due to the non homogeneous size of the fresh pears, the pears dried by the traditional method were divided in two sets, and the properties of each lot were analyzed. Set 1 corresponds to pears with mass and size similar to those obtained with the drying processes under study and set 2 are pears with higher values of size and mass. The properties of the pears obtained through the open drying method are illustrated in Table 1 and highlight that the drying process allows a decreasing in all properties analyzed as compared with the fresh state. The decrease in the acidity of dried pears can, eventually, indicate that a major part of acidity that is present in fresh pears is volatile and therefore the high levels of temperature in the process promote its evaporation.

Table 1 – Properties of the traditional dried pears.

	Set 1	Set 2
Moisture (% wet basis)	18.1	20.1
Acidity (cm^3 NaOH/100 g dry solids)	13.9	7.9
TSS (g/100 g dry solids)	34.9	39.2
Hardness (N)	65	56
aw	0.53	0.53

The comparison of both sets of traditionally dried pears has allowed us to conclude that smaller pears have a lower decrease of acidity and a higher reduction in total soluble solids. The set of pears of higher size has a TSS/acidity reason double of that of the smaller ones.

The water activity results (Table 1) have permitted us to infer that sun dried pears are potentially safe, since the value of this parameter and the microbial charge in this variety of dried pears suggest that this dried fruit is a safety food (3). In addition, Rao and Rizvi, 1986 argued that dried fruits with water activity in the range 0.72–0.8 are largely protected against microbial spoilage.

The properties of pears dried in solar stove, solar drier and tunnel drying are presented in Figure 3. To ensure the shelf stability of the dried fruits, the moisture content was reduced to less than 20 % in all the three methods of drying. The results highlight that the values of acidity and total soluble solids are similar in the different processes of drying tested, and are also analogous to those of the traditional open sun drying. However, the value of hardness of the open sun drying pears is much higher than the hardness of pears dried in the tunnel. The hardness of the dried pears in the solar stove and the solar drier was not measured.

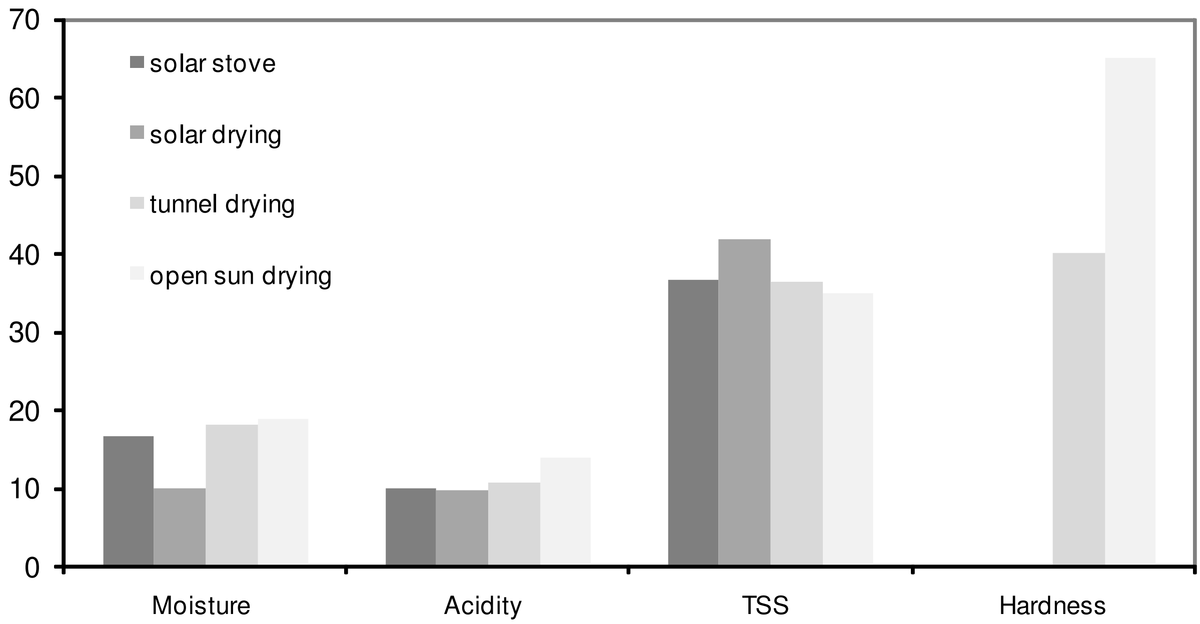

Figure 3 – Moisture, acidity, total soluble solids and hardness of pears dried in open sun drying, solar stove, solar drying and tunnel drying.

The results obtained, not considering hardness, enabled to conclude that pears dried by the three alternative methods studied have a chemical composition comparable to those of the traditional open sun drying.

Conclusions

Pears of the S. Bartolomeu variety were dried, at the same time, in a solar stove, solar drier and a drying tunnel and the efficiency of drying and the chemical composition of the final product was compared with the traditional ones. The results indicated that the drying time was reduced to 40% in the solar stove and solar drier and 60 % in the tunnel drying as compared with traditional open sun drying.

The profile of TSS/acidity ratio presents some variability along drying in the three methods, and the dried pears obtained through the solar stove and solar drier present a higher value of total soluble solids/acidity ratio. This can be due to the larger drying time in these methods, when compared with the tunnel drier. In addition, all the three drying processes maintain the chemical characteristics of the dried pears similar to those of the traditional pears and potentially produced foods of higher safety.

From the results presented it was possible to conclude that the solar stove, solar drier or drying tunnel could be an alternative to the traditional sun-drying process used in Portugal to dry the S. Bartolomeu pear.

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