ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

AGNI-PANKH 16

Jawaharlal Darda Institute of Engineering and Technology, Yavatmal

Vol. 4, Special Issue 3, January 2017

Drying of Food Material using Butterfly Type Solar Concentrator Dryer

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Abstract: Butterfly type solar dryer can be use for drying various products in a rural area under hygienic conditions. Present paper deals with the drying of ginger using butterfly type solar dryer. Solar drying system was constructed, consisting of two parts (solar collector and solar drying dishes). A frame required for this experiment was made from iron or steel. It was observed that, the moisture content of ginger was reduce from 25 grams (initial moisture content) to 3 grams (equilibrium moisture content) within the drying period of 120 min.

Keywords: Solar dryer, glass frame, potato, drying rate.

I. INTRODUCTION

Drying is one of the oldest methods used to preserve food products for longer periods. The heat from the sun coupled with the wind has been used to dry food for preservation for several thousand years.

Almost everywhere in the world, people have utilised some food drying method in order to save food from one season to the next, be it hay or corn or seal meat or apples. Microorganisms and enzymes that spoil food and make it unsafe to eat need water to be active and drying make it preserve by simply depriving them of water. Drying of agricultural products using renewable energy such as solar energy is environmental friendly and has less environmental impact. The various types of drying techniques used worldwide are:

A. Oven Drying

Oven drying is the simplest way to dry food because you need almost no special equipment. It is also faster than sun drying or using a food dryer. But oven drying can be used only on a small scale. An ordinary kitchen oven can hold only 4 to 6 pounds of food at one time.

B. Food Dryer

A commercial or homemade food dryer or convection oven provides automatically controlled heat and ventilation. Most households will not need a dryer unless they dry large quantities of food. A food dryer takes less electricity than drying the same amount of food in an electric oven. However, the temperature is usually lower (about 120^{o}F. or 50^{o}C.), so drying takes a little longer than in an oven.

C. Sun Drying

Open sun drying is a form of drying where the food crops are directly exposed to the sun's radiation whereas a more advanced method, solar drying, houses the food in drying chambers and is directly or indirectly heated by the sun. Despite the numerous advantages of the solar drying over the open sun drying, the latter is the most preferred method in the rural areas particularly due to that fact that it is easy to execute and does not require great skill. Unfortunately this mode of drying has been wrought with many disadvantages one of which is the poor quality of food derived. [2] However, various researchers have found ways of improving upon this ancient method of drying in the form of the solar dryer. The solar dryer still harnesses the sun's energy but utilises it more efficiently and subsequently results in better final products.

II. LITERATURE REVIEW

Haque et. al. (2013), studied the drying kinetics of ginger rhizome under blanched and non blanched conditions using solar dryer and mechanical tray dryer at three temperature levels. He observed that, the drying rate increases with the increase in drying air temperature. The drying rate depends on shape and size of the ginger rhizomes. The highest drying rate was found for sliced samples of ginger rhizome followed by splitted and whole root samples. Five thin layer drying models were fitted to the experimental data of blanched and sliced ginger rhizomes. The agreement between the predicted and experimental results was excellent. Color of ginger rhizomes was slightly changed after drying. Lightness of ginger rhizomes decreased with an increase in drying temperature for all samples except sliced and blanched samples. For drying of ginger rhizome, it should be sliced and blanched and dried below 70^{0}C for better quality dried products.

Deshmukh et. al. (2013), investigated drying of commercially important and export oriented ginger.

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Freshly harvested ginger slices were successfully dried from initial moisture content of 621.50 to 12.19% (d.b.) and their drying characteristics, quality parameters, and kinetics were evaluated. The results showed that present solar dryer could be successfully applied for drying of ginger in view of quality, reduced drying time, and zero energy requirement as compared to conventional open sun drying and convective drying techniques, respectively. Drying curves showed that drying occurred in falling rate period and no constant period was observed. The effective moisture diffusivity was determined by using Fick's second law and found to be 1.789×10^{-9} m^2/s. The drying data was fitted to five thin layer drying models and compared using statistical criteria. Page model was found to be most suitable to describe the drying kinetics of ginger in solar dryer under natural convection among the tested models.

III. MATERIAL AND METHODS

A. MATERIAL

Frame required in this study was made from iron or steel. It was painted black in color. There are two provisions made for fixing the parabolic dishes which is adjustable according to the position of the sun. There is also provision for keeping the food materials for drying.

Fig. 1 Metal Frame

The parabolic dishes are made up of iron which is painted in white in color. The reflecting surface is made from aluminum foil and reflecting radium for extra reflectance. Aluminum strips are cut down and stuck using the solution

Fig. 2 Parabolic Dish

such that the extra reflecting part should be on exposed side. Same is done with the reflecting radium and the layer of reflecting radium is stuck on the layer of aluminum foil strips.

B. METHOD

Solar drying using butterfly type solar concentrator dryer was carried out for different materials. The solar concentrator dryer can achieve the temperature of about $65\text{-}70^0$ c and it can be controlled for different food materials as some food materials does not require this high temperature.

Parabolic dishes were calibrated and adjusted according to the position of the sun so that the focal point of both the parabolic dishes are at the common point and that common point should be at the base of the glass tray provided for placing the food materials. Ginger weighing 50 gm cut or sliced into small pieces were spread uniformly in the glass tray on the provision of the dryer and covered with the translucent glass lid to avoid heat loss. The study was carried out during daytime (from 12 pm to 2 pm) when the intensity of the sun is at its peak. Material was weighed at equal interval of time of 15 minutes. Same material of equal weight was kept in the oven at 65^oC and it was weighed at equal interval of time of 15 minutes to find the total moisture content.

IV. RESULT AND DISCUSSION

From the study, the initial and equilibrium moisture content was found as 25 gm and 3 gm respectively.

Figure 3 shows the variation moisture content of ginger with time. It is observed that with increase in time of drying, the moisture content of material decreases. From figure it is observed that, the equilibrium moisture content is 3 gm and it reaches after around 120 min.

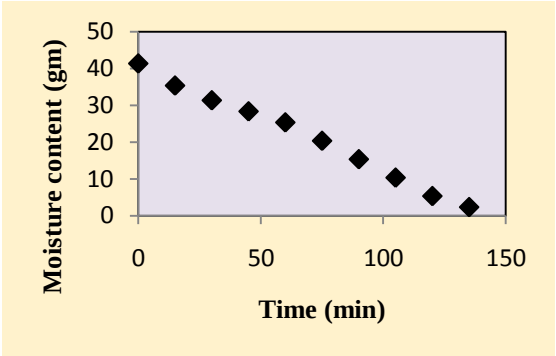

Fig. 5.1 Variation of moisture content with time

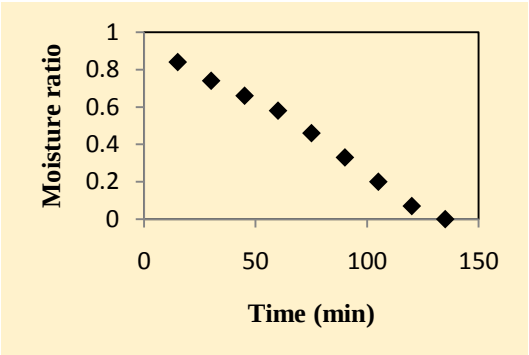

Fig. 5.2 variation of moisture ratio with time

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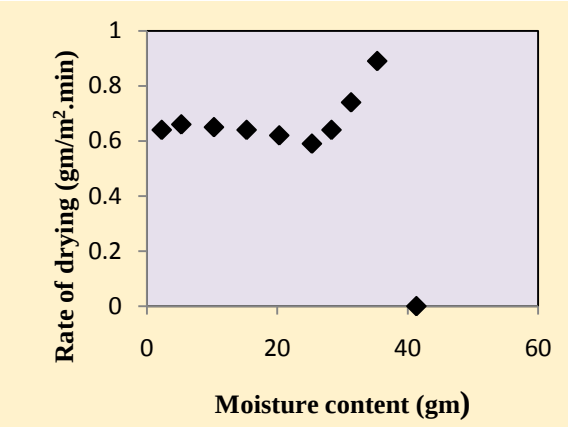

Fig.5.3 Moisture content w.r.t Rate of drying

Variation of moisture content of ginger with respect to rate of drying was studied and shown in figure 5. From Figure 5, it is observed that with decrease in moisture content of ginger, the rate of drying initially increases upto 21 gm called as warming up period, then remains constant upto the moisture content of almost 9 gm called as falling rate period and then the rate starts decreasing up to the equilibrium value of 3 gm called as falling rate period.

V. CONCLUSION

- The drying of Ginger using butterfly type solar dryer was carried out.
- It was observed that there was warming up period, falling rate period and constant rate period.
- The moisture content of the material decreases with time.
- The moisture ratio also decreases with time.
- As the drier makes use of solar concentrator, it can perform better during winter season and less sunshine period.
- Another advantage of the designed drier is that the temperature for different materials can be controlled. Also this drier can be used to dry any agricultural products and products that cannot be dried under natural sun drying.
- So, it is evident that the designed drier with parabolic solar concentrator is better for food drying.

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