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An experimental study of mints solar drying systems

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Abstract

Many research studies have been performed on forced convection (active) solar dryers for fruit, vegetables and plants. A short survey of these showed that applying the forced convection solar dryer not only significantly reduced the drying time but also resulted in many improvements in the quality of the dried products.
The objective of this study was to investigate the drying kinetics of mint was dried using solar dryer. Air temperatures of 40 to 60°C were used for the drying experiments. The key parameters for suitable drying are temperature, humidity and flow rate levels. These parameters determine the moisture removal rates which are important to evaluate the appropriate drying duration for a particular food product.

Keywords: Solar energy; Solar system; Energy conversion; Mint drying; Forced convection solar dryer.

1. Introduction

Mint leaves (*Mentha spicata* L.) are a common name for members of the Labiatae (Laminaceae Family) Spearmint grows well in nearly all temperate climates. Gardeners often grow it in pots or planters due to its invasive spreading roots. The plant prefers partial shade, but can flourish in full sun to mostly shade. Spearmint is best suited to loamy soils with plenty of organic material [1,2,3].

Spearmint leaves can be used fresh, dried, or frozen. They can also be preserved in salt, sugar, sugar syrup, alcohol, or oil. The leaves lose their aromatic appeal after the plant flowers. It can be dried by cutting just before or right (at peak) as the flowers open, about 1/2 to 3/4 the way down the stalk (leaving smaller shoots room to grow). There is some dispute as to what drying method works best; some prefer different materials (such as plastic or cloth) and different lighting conditions (such as darkness or sunlight) [4].

Mint, like many other herbs, is highly seasonal in nature. In order to preserve this seasonal and highly perishable plant and make them available to consumers all year round at low pieces, it is subjected to past harvest technological treatments such as drying and freezing . Drying is one of the oldest preservation techniques. Natural drying (drying in the shade) and hot air drying are still most known and widely used

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methods of drying. Natural drying has many disadvantages due to the inability to handle the large quantities and to achieve consistent quality standards [4]. High ambient temperature and relative humidity during the harvesting and drying season and long drying time promote the insect and mould development in harvested and/or dried crops. Therefore, continuous and batch dryers are generally used depending on the daily processed product tonnage [5].

The fresh or dried leaves and flowering tops of the mint (*Mentha spicata* L.) are particularly used as a garnish for meats and desserts, an ingredient to flavour soups, sausages and candies, traditionally, it is used as an herbal tea against cold, spasms, cramps and digestive problems [6]. The essential oil of mint is used for flavouring of toothpaste, mouthwashes and chewing gums. It is also used in aromatic soaps, perfumery, detergents, repellents and pesticides for various insects [7].

Essential mint oil is extracted either from freshly harvested mint leaves or from semidried or dried leaves through distillation process for industrial applications. Drying is one of the oldest methods of food preservation and represents a very important aspect of food processing. Drying of food products is aimed at longer storage periods, lower packaging requirements and shipping weights (Okos et al., 1992; Kadam et al., 2005, 2006; Kadam and Samuel, 2006). To analyze the drying behaviour of a food product, it is quintessential to study the drying kinetics of the food. Thin layer drying is widely used for fruits and vegetables to prolong their shelf life [8-10].

The dried mint should have a bright green colour. Therefore it should be dried quickly in order to inactivate the enzyme chlorophyllase which breaks down the chlorophyll and turns the leaf yellow. however, temperature above 60°C will remove the volatile oils reducing flavor. Thus, to produce green mint, drying temperature above 60°C is generally suggested. In addition to this, other major drawbacks of hot air drying are low energy efficiency and a lengthy drying time during the last stage of drying [11].

2. Materials and methods

Fresh green mint (Mentha spicata L.) leaves used for the drying experiments were obtained from the local market in the Bou-Ismail region of Algeria.The solar drying experiments were carried out during the period of September 2012 in Bou-Ismail. The mass of the (Mentha spicata L) leaves used in drying experiments was (331.0 ± 0.01) g per tray. The product was uniformly distributed in a single layer on the first shift of the drying cabinet.

Temperature measurements and recording at different points in the solar dryer were made by thermocouples (Chromel-Alumel, 0.2 mm diameter) connected to a data logger enabling (± 0.1 °C) accuracy and the outlet temperatures were measured with thermometer.

The experiment has been performed in Unit of Solar Equipments Development, BouIsmail, Algeria in September 2012. A prototype of the dryer is so designed and constructed with a collector area of 1.656 m^2 which is appropriate and sufficient for household applications of mint drying. This prototype dryer will be used in experimental drying tests under various loading conditions. A schematic diagram of the experimental set up has been shown in fig.1

Fig.1 Photograph of the indirect drier.

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Drying was started after completion of the loading, usually at 11:00 hours and discontinued with the final moisture content of the mint. Weight losses of mint in the solar dryer were measured during the drying period in day time (11:00 to 15:00 hours) at 10 minutes intervals with an electronic balance (BL 310, Sartorius AG Göttingen, Germany). During the day time, the solar dryer was placed on a raised platform, far from the shade of trees or buildings during the whole duration of the experiment .The positions of the collector and its reflector were adjusted with the solar angle so that maximum solar radiation could be captured by the solar collector as well as by the reflector.

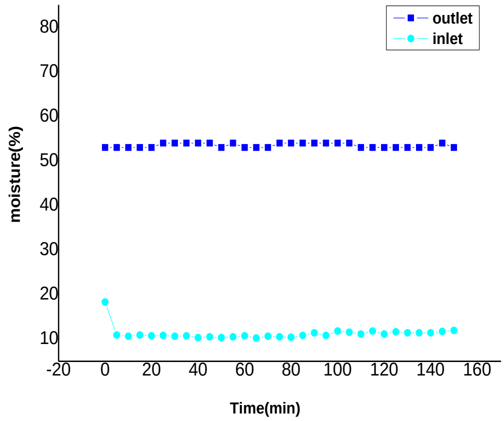

Fig. 2.Variation of moisture content (outlet and inlet) with drying time for sample of mint in solar dryer

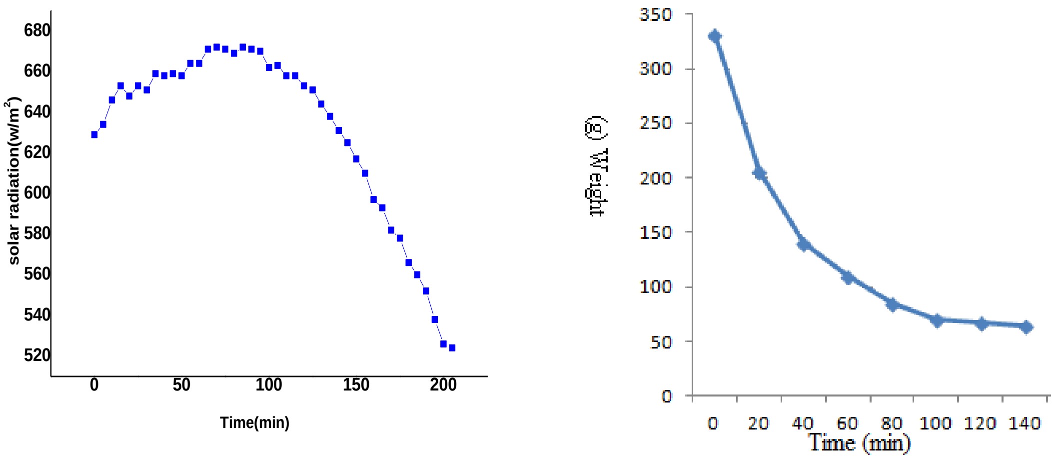

Fig. 3. (a) solar radiation and versus time for typical sunny day; (b) Variations of weight as a function of time for sample of mint in solar dryer.

3. Results and discussion

Fig. 2. show relative humidity at inside the dryer for a typical experimental run during solar drying of mint. Relative humidity decreases over time at different locations inside the dryer, during the first half of the day. This is caused by decreasing relative humidity of the drying air due to temperature increase, whereas the opposite is true for the latter half of the day. The relative humidity of the air inside the dryer is always lower than that of the ambient air and the lowest relative humidity is in the middle of the day.

the solar radiation during a typical experimental run of solar drying of mint long an in the solar dryer are shown in Fig.3. (a) In days of this experimental run, solar radiation increased sharply from 8 am till noon but was considerably decreased in the afternoon with fluctuations due to clouds.

The figure.3. (b) indicate that the sample takes a shorter time to dry in comparison to the other samples of mint leaves drying with microware were reported in several studies [12-14]. Drying during the falling drying rate period is thus governed by water diffusion in the solid. This is complex mechanism involving water in both liquid and vapour states, which is very often characterized by a so-called effective diffusivity.

4.Conclusion

The drying behavior of mint was investigated under force convection indirect solar drying system for Bou-Ismail climatic conditions. Drying time varied from 0 to 140 min to dry a 331 g of mint leaves samples at temperatures from 40 to 60°C. The obtained results indicate a direct correlation between temperature, moisture content and drying time. The total energy required for drying of mint decreased with increase in drying air temperature.

References

[1]Park KJ, Vohnikova Z, Brod FPR. Evaluation of drying parameters and desorption isotherms of garden mint leaves (Mentha crips L.). *J. Food Eng*. 2002, 51 ;193-199.
[2]The Columbia Electronic Encyclopedia (2005). Columbia: Columbia University Press.
[3]Thompson A K. Fruits and vegetables (2nd ed.) pp: 273. Oxford: Blackwell Publishing, UK.2003.
[4]en.wikipedia.org/wiki/Mentha_spicata.
[5]Soysal, Y. and S. Oztekin, 2001. Technical and economic performance of a tray dryer for medicinal and aromatic plants. *J.Agric.Eng.Res*. 2001, 79; 73-79
[6] Baytop,T .Turkiye'de bitkiler ile tedavi: Geçmipte ve bugun-ilaveli ikinci baski.Therapy with Medicinal Plants in Turkey: Past and Presnt extended 2nd Edn, Nobel Tip Kitaberleri Ltd, Turkey: çapa-Istambul, 1999, pp:480.
[7] Park, K.J., Vohnikova, Z. and Brod, F.P.R. Evaluation of drying parameters and desorption isotherms of garden mint leaves (Mentha crispa L. I).*J.Food Eng*. 2002,51; 193-199.
[8] Kadam D M, Lata, Samuel D V K, Pandey A K. Influence of different treatments on dehydrated cauliflower quality. Int. J. Food Sci. Technol., 40: 849-856 doi:10.1111/j.1365-2621.2005.01007.x.2005
[9] Kadam D M, Samuel D V K. Convective flat-plate solar heat collector for cauliflower drying. Biosyst. Eng., 93 (2): 189-198. doi:10.1016/j.biosystemseng. 2005.11.012. 2006.
[10] Okos MR, Narsimhan G, Singh RK, Weitnauer AC. Food Dehydration. In D. R. Heldman DR, Lund DB (Eds). Handbook of Food Engineering, New York: Marcel Dekker. 1992.
[11] Deans, S.G. and K.P. Svoboda,. Effects of drying regime on volatile oil and microflora of aromatic plants. Acta Hortic, 1992. 450-452.
[12] Funebo,T. and T. Ohlsson,. Microwave assisted air dehydration of apple and mushroom. *J.Food Eng*, 1998. 38;353-367
[13] Soysal,Y., Microwave drying characteristics of parsley. *Biosystems Eng*, 2004. 89;167-173
[14] Maskan, M. Microwave /air and microwave finish drying of banana. *J. Food. Eng*, 2000. 44;71-78.