2013 4th International Conference on Food Engineering and Biotechnology
IPCBEE vol.50 (2013) © (2013) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2013. V50. 2

Infrared Assisted Microwave Drying of Eggplants

Ayca Aydogdu[1,2],GulumSumnu[1+],Serpil Sahin[1]

[1] Department of Food Engineering,Middle East Technical University, 06800, Ankara, Turkey

[2] Department of Food Engineering, University of NecmettinErbakan, 42090, Konya, Turkey

Abstract. The objective of the study is to investigate the effect of microwave-infrared (MIR) combination drying and osmotic dehydration on drying characteristics and color of dried eggplants.Solution of salt with concentration 10% and 20% (w/w) was used to provide osmotic dehydration as a pretreatment. Untreated eggplant slices were used as control. Bothuntreated and osmotically dehydrated eggplant slices were dried by using MIR combination oven in which different microwave powers (30%,40% and 50%) were combined with different infrared powers (10%, 20% and 30%). At the end of drying, initial moisture content decreased from 14 kg water/ kg dry solid to approximately 0.13 kgwater/ kgdrysolid for control eggplants and 0.03 kg water /kg dry solid for osmotically dehydrated eggplants. Drying time was reduced with increasing microwave and infrared power. Eggplants treated with osmotic dehydration had higher L* value after drying.

Keywords: microwave, infrared, drying, eggplant.

1. Introduction

Drying is one of the most important methods of food preservation. The growth and reproduction of spoilage microorganism is prevented and many of the moisture deteriorative reactions are minimized by removing of moisture from the food material [1]. Longer shelf-life, lighter weight for transportation and smaller space for storage are provided with drying. Eggplant is a perishable vegetable which has limited shelf life. It is common to dry eggplants under sun in Turkey to prolong their shelf-lives. However, sun drying has many disadvantages such as long drying time, exposure to contamination from dust, soil, sand particles and insects, etc. [2]. Therefore, in order to improve the quality, the traditional sun drying technique should be replaced with modern drying methods.

Although hot air drying method is used most commonly in industry, it has major disadvantages that are low energy efficiency, quality loss and lengthy drying time during the falling rate period. Heat transfer to the inner sections of food during conventional heating is limited due to the low thermal conductivity [3]. In order to eliminate these problems, microwave heating can be used for drying of foods. In recent years, microwave drying has been used in drying of apples [4].In addition, for drying of red peppers, microwave- convective combination drying [5] and for mushrooms [6] and apple slices [7] microwave-vacuum drying has been used.

MIR drying combines the time saving advantages of microwaves with surface moisture removal advantages of infrared heating. In MIR oven, the radiation is focused at the surface of the food which can help to remove moisture from the surface and to prevent sogginess of the dried product [8]. However, in literature there is a lack of studies about microwave-infrared combination drying.

The objective of this work was to study the effect of microwave-infrared combination drying and osmotic dehydration on drying characteristics and color of dried eggplants.

2. Material and Methods

+Correspondingauthor. Tel.: +90-312-2105628; fax: +90-312- 2101270.
E-mail address: gulum@metu.edu.tr

Fresh eggplants with initial moisture content of about 14 kgwater /kg dry solid were obtained from a local market. Prior to drying and osmotic treatment, samples were sliced having a thickness of about 5 mm. To study the effects of osmotic dehydration, samples were soaked in salt solution (10% and 20% w/w) at 50 ℃ for 2 hours. The ratio of sample to osmotic solution was 1:10 (w/w). In MIR combination oven (Advantium oven, General Electric Company, Louisville, KY, USA), microwaves were operated at 30%, 40% and 50% power and halogen lamps at the top and bottom were operated at 10%, 20% and 30% power. In each experiment, 100-115 gr of eggplants were dried. Weight and color of samples were recorded at every 5 minutes interval. Color of the samples was measured using a Minolta color reader (CR-10, Japan). The color readings were expressed by CIE coordinates (L* a* b*) system.

3. Result and Discussion

Eggplants have moisture content of almost 14 kg water/kg dry solid initially.Fig. 1 shows the moisture content of untreated eggplants dried at 40% microwave power and different infrared powers. Drying time was reduced with increasing the infrared power.

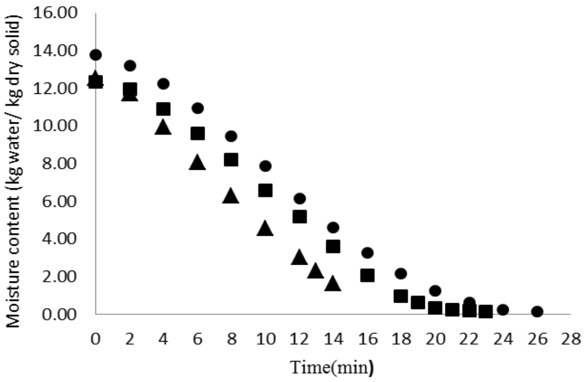

Fig. 1:The effect of infrared power on moisture content of eggplant dried in microwave-infrared combination oven at 40% microwave power; (●): 10% infrared power, (■) : 20 % infrared power,(▲): 30% infrared power.

The effect of microwave power to drying characteristic is shown inFig.2. When 50%, 40% and 30% microwave power were combined with 10% infrared power, eggplants were dried to almost 0.13 kg water/kg dry solid in 23 min, 26 min and 39 min respectively. Higher absorbed microwave power led to an increase in evaporationrate and moisture loss and a decrease in drying time. Shorter drying time in microwave oven might be explained by higher internal pressure and concentration gradients, which increased the flow of liquid through the food to the boundary. [8]

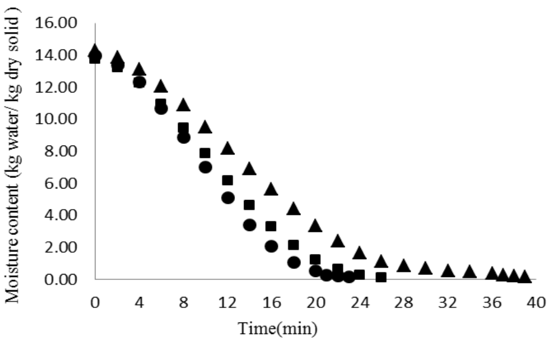

Fig. 2: The effect of microwave power on moisture content of eggplant dried in MIR combination oven at 10% infrared power. (●): 50 % microwave power, (■): 40 % microwave power,(▲): 30% microwave power.

The effect of osmotic treatment on moisture content and drying time is presented in Fig. 3. After 2 hour osmotic treatment with 10% and 20% solution, moisture contents of eggplants were almost 5 kg water/kg dry solid and 3.2 kg water/kg dry solid, respectively. When osmotically dehydrated eggplants were compared with control ones, it was seen thatdrying time in MIR combination oven was significantly reduced. This could be explained by higher dielectric properties of osmotically dehydrated eggplants which led to higher drying rate.

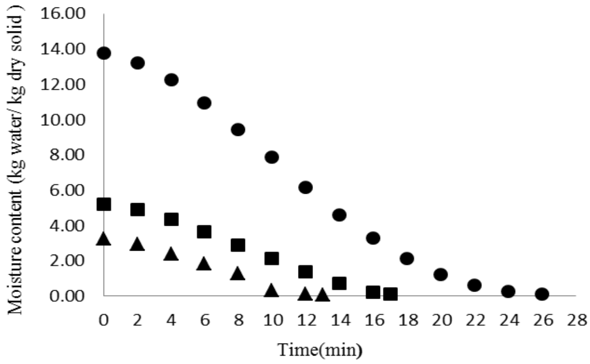

Fig. 3: The effect of osmotic dehydration on moisture content of eggplant dried in MIR combination oven with 10% infrared power and 40% microwave power. (●): control, (■): 10% osmotic dehydration, (▲): 20% osmotic dehydration.

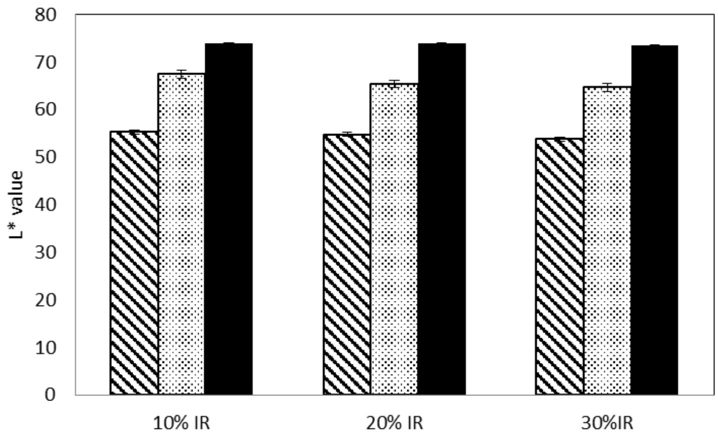

Fig. 4: shows the effect of osmotic treatment on the L* value of dried eggplants. Lighter color was obtained when osmotic dehydration was used. Eggplants treated with osmotic dehydration had lower a* value after drying. (Data not shown)

4. Conclusion

Higher infrared and microwave power provided shorter drying time. Dried eggplants treated with osmotic solution had shorter drying time in MIR combination oven and lower final moisture when compared to control dried eggplants. Moreover pretreated and dried eggplants had higher L* value than that of control eggplants.

5. References

[1] L. Wu, T. Orikasa, Y. Ogawa and A. Tagawa. Vacuum drying characteristics of eggplants. *Journal of Food Engineering*. 2007, **83**: 422-429.

[2] I. Doymaz, and E. Göl. Convective drying characteristics of eggplant slices. *Journal of Food Processing Engineering*. 2009, **34** (4): 1234-1252.

[3] J. Wang, and K. Sheng. Far-infrared and microwave drying of peach. *LWT*. 2006, **39**: 247-255.

[4] G. Cuccurulo, L. Giordano, D. Albanese, L. Cinquanta, and M. Di Matteo. Infrared thermography assisted control for apples microwave drying. *Journal of Food Engineering.* 2012, **112**: 319-325.

[5] Y. Soysal, Z. Ayhan, O. Esturk, and M.F. Arikan. Intermittent microwave-convective drying of red pepper: drying kinetic, physical (colour and texture) and sensory quality. *Biosystem Engineering*. 2009, **103**: 455-463.

[6] D. Argyropoulos, A. Heindl, and J. Müller. Assessment of convection, hot air combined with microwave-vacuum and freeze-drying methods for mushrooms with regard to product. *International Journal of Food Science & Technology.* 2011, **46**: 333-342.

[7] Q. H. Han, L. J. Yin, S. J. Li, B. N. Yang, and J. W. Ma. Optimization of process parameters for microwave vacuum drying of apple slices using response surface method. *Drying Technology*. 2010, **28**: 523-532.

[8] G. Sumnu, E. Turabi, and M. Oztop. Drying of carrots in microwave and halogen lamp–microwave combination ovens. *LWT*. 2005, **38**: 549-553.