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Evaluation of the colour of pears dried using different methods

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Abstract

Pears of the variety S. Bartolomeu (Pyrus communis L.) have been used over the years in Portugal to produce a traditional dried pear known as "pera passa". It is a very much appreciated dried fruit, despite the drop in the production that has occurred during the past years. The processing comprehends a solar drying performed at open air, with obvious disadvantages, either concerning the drying efficiency or the sanitary quality of the final product, taking into account that the products are exposed to multiple contamination agents. Obviously, these handicaps do not guarantee the necessary quality and sanitary standards for commercialization. Therefore, in the past years some work has been done in order to encounter alternative reliable drying methods that can replace the traditional drying. These include the use of solar stoves, either with forced air convection or with natural convection, and a drying tunnel with air heated though a solar collector. However, not only the drying efficiency and economic or sanitary aspects matter in the present case, since this particular product is very much appreciated for its unique colour. In fact, these pears in particular, when dried by the traditional method, develop a reddish colour that is not found in other varieties of pears, and this aspect constitutes one of the quality parameters for their acceptability by the consumers.

In this work, pears of the variety S. Bartolomeu were dried in four different drying systems: (a) following the traditional open air sun exposure method, (b) solar stove with forced convection (STFC), (c) solar stove with natural convection (STNC) and (d) drying tunnel (DT), and their colour was measured. From the results obtained, it was possible to see that both solar stove systems present similar colour difference values, much lower that that obtained for the drying tunnel, thus allowing to conclude that this last method is not so advisable.

Keywords: Pear, colour, drying, dried pear.

1. Introduction

Open-air sun drying is the oldest method used to dry foods, being still used today to dry many agricultural products in areas where the combination of solar radiation, temperature and relative humidity is adequate. However, in spite of being a cheap method, the open-air natural sun drying is not always applicable to large-scale production (1). Furthermore, the product quality can be quite compromised, since the foods are exposed to many potentially contaminating agents, such as dust or animals, or even deteriorating factors like adverse weather conditions, such as rain or night moist (2, 3).

In Portugal pears of the variety S. Bartolomeu (*Pyrus communis L.*) are dried using a traditional complex solar drying methodology, based on an open-air sun exposure (3, 4). Even though it is quite a cheap drying method, because it uses the sun as energy source, it has the disadvantages of the open-air exposure, associated to those of the weather dependence. Therefore, alternative drying methods have been tested to dry there pears, namely using a solar stove or a drying tunnel with air heated through a solar collector. These allow conciliating cheapness of the energy source with the improvement in quality by protecting the fruits against external dangers.

The traditional dried pears of this particular variety, present a very characteristic reddish-brown colour, resembling the colour of paprika, which is absolutely unique among dried pears. This is why

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the implementation of alternative drying methods must not influence significantly the colour of the product, so as to maintain its characteristics and therefore acceptance.

Humans perceive colour in the retina of the eyes through wavelengths coming from the surface of the objects (5). When light reaches a food, part is absorbed, another part is reflected and finally another part is transmitted, all these in different proportions according to the surface characteristics of the food. The reflected light is the one responsible for the colour of the food. This is why factors such as source and amount of light or even angle of observation exert some important influence on the appearance of the foods (6). Despite these factors, instruments for standard colour measurements correspond to visual perceptions of the food colour, and therefore, constitute a critical objective parameter (7). In this way, it can be used as a quality index or for the determination of conformity of food quality to specifications. Furthermore, it can be used to analyse the changes originated by food processing operations, packaging or storage, among others (7).

Different colour scales can be used to describe the colour of objects, being the Hunter colour *L*, *a*, *b* CIE system and Munsell colour solid the most used for the food industry applications (6).

One of the processing operations that greatly influences colour of foods is undoubtedly drying. Therefore, the evaluation of the colour of the dried fruits or during the drying process, assumes a pivotal role in determining the quality of these dried products.

The present work aims at comparing the colour of the pears dried by different methods, in order to evaluate which method allows the obtaining of a final product as much similar as possible to the traditional one.

2. Materials and methods

Pears of the Portuguese variety S. Bartolomeu were dried in four different drying systems: (a) following the traditional open air sun exposure method, (b) solar stove with forced convection, (c) solar stove with natural convection and (d) drying tunnel.

In all cases the pears were peeled, and dried uncut. In the traditional drying the pears were left at the sun during some days - the first drying period, and then were pressed and dried again for more 3 days. The drying conditions were weather dependent, and therefore not at all controlled. In the solar stove with forced convection and solar stove with natural convection systems, the temperature and relative humidity were also variable according to the weather conditions and night/day hours during the period of drying. However, in these cases the pears were protected against nigh moisture or rain. In the drying tunnel system, the temperature was kept constant at 40-42 ºC and the drying air velocity was always 1.1 m/s. In the solar stove with forced convection system the air velocity was also kept constant at 0.4 m/s.

The dryings finished when the pears reached the desirable moisture content of 20 % (wet basis). After drying 10 pears were analysed in terms of colour parameters. In some cases 10 measurements were done to each pear (solar stove methods, with forced and natural convection) and in other cases 6 measurements were done (traditional and drying tunnel). Colour measurements were done on the pears dried by the different systems with a colorimeter (Chroma Meter - CR-400, Konica Minolta). The illuminant used was D65 and the colorimeter was calibrated with a white standard tile.

The colour parameters for the colour change of the materials were quantified by the Hunter *L* (whiteness/darkness), *a* (redness/greenness) and *b* (yellowness/blueness) system. *L* values represent light–dark spectrum with a range from 0 (black) to 100 (white), *a* values represent the green–red spectrum with a range from -60 (green) to +60 (red) and *b* values represent the blue-yellow spectrum with a range from -60 (blue) to +60 (yellow). The values of *L*, *a* and *b* were also used to calculate the total colour change (ΔE), as a means of quantifying the deviation from the colour desired, i.e., the colour of the traditional product. Total colour difference was calculated using equation (1), where subscript “0” refers to the colour measurement of the reference material, which in the present case was the traditional dried pear. The greater ΔE, the greater is the difference in relation to the reference material.

$$\Delta E = \sqrt{(L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2} \qquad (1)$$

3. RESULTS AND DISCUSSION

Figure 1 shows the colour parameters (L, a, b) measured in ten pears dried following the traditional method. Each pear was analysed with 6 different measurements. From the results is possible to see that there are some differences among samples, and that these differences are greater with respect to parameter a (redness/greenness).

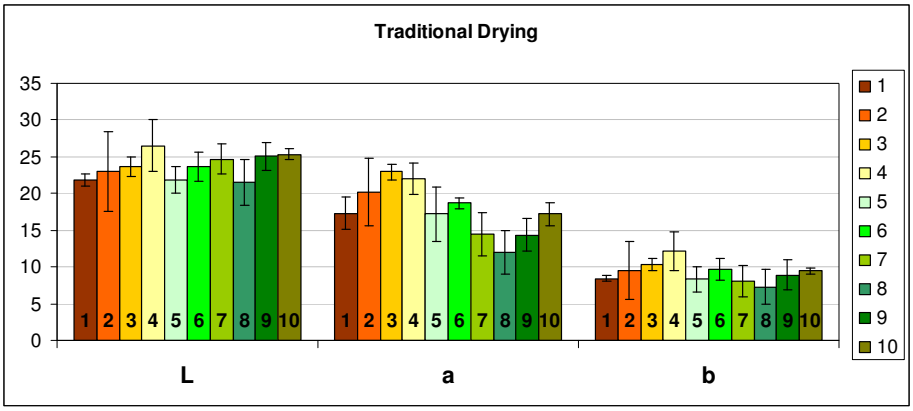

Figure 1. Colour parameters measured in ten pears dried following the traditional method.

Figures 2 and 3 show the colour parameters measured in the pears dried in the solar stove with forced and natural convection, respectively. In these cases 10 samples were analysed and 10 measurements were made in each pear. The results reveal a higher consistency in the measurements of colour parameter b (yellowness/blueness), and when compared to the traditional pears these results present themselves less variable.

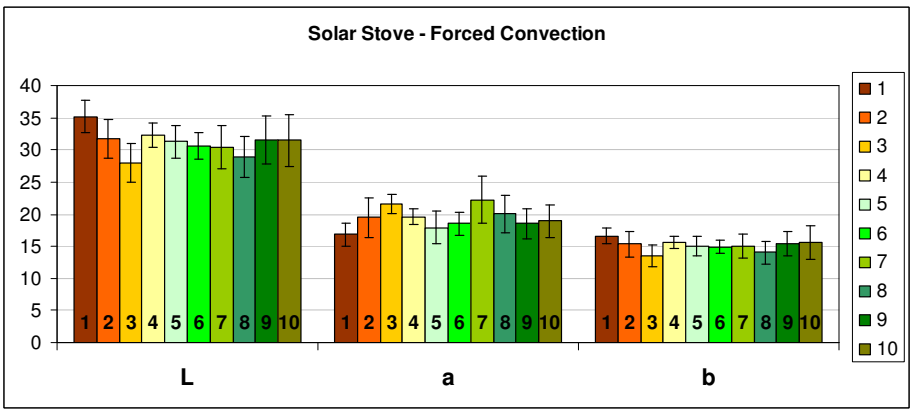

Figure 2. Colour parameters measured in ten pears dried in the solar stove with forced convection.

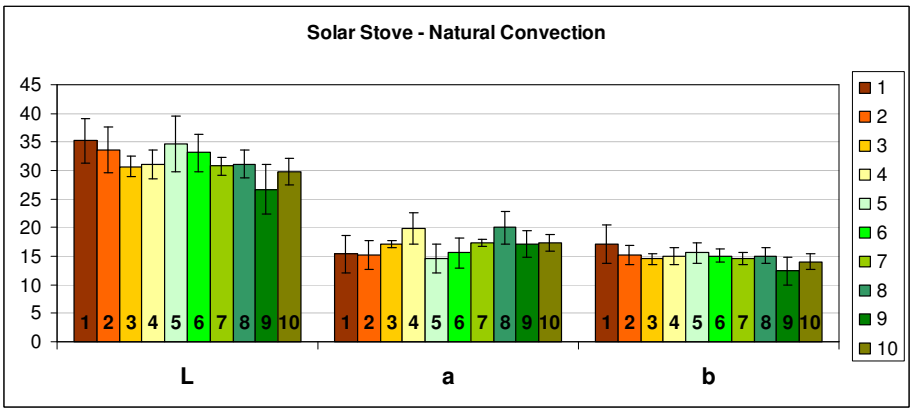

Figure 3. Colour parameters measured in ten pears dried in the solar stove with natural convection.

Figure 4 presents the colour parameters measured in the pears dried in the drying tunnel, having each pear been analysed with 6 measurements. The results tell us that the parameters a and b are quite regular in all samples analysed, and that the whiteness/darkness parameter (L) is the more variable.

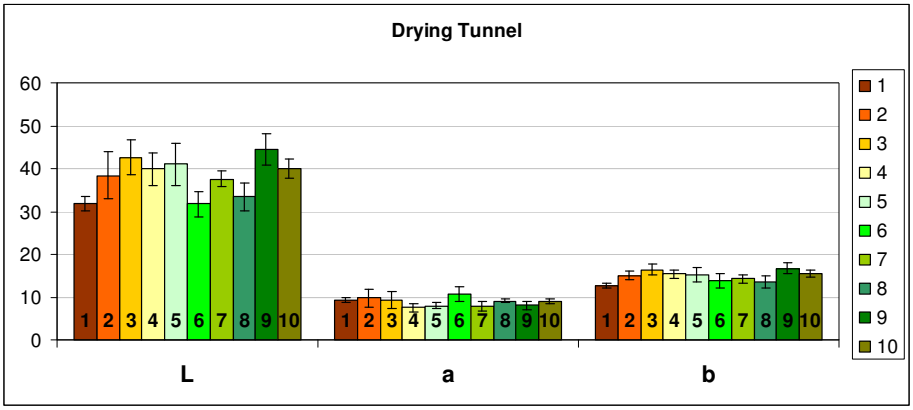

Figure 4. Colour parameters measured in ten pears dried in the drying tunnel system.

Figure 5 shows the medium values and standard deviations of the colour parameters fund for the pears dried under different systems. It is possible to observe that the two solar stove methods tested result in very similar products with respect to colour, whereas the drying tunnel produces clearer fruits (higher L) and less reddish (lower positive a). As to comparing with the traditional product (the reference), once again is the drying tunnel method the one which originates more different products, as it can be proved by the values calculated for the colour difference parameter ΔE, presented in Table 1. In fact, the colour difference is much higher in this case than in the two solar stove methods.

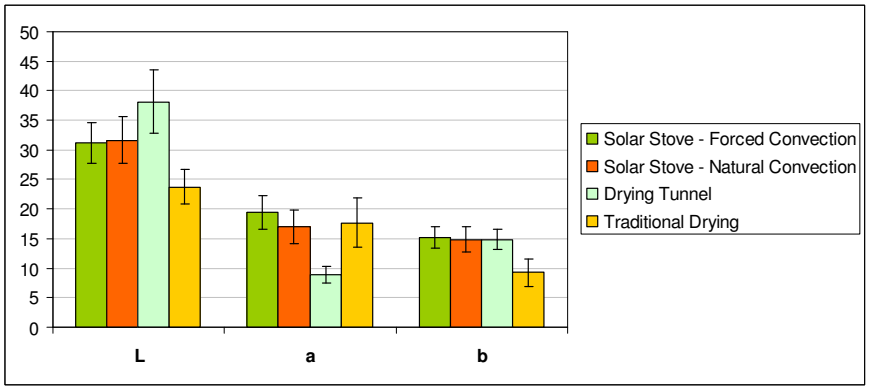

Figure 5. Comparison between colour parameters of pears dried under different methods.

Table 1. Medium values calculated for the colour parameters and colour difference in the different drying systems analysed.

	L_{med}	a_{med}	b_{med}	N	ΔE
Solar Stove - Forced Convection	31,15	19,36	15,11	100	9,64
Solar Stove - Natural Convection	31,67	16,97	14,86	100	9,77
Drying Tunnel	38,12	8,87	14,87	60	17,78
Traditional Drying	23,72	17,64	9,21	60	0,00

4. Conclusions

The results obtained from the present work allowed to conclude that the drying tunnel system is not a very viable alternative to the traditional drying of the S. Bartolomeu pear, since it produces fruits with very distinct colour characteristics. On the other hand, both solar stove methods proved to be

similar, independently of the circulating air system, and originated fruits similar among themselves and more resembling to the traditional fruits, as desired.

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