International Journal of Current Research and Modern Education (IJCRME)
Impact Factor: 6.925, ISSN (Online): 2455 - 5428
(www.rdmodernresearch.com) Volume 8, Issue 2, 2023

DESIGN, FABRICATION AND EXPERIMENTAL INVESTIGATION OF LAB TYPE DRYER FOR AGRO PRODUCT

P. Dharmadurai*, S. Rajkumar, K. Gurunath*** & D. Katherasan******
Department of Aeronautical Engineering, Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamil Nadu

Cite This Article: P. Dharmadurai, S. Rajkumar, K. Gurunath & D. Katherasan, "Design, Fabrication and Experimental Investigation of Lab Type Dryer for Agro Product", International Journal of Current Research and Modern Education, Volume 8, Issue 2, July - December, Page Number 63-70, 2023.

Abstract:

A new lab type dryer, which consists of an electric air heater and a drying chamber, was fabricated and used for drying the agricultural products. The present lab type dryer system was successfully tested using Radish, Bitter Gourd, and also compared with open sun drying. The different parameters was noted and also graphs were plotted between various parameters which shows that the efficiency of the lab type dryer. Compared to open sun drying the lab type dryer was produce the prevented mass losses and provide better product quality.

Key Words: Mechanical Dryer, Design Drying Chamber, Air Heater Etc.

Introduction:

Drying has remained one of the popular methods for preserving food for many years. The drying process involves reducing water from the product to an acceptable level for marketing, storage, or processing. Given the absence of sufficient water, microorganisms are unable to grow and multiply. Many of the enzymes that cause food spoilage cannot

Function without water. The old method of food drying is executed by spreading the food material on the ground and exposing the food to sunlight. This method is practiced until today for certain products because of the advantages of simplicity and economy. However, open sun drying has some drawbacks. Open sun drying requires longer drying time and product quality is difficult to control because of inadequate drying, high moisture, fungal growth, and encroachment of insects, birds and rodents and others. Open sun drying also requires a large space. Drying is usually conducted by vaporizing water in the product. Thus, the latent heat of vaporization must be supplied. Airflow is also required to remove the vapor away from the product. The lower the humidity of hot air supplied to the drying chamber is, the better the drying rate, as the less humid air can carry more moisture from the product surface than the more humid air. Generally, increasing the temperature and velocity shortens the drying time. However, for heat-sensitive products, such as food and pharmaceutical products, high temperature and humidity is required to maintain the fresh color of the product using the desiccant system

Air drying of food can be accomplished by using mechanical drier, solar dryer or in direct sunlight. In mechanical dryer, temperature and air velocity could be controlled as compared to sun drying. This leads to higher production rates and high quality products due to shorter drying time and reduction of the risk of insect infestation and microbial spoilage. Since mechanical drying is not dependent on sunlight, drying can be performed whenever necessary. Traditional sun drying takes place by exposing the product under direct sun light with consequent loss in product quality due to radiation, dust, animal, insects, microbes etc. (Karathanos and Belessiotis, 1995).Various forms of sun drying however, have the advantages of small or negligible installation and energy costs, though the running cost is high (as sun drying being a slow process due to climatic variation, is a labor intensive operation). In order to obtain good quality product an alternative to sun drying is solar drying or combined solar and mechanical drying utilizing renewable energy as much as possible. (Njie and Rumsey, 1997) pointed out that the drying is most significantly affected by the temperature followed by air velocity and radiation when sample thickness is constant. Some dryers are coupled to solar collector to increase inlet temperature and consequently reduce relative humidity (Selkuc et al., 1974 and Eissen et al., 1985). The overall objectives of the research work were (1) To construct a combined solar and mechanical cabinet dryer; (2) To evaluate the performance of thickness is constant. Some dryers are coupled to solar collector to increase inlet temperature and consequently reduce relative humidity (Selkuc et al., 1974 and Eissen et al., 1985). The overall objectives of the research work were (1) To construct a combined solar and mechanical dryer; (2) To evaluate the performance of dryer and (3) Drying of agro product with the constructed dryer.

Description of Dryer:

During mechanical drying, the electrical heater attached with blower was used. There were several arrangements of heater and blower, this various arrangement provides various temperature with the variation in upper shelf and lower shelf temperature. And for solar drying, the surrounding air comes in to the air heating chamber and becomes hot as it collects heat from black collector as well as from direct sunlight. The heated air passes through the duct as a result of density variation. For the combined mode, both the open sun drying and mechanical arrangement runs together providing heated air for air drying.

Drying of Agro Product:

For both the open sun drying and mechanical drying, the agro product slices of 5mm thickness were placed on each shelf in single layer and hot air passed through the shelf and the product was dried for 11 consecutive hours. The weight of slices was noted at a regular interval of ½ hr. and from the known initial moisture content, moisture content at any time interval was calculated. To investigate influence of temperature on drying rate at constant air velocity, sample with constant thickness was dried at variable temperature using various blower-heater combinations.

Drying Analysis:

Moisture Content:

The percentage moisture content was determined by using following formula,

$$M_C = \frac{M_i - M_d}{M_i}$$

Where, Mi is the mass of sample before drying and Md is the mass of sample after drying.

Drying Rate:

The drying rate of sample during drying period was determined as follows,

$$R_d = \frac{M_i - M_d}{t}$$

Where, t is time interval of drying readings

Drying Efficiency:

Amount of heat required to evaporate the moisture inside the product is called as drying efficiency. Total heat in case of solar dryer is the availability of solar radiation on collector surface of the dryer. This drying efficiency was calculated by equation,

$$\eta_d = \frac{W \times \Delta H}{AC \times IC}$$

Where, W= moisture evaporated (kg), ΔHl = Latent heat of vaporization of water, 2320 (kJ/kg), Ic= Total hourly isolation upon collector, (Wm^2), Ac= Area of collector (m^2)

Materials and Methods:

Material:

The experiment was conducted on effect of drying on storage and dried quality of vegetables. The fresh vegetables were collected from local market during Feb-March.

Selection of Product:

Table 1

SI NO:	PRODUCT	ENERGY (kcal)	PROTEIN (gm)	PRESENT WATER (%PER 100gm)
1	RADISH	16	0.68	95
2	BTTER GOURD	17	1.00	92.14

The average dimensions of fruit vegetable were 60-80 mm long and 15- 20 mm average diameter, dark green colored vegetable were selected for the study. The vegetable were thoroughly washed and sliced into 5 mm thickness using sharp sterilized knife.

Experimental Set Up:

Instrument Specification:

Blower	Power Input=335 W, Voltage=230v, Speed=13000rpm, Air Volume=2.3 M^3/Min
Heater	Material=Copper, Copper Tube Dia=O.5cm, Voltage=230v
Thermocouple	Type=K, Resolution=1^{0}c, Voltage=230v, Measuring Range=-50^{0}c To 750^{0}c, Weight=120g

The experimental set ups used for determining the influence of various drying methods on the drying behavior of agro product. The laboratory scale batch type hot air dryer is used and dryer used in present which is modified in form of vents for natural air flow in dryer and also platform constructed as in

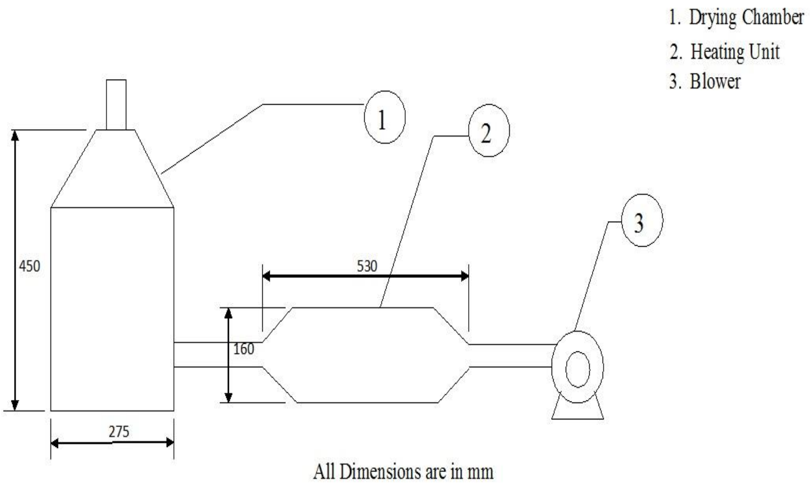

Figure 1: Experimental Setup

Method:

The slices were then weighed exactly 500 gms for each treatment. These were kept for drying in three replications. The hot air drying was carried by drying the samples at 50 air temperatures and a constant air velocity of 2 m/s. For sun drying the weighed agro product slices were taken in paper plates and kept on the open floor on the top of terrace. For solar drying the weighed product slices were taken in paper plates and kept inside the solar dryer platform. The hot air drying was carried out by keeping the weighed slices in steel plates. Observations on physiological loss in weight and colour change in each sample were recorded at the particular interval of in sun drying 1 hrs, 1 hour in solar drying and 10-20 minutes for hot air drying. The change in color of slices was observed for further analysis. The texture of end produce was also tested by breaking the dried slices and the produce was categorized into different grades. Temperature and relative humidity in the open sun drying and solar drying was recorded throughout the drying period using hygro- thermometer. The hot air drying experiments were conducted at 40, 50 and 60 air temperatures and a constant air velocity of 2 m/s. In each experiment, about 500 g of samples were used. Moisture losses of samples were recorded at 10 min intervals for first one hour and 20 min subsequently thereafter for determination of drying curves. The open sun and solar drying experiments were carried out during the periods of February-March under the clean climatic conditions of Vidarbha. Each experiment started at 8:00 am and continued till 6:00 pm. To determine the moisture loss of drying samples during experiments, samples were taken out of the solar dryer and weighed at various time intervals, ranging from 30 min at the beginning of the drying to 1hr during the last stage of the process. The moisture loss of samples was determined with the help of a digital electronic balance having an accuracy of 0.01 g. These were again spread in the dryer in the next morning and the drying process was continued until no further changes in their mass were observed. Also, to compare the performance of the solar dryer with that of open sun drying, both samples were dried simultaneously under the same weather conditions.

Result and Discussion:

The effect of different drying methods on drying time, color and texture of the agro product slices were determined. The result shown that there was a general decline in moisture content of the sample from 500 g to 50 g in all methods of drying.

Figure 4: Product of Radish

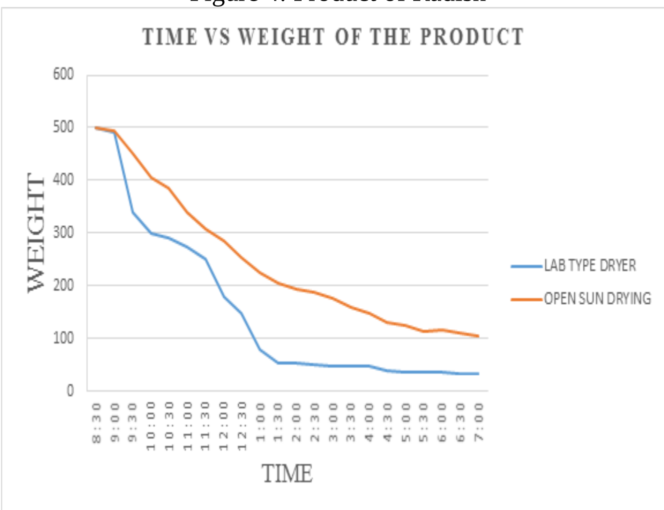

Figure 5: Time Vs Weight of the Product

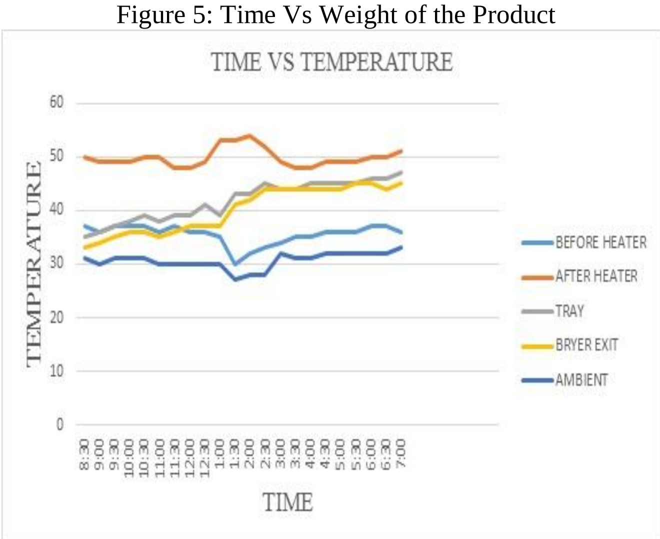

Figure 6: Time Vs Different Temperature

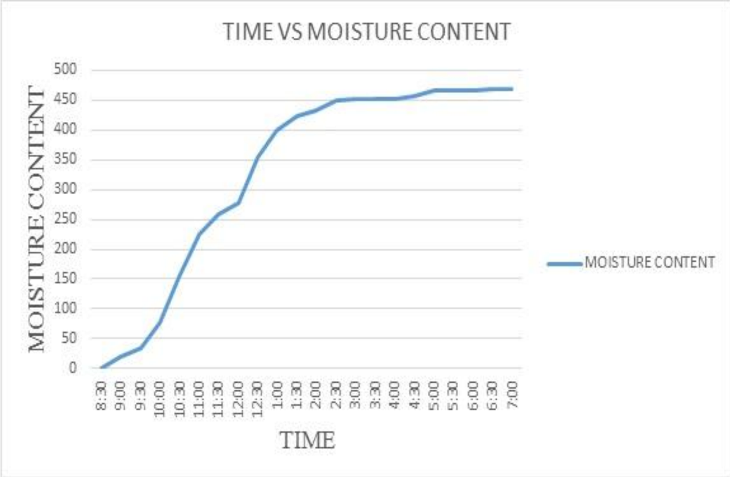

Figure 7: Time Vs Moisture Content

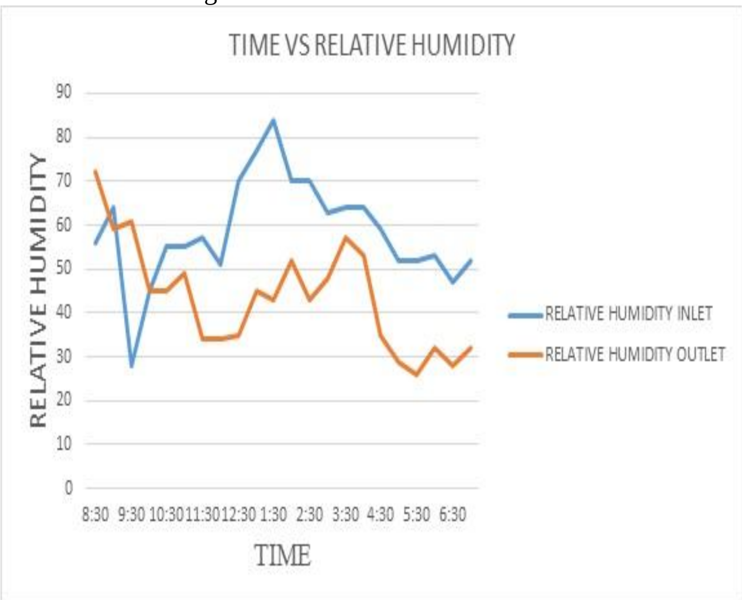

Figure 8: Time Vs Relative Humidity

Hot air drying of radish the moisture content versus drying time curves as affected by various air temperatures are shown in Fig. 2. The samples of average initial mass of around 500 gm were dried to the final mass of about 32 gm until no further changes in their mass were observed. It is evident from these curves that the moisture content decreases continuously with the drying time. As expected, the air temperature had a significant effect on the moisture content of samples. Solar drying of radish.

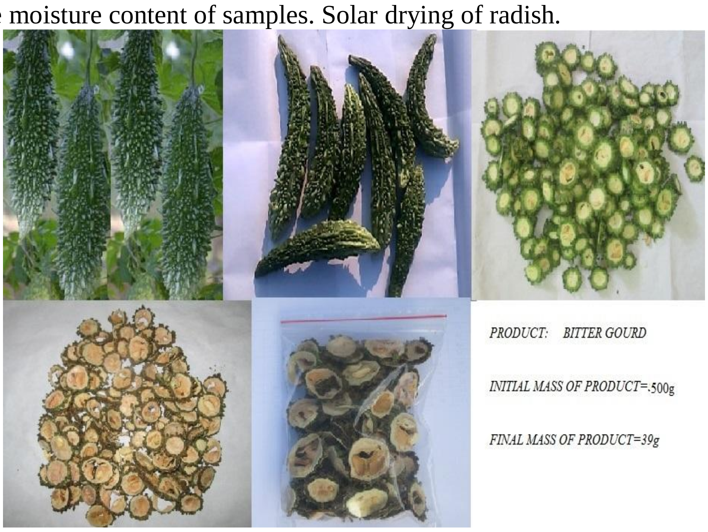

Figure 9: Final Product of Bitter Gourd

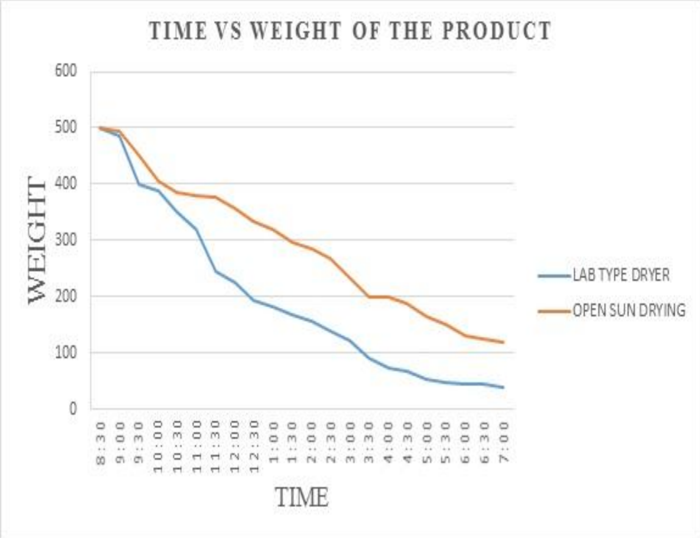

Figure 10: Time Vs Weight of the Bitter Gourd

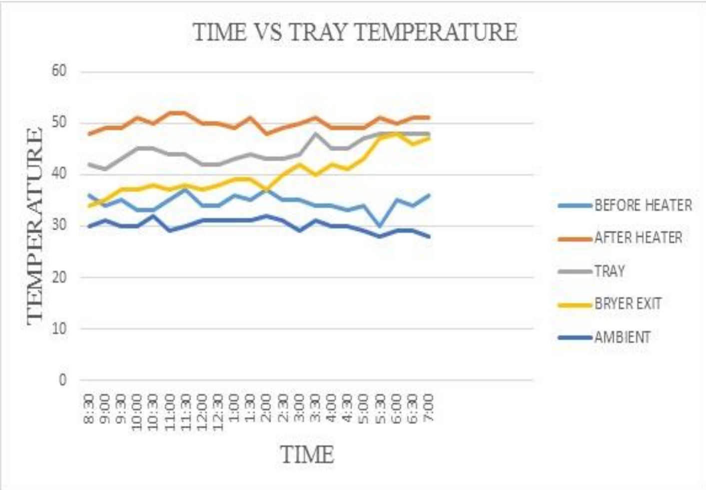

Figure 11: Time Vs Different Temperature

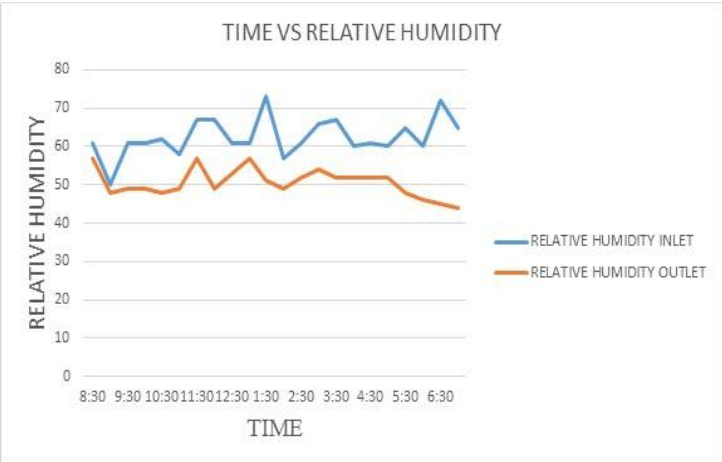

Figure 12: Time Vs Relative Humidity

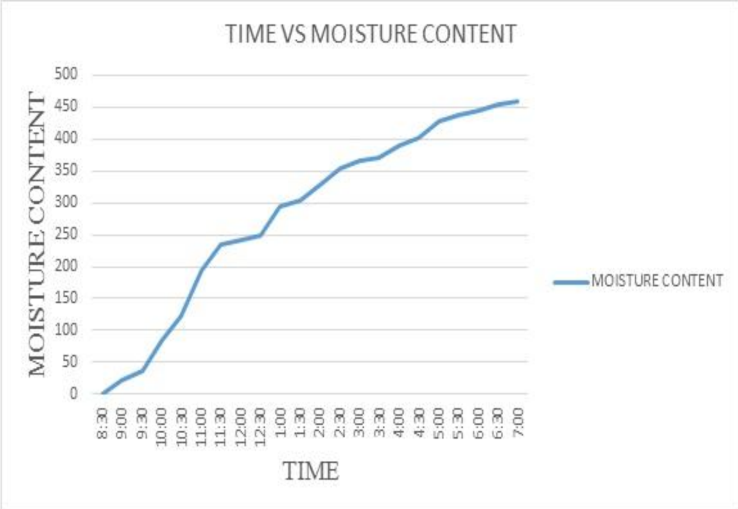

Figure 13: Time Vs Moisture Content

This clearly indicates that the drying rate in the solar drying would be higher than open sun drying. Figure 2 suggests drying curves for okra dried by solar dryer and open sun drying methods. Whereas the drying is smooth and controlled by temperature variation using hot air dryer. Drying rate goes on decreasing with decrease in moisture content as shown in Figure 5. And it appears to be smooth and controlled in hot air dryer than in open sun and solar dryer Further the observations were also recorded on change in colour of the dried product. The change of colour from green to light green was observed with solar drying. The change of colour in hot air dryer at 90 air temperature was brownish and dark brown respectively. Whereas the colour was found to be better (green) at 40 air temperature in hot air dryer.

Conclusion:

The two drying methods used greatly affected the drying characteristics agro product. The lab type dryer was found to be more efficient than the open sun drying. In addition, the samples of lab type dryer were completely protected from insects, birds, rain and dusts. The commonly consumed vegetables was dried under conventional drying, sun drying and open sun drying. The drying characteristic and time required for drying of product was studied and final dry weight of the vegetable slices were estimated. It was found that product samples, dried by hot air drying were reported to take minimum time for drying with maximum removal of moisture. The initial first hour of hot air drying and sun drying and initial 6 hours under open sun drying resulted in maximum removal of moisture from agro product. The vegetables slices dried in hot air dryer at 50 gives better results in maintaining better appearance, colour and texture.

References:

1. Jayaraman, D.K., Das Gupta and N. Babu Rao (1991), Quality characteristic of some vegetables dried by direct and indirect sun drying, Indian food packer, 45, 18-23.
2. Kalra, S. K. and K. C. Bhardwaj (1981), Use of simple solar dehydration for drying fruits and vegetable products. Journal of Food Science Technology, 45, 18-23.
3. K.R. Ajao, A.A. Adedeji, Assessing the Drying rates of some Crops in Solar Dryer. Journal of Research information in Civil Engineering, Vol.5, No.1, 2008
4. Maskan, A., Kaya, S., & Maskan, M. (2002). Hot air and sun drying of grape leather (pestil). Journal of Food Engineering, 54(1), 81-88.
5. Mujumdar, A. S. (1995). Handbook of industrial drying (second Ed.). New York: Marcel Dekker.
6. Pangavhane, D. R., Sawhney, R. L., & Sarsavadia, P. N. (2002). Design, development and performance testing of a new natural convection solar dryer. Energy, 27(6), 579-590.
7. Sacilik, K., & Elicin, A. K. (2006). The thin layer drying characteristics of organic apple slices. Journal of Food Engineering, 73(3), 281-289.
8. Schirmer, P., Janjai, S., Esper, A. Smitabhindu, R., & Mu¨hlbauer, W. (1996). Experimental investigation of the performance of the solar tunnel dryer for drying bananas. Renewable Energy, 7(2), 119-129.
9. Tiris, C., Tiris, M., & Dincer, I. (1996). Energy efficiency of a solar drying system. International Journal of Energy Research, 20(9), 767-770.
10. Togrul, I. T., & Pehlivan, D. (2003). Modelling of drying kinetics of single apricot. Journal of Food Engineering, 58(1), 23-32.
11. Westerman, P. W., White, G. M., & Ross, I. J. (1973). Relative humidity effect on the high temperature drying of shelled corn. Transactions of the ASAE, 16, 1136-1139.

12. Hiia, C.L., C.L. Lawb, M. Clokea and S. Suzannah, 2009. Thin layer drying kinetics of cocoa and dried product quality. Bio Systems Engineering, 102: 153-161.
13. Abul-Fadl, M.M. and T.H. Ghanem, 2011. Effect of Refractance-window (RW) drying method on quality criteria of produced tomato powder as compared to the convection drying method, World Applied Sciences Journal, 15(7): 953-965.
14. Augustus Leon, M., S. Kumar and S.C. Bhattacharya, 2002. A comprehensive procedure for performance evaluation of solar food dryers. Renewable and Sustainable Energy Reviews, 6: 367-393.
15. Chua, K.J. and S.K. Chou, 2003. Low-cost drying methods for developing countries. Trends in Food Science and Technology, 14: 519-528.