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

Younès NOUTFIA*[1], Aouatif BENALI[1], Ibtissame GUIRROU[1], Kaoutar EL FAZAZI[1], Hajar TANTAOUI[1]

[1] Department of Agro Food and Quality, National Institute of Agronomic Research, Rabat, Morocco

[*] Corresponding author noutfiaa@yahoo.fr

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Abstract

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.

Table 1: Quantitative scoring guide for dried figs

Attribute	Very poor	Poor	Satisfactory	Good	Excellent
Score	1 – 2	3 – 4	5 – 6	7 – 8	9 – 10

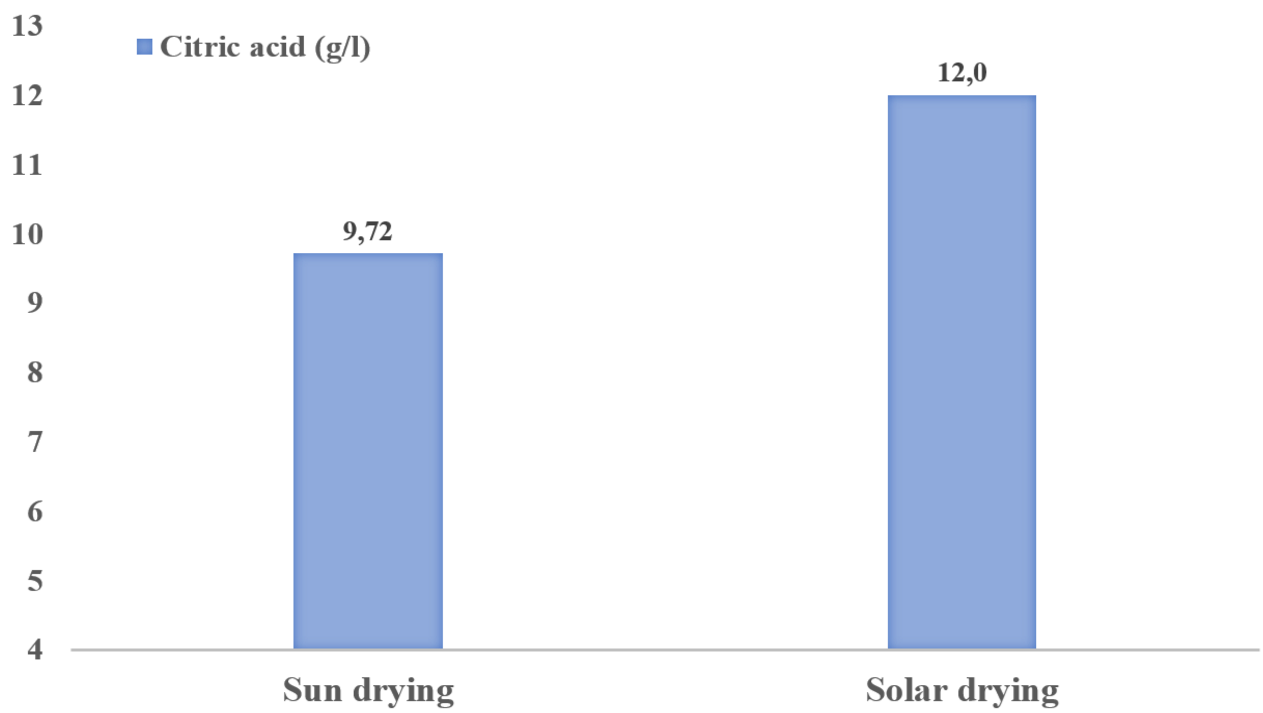

Figure 1: Citric acid content of dried figs using sun drying and solar drying

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 (a_w)

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 de-

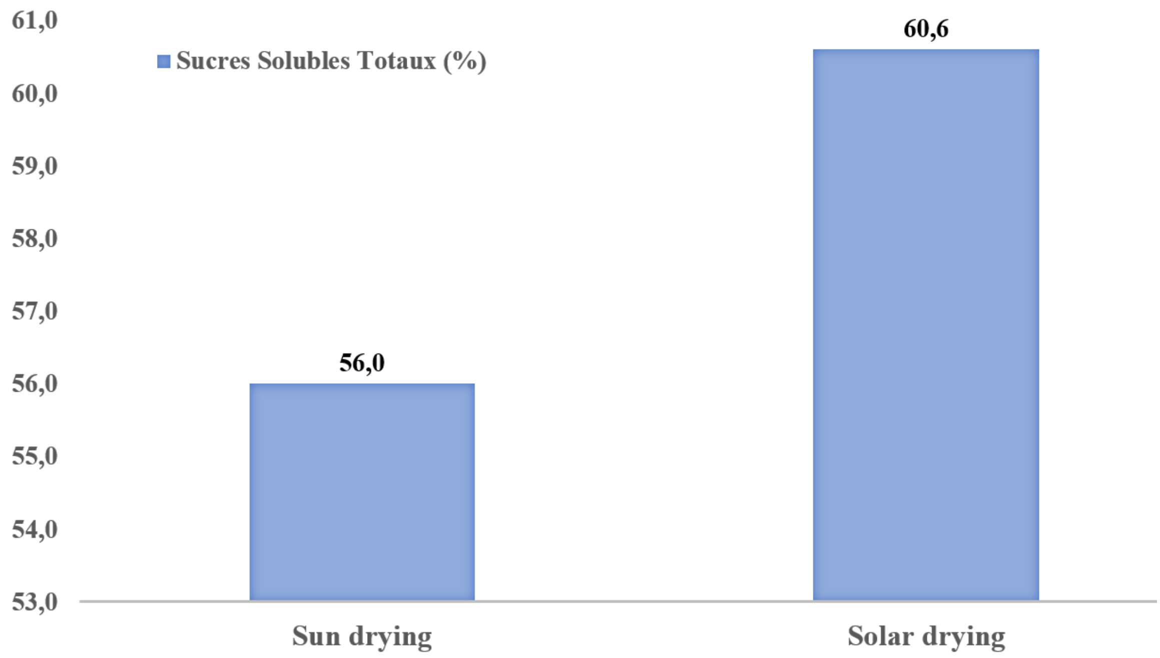

Figure 2: TSS content of dried figs using sun drying and solar drying

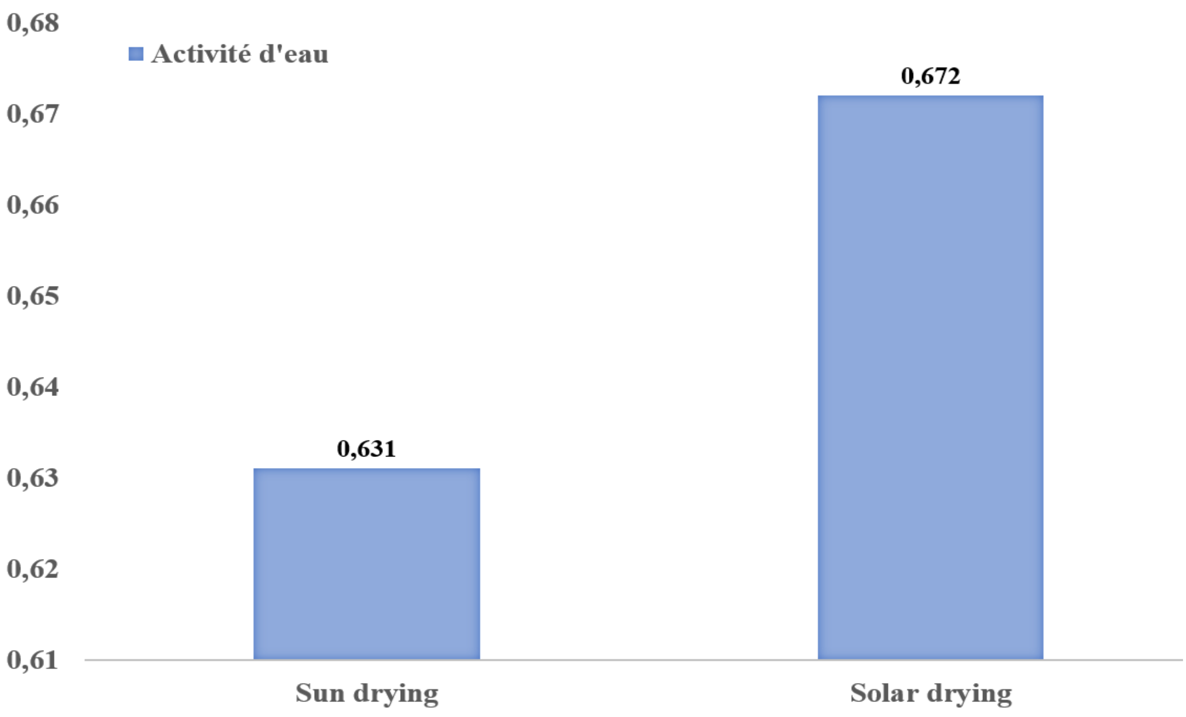

Figure 3: Water activity of dried figs using sun drying and solar drying

creased 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

In terms of conclusion, this study suggest that 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. On other hands, this study must be completed by more specific analyses such as fibers, phenolic/bioactive compounds, antioxidant activity and individual sugars (fructose, sucrose, sucrose, etc). This could help to understand links between consumers' preferences and functional characteristics of dried figs.

REFERENCES

AbulFadl M.M., Ghanem T.H., EL Badry N., Nasr A. (2015). Effect of some different drying methods on quality criteria of dried fig fruits. *Curr. Sci. Int.*, 4: 548-566.

Ait Haddou L., Blenzar A., Messaoudi Z., Van Damme P., Boutkhil S., Boukdame A. (2014). Effet du cultivar, du prétraitement et de la technique de séchage sur quelques paramètres physico-chimiques des figues séchées de sept cultivars locaux du figuier au Maroc. *European Journal of Scientific Research,* 121: 336-346.

AOAC. (2012). Official Methods of Analysis (19th ed.). Washington DC.

Dudez P. (2000). Guide pratique: Le séchage solaire à petite échelle des fruits et légumes. Expériences et procédés Editions du GRET, Paris.

El Khaloui M. (2010). Valorisation de la figue au Maroc. *Bulletin mensuel d'information et de liaison du PNTTA. Transfert de Technologie en Agriculture,* 186: 1-4.

FAOSTAT. (2018). http://faostat.fao.org/, (Mars, 3 2020).

Hiregoudar S., Nidoni U., Meda V., Gadade S., Basavaraj V.P. (2010). A study of different drying methods for fig (*Ficus Carica* Linn) fruit. MBSK 10-505, ASABE/CSBE North Central Intersectional Meeting.

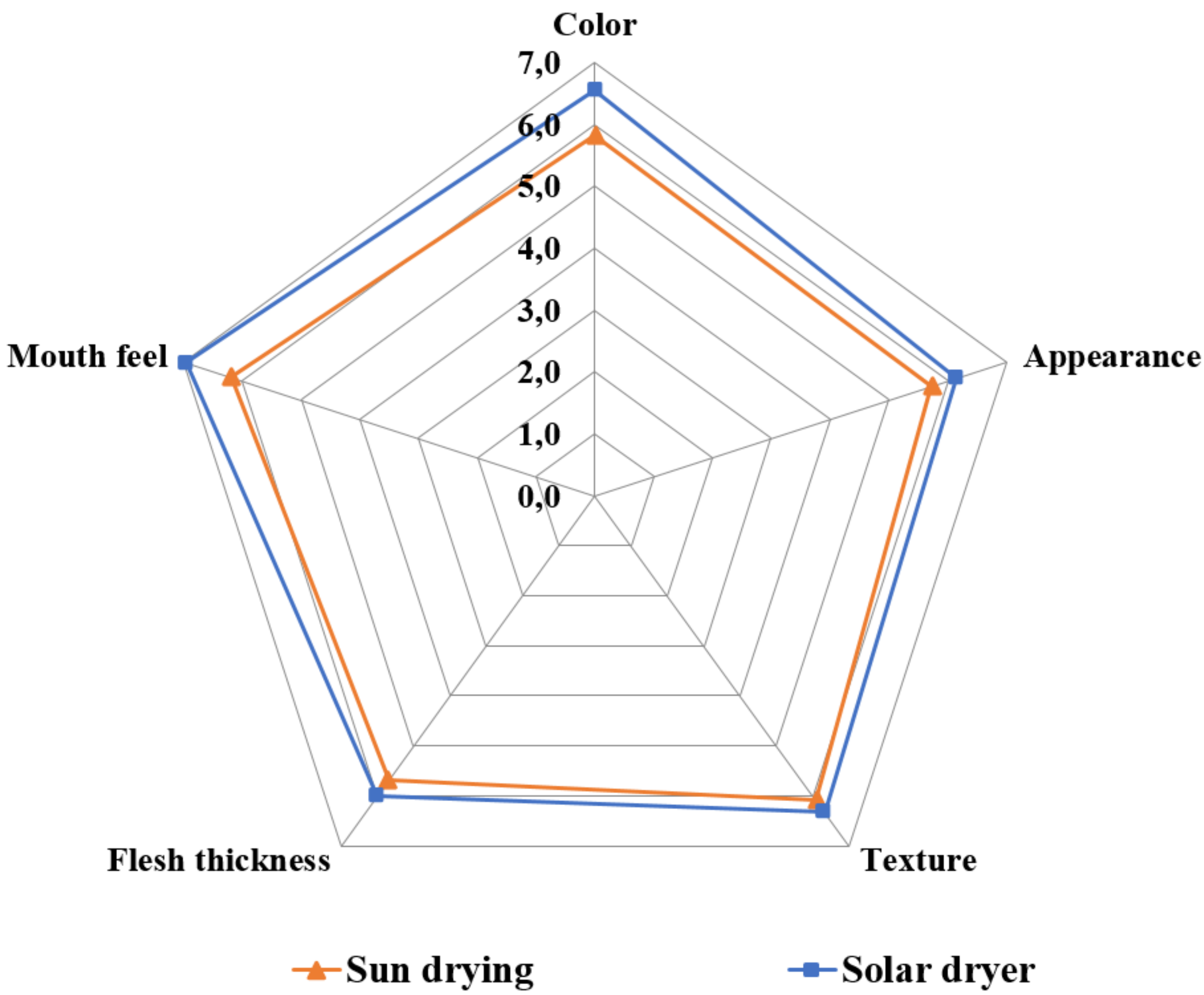

Figure 4: Sensory attributes of dried figs

Ismail B., Haffar I., Baalbaki R., Henry J. (2001). Development of a total quality scoring system based on consumer preferences weightings and sensory profiles: Application to fruit dates (tamr). *Food Quality and Preferences*, 12: 499–506.

Naikwadi P.M., Chavan U.D., Pawar V.D., Amarowicz R. (2010). Studies on dehydration of figs using different sugar syrup treatments. *J. Food. Sci. Technol.*, 47: 442-445.

Noutfia Y., Benali A., Alem C. (2018). Design of a solar dryer for small-farm level use and studying fig quality. *Acta Scientiarum Polonorum Technologia Alimentaria*, 17: 359-365.

Piga A., Pinna I., Ozer K.B., Agabbio M., Aksoy U. (2004). Hot air dehydration of figs (*Ficus carica* L.): Drying kinetics and quality loss. *International Journal of Food Science and Technology,* 39: 793-799.

Pourghayoumi M., Bakhshi D., Rahemi M., Noroozisharaf A., Jafari M., Salehi M., Hernandez F. (2016). Phytochemical attributes of some dried fig (*Ficus carica* L.) fruit cultivars grown in Iran. *Agriculturae Conspectus Scientificus*, 81: 161-166.

Salih G. (2020). Assessment of production and marketing practices for dried figs: Surveys of Moroccan fig producers and sellers. *Moroccan Journal of Agricultural Sciences,* 1: 84-90.

Slatnar A., Klancar U., Stampar F., Veberic R. (2011). Effect of drying of figs (*Ficus carica* L.) on the contents of sugars, organic acids, and phenolic compounds. *Journal of Agricultural and Food Chemistry* 59: 11696-11702.