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Effect of two drying methods on key physicochemical properties and sensory profile of dried figs (Ficus carica L)

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In Morocco, the majority of small farmers carry out solar drying of the fruits by traditional process on their farms. Such practice leads to losses in quality and quantity in dried fruits. This study aims to evaluate sensory and physico-chemical quality of dried figs by using two drying methods: (1st) Usual solar drying practiced by farmers and (2nd) Natural convection solar drying using a green solar dryer. The obtained results showed that second method reduced the drying time from 10 days (first method) to 4 days on average. In addition, it was found that the green solar dryer allows an increase in the temperature inside the drying chamber of + 8.1°C, on average, compared to the ambient temperature. Sensory analysis showed that the five assessed attributes (Mouth feel, color, appearance, flesh thickness and texture) were highly appreciated by using natural convection solar drying. The high difference was noted for the "mouth feel" attribute, followed by "color" which are the two main aspects searched by consumers. Regarding physico-chemical properties, solar-dried figs are rich with citric acid (12.0 g/l vs 9.72 g/l) and in total soluble sugars (60.6% vs 56.0%) compared to sun-dried figs. The water activity was respectively 0.631 and 0.672 for the 1st and 2nd method. In general terms, farmers are encouraged to enhance their drying methods by using natural convection solar drying as a preservative method that maintain nutritional and sensory quality of dried figs.

Keywords: Figs, Quality, Sensory, Physico-chemical, Morocco, solar drying prototype

Introduction

Sun-drying has largely prevailed in arid and semiarid areas with optimal climatic conditions: a long dry season with high levels of sunshine, low rainfall and low humidity. Sun-drying extends the shelf life of surplus production that cannot be sold or consumed immediately. The solar drying process is done according to several methods: traditional drying, drying in direct or indirect dryers with natural or forced convection (Ait Haddou et al., 2014; Abul-Fadl et al., 2015; Noutfia et al., 2018).

The fig (Ficus carica L.) is one of the most important fruit species in the world which is highly perishable even in refrigerated conditions and thus nearly all global production is preserved in a dried form. The top five producers, supplying almost 70% of the world's fig market, are Turkey (269 k Tonnes), Egypt (201,7 k Tonnes), Morocco (85,2 k Tonnes), Algeria (81,8 k Tonnes) and Iran (71,8 k Tonnes) (FAOSTAT, 2018).

In the Moroccan context, the national production of figs is intended mainly for the fresh market and for dried figs production. A small part of the production of fresh figs is oriented for the jam processing industry (Salih, 2020). In the areas of production, the fig is an important fruit and a source of income, which is sold both as a fresh and dried product. The majority of farmers are engaged in solar drying of this fruit based on traditional methods. These methods required low capital, simple equipment and technicity and no energy input but leads to losses in quality and quantity of dried fruits. In order to improve the traditional method of solar drying, equipment using various energy sources (electricity, fuel, gas, wood fires) have been developed (El Khaloui, 2010).

This equipment is expensive to setup and operate. It requires high technicity for their design, installation, use and maintenance. In addition, investment in this type of equipment is difficult for rural farmers to sustain (Dudez, 2000).

Hence, the objective of this investigation is to compare the effect of two solar drying methods on the physico-chemical parameters and sensorial attributes of figs from the Southeastern region of Morocco.

Material and methods

Plant material

Local cultivars of fig (Ficus carica L.), planted in the Experimental station of Errachidia (altitude: 1029 m, longitude: 4°25’, latitude: 31°75’) were used for this study. All trees were managed according to integrated cultivation protocols and trained as an open vase with 6*4 m spacing. Fresh figs were picked by hand two times in July and August at commercial maturity. Only fruits with no or minimal peel defects were selected and immediately transported to the laboratory for analysis and drying.

Fig-drying experimental design

Fresh figs were treated before drying to facilitate and accelerate the drying process. Figs were blanched in boiling water, washed and drip-dried. Then, two methods of drying were used:

• 1st method: Usual sun drying practiced by farmers;

• 2nd method: Natural convection solar drying using a green solar dryer (Noutfia et al., 2018).

Physicochemical quality analysis

The analysis focused on the following:

• Total soluble solids (TSS) was measured with juice obtained from diluting 100 grams of figs into 500 ml of distillated water. A hand refractometer (Model DR-A1; Atago, Japan) was used for measuring this parameter. Results were expressed as a percentage of TSS in juice at 25°C.

• Acidity (expressed at citric acid scale) were carried out according to AOAC methods in triplicate (AOAC, 2012).

• Water activity (aw) was measured at room temperature using an activimeter (Novasina, Pfaeffikon, Switzerland).

Sensory evaluation

To evaluate the hedonic quality of dried figs, a taste panel was conducted using the sensory

procedure developed by Ismail, Haffar, Baalbaki, and Henry (2001). Sensory evaluation was carried out for five defined quality attributes: color, appearance, fruit texture, mouthfeel, and flesh thickness by a panel of 10 semi-trained members on a 10-point scale (Table 1). Each sample was rated separately by panelists.

Result and discussions

Assessment of drying conditions

For the first method (sun drying), the test conditions can be summarized as follows:

• Relative humidity varies between 20.9% and 29.9%.

• Ambient temperature varies between 25.8°C and 38.7°C.

For the second method (solar drying), daily Mean temperature inside the dryer was significantly greater than mean temperature outside the dryer. In-out temperature mean difference increased over time and was 8.3°C, on average, between 12 h and 15 h. The maximum drying temperature reached 51°C and yielding a temperature difference that exceeded 12°C in some instances.

Physicochemical quality of dried figs

Citric acid content

The citric acid content for both dried figs from the two methods is reported in figure 1.

Citric acid content was significantly affected by the drying method. Thus, this parameter was higher for figs dried by solar drying when compared to figs dried by traditional methods (direct sun drying). The amount of this organic acid was respectively 12.0 g/l and 9.7 g/l. This shows that the drying away from sun rays, as was the case for the second method where the drying is carried out in a drying chamber protected from light, makes it possible to keep the citric acid content at a high rate. A lower range of citric acid (2.4 to 5.6 g/l) was reported by Slatnar et al. (2011) for ‘Bela petrovka cv.’ dried figs, which is a local cultivar of Slovenian Istria.

Total soluble solids (TSS)

The TSS content for both dried figs from the two methods is reported in figure 2.

The green solar drying permitted to conserve TSS content at a higher level (60.6%) compared to direct sun drying (56.0%). Our results were slightly greater when compared to results from other authors (Hiregoudar, 2010; Naikwadi et al., 2010). In these studies, Total Solid Sugars content did not exceed 36% and 55% respectively. Pourghayoumi et al. (2016) reported a high TSS content of nine Iranian dried figs. In their study, these authors reported a range of Total soluble sugars of 60.0 - 84.4%.

Water activity (aw)

Water activity for solar and sun dried figs is reported in figure 3.

For water activity, the obtained values were about 0.672 for solar drying and 0.631 for sun drying. This range of water activity is below the optimum levels for growth and toxin production of Aspergillus flavus or A. parasiticus (Piga et al., 2004).

Sensory quality

The five assessed attributes of dried figs are reported in figure 4.

The sensory scores for different attributes gradually decreased while moving from sun drying to solar drying especially for mouth feel and color which have respectively scores of 6.95 to 6.18 and 6.55 to 5.82 for solar and sun drying.

The panelists gave good assessments of the solar dried figs, especially for mouth feel, color and texture. Also, sensory analysis showed that the five assessed attributes (Mouth feel, color, appearance, flesh thickness and texture) were highly enhanced by using natural convection solar drying. The high difference was noted for the “mouth feel” attribute, followed by “color” which are the two main aspects sought by consumers. These sensory parameters seemed to be deteriorated with solar drying.

Conclusion

This study suggests that farmers be encouraged to enhance their drying methods by using natural convection solar drying as a preservation method that maintains nutritional and sensory quality of dried figs. Also, this study should be supplemented with additional analysis such as fibers, phenolic/bioactive compounds, antioxidant activity and individual sugars (fructose, sucrose, etc). This could help to understand links between consumers’ preferences and functional characteristics of dried figs.

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