Paper ID HP 08

EVALUATION OF DRYING CHARACTERISTICS FOR GINGER IN FORCED CONVECTION DRYER

Toufik G Tamboli ,
Department of Mechanical Engg, Indira College of Engg. & Management, Pune,
tamboli.tg@gmail.com

Mahesh G Bhong ,
Department of Mechanical Engg, Indira College of engineering & Management
mahesh.bhong@gmail.com

ABSTRACT:-
Drying or dehydration or dewatering is the oldest in the present work, quality drying characteristics of sliced ginger with forced convection method were studied. The high moisture content of the ginger and low shelf life of raw ginger makes the transportation and marketing of ginger an expensive proposition. Due to excess moisture content, it subjected to spoilage and become waste. Drying improve the shelf life and decrease volume of particular product. Thereby, making the product more useful with long storage capacity.

In the experimentation, different combinations of temperature and air velocity on the charge mass are used to get readings. This work involves experimental determination of effective drying parameters such as moisture content, Moisture ratio and drying rate to analyze these parameters in relation to each other. The air heater will provide the thermal energy to pass heat over ginger slices (2 to 4 mm thickness). The effects of inlet hot air temperature and inlet air velocities on the charge mass is to be determined. Drying characteristics at different temperature like 50°c, 60°c & 70°c and Reynold nos.10R, 20R, 30R& 40R are used. The moisture content decreased more rapidly when drying was performed at higher drying temperatures.

Keywords:- Drying, electrical heater, forced convection, moisture content, moisture ratio, drying rate

1. INTRODUCTION

Drying technologies are useful for rural farming areas and food processing industries. [1] It is a preservation process in which preservation is done through the decrease of moisture content, which avoid potential deterioration and contamination during long storage periods. Also, food quality and the hygienic conditions are preserved. [5].Quality distinction was made some 4000 years ago in ancient Egypt between medicinal plants dried in the sun and those dried in the shade. However, factors such as scale of production, availability of new technologies and pharmaceutical quality standards must be considered for medicinal plant drying. [11].

Drying process deals with moisture removal caused by simultaneous heat and mass transfer. Heat available from the surrounding environment evaporates the surface moisture content of the drying object. The moisture inside the product can be transported to the surface of the product and then evaporated, or evaporated internally at a liquid vapours interface and then transported to the surface as vapour. Dehydrated foods have low moisture content which prevents the growth of microorganisms that causes spoilage reactions Thus more research to optimize the dehydration processes in the agro-food industry come out with the study of technological variables involved in the process itself. While choosing dryer, certain performance factors such as energy efficiency, thermal efficiency, adiabatic thermal efficiency, specific heat energy consumption, specific electric energy consumption, and specific volume of dryer and specific fuel Modelling of the dehydration process is also very useful in the design and optimization of dryers. [2]

2. MATERIALS AND METHODS

2.1. Ginger

The fresh ginger rhizomes were procured in bulk from the local market of Pune which was, then washed under running water to remove adhering impurities. The ginger rhizomes were cut into slices (3 to 5 mm thickness) with a sharp stainless steel slicer.

2.2. The Drying Equipment

The drying setup consists of following basic units:-

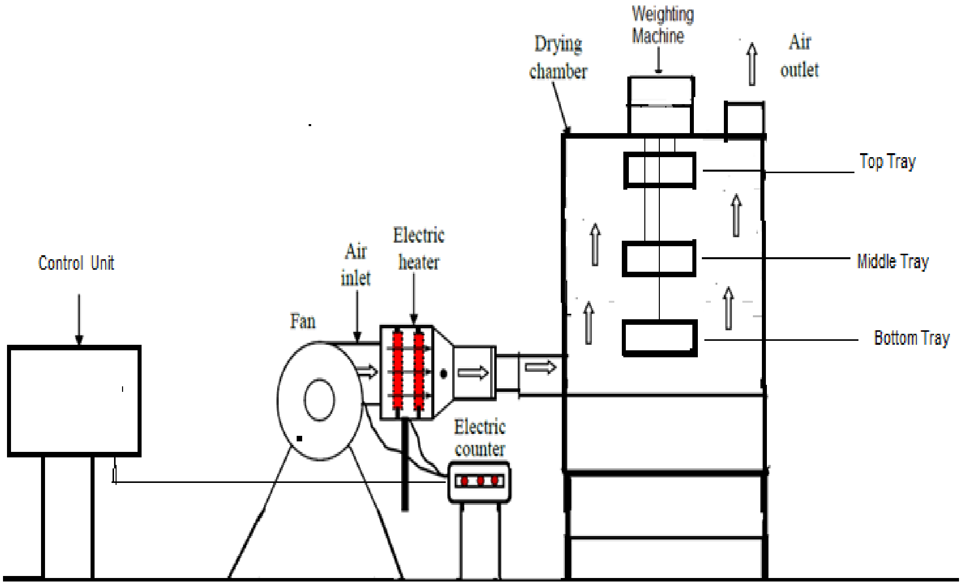

Fig.1. Experimental Setup

(1) Blower:- It is used to provide the desired drying air velocity. Blower used for experimentation with capacity of 1200 CFM. The velocity of air flow is to be controlled by an air-control-valve and measured using a vane anemometer sensor with an accuracy of ± 0.1 m/s and to place two centimeters above the drying tray.

(2) Electrical heater: - A heating unit coupled with an air temperature control system. 2 Heater's with combined capacity of 3 Kw (2 Kw & 1 Kw) is used for experimentation. The controller could maintain the air temperature within ± 0.1°C of the set limit. An electric meter was used to measure the amount of energy consumed by the electric heaters during each experiment. A constant temperature during the experiment could be maintained with an accuracy of ± 0.1°C by the repeated on/off action of the burner.

(3) The drying chamber:- The drying chamber is made from the plywood with thickness 18 mm. The dimension of box are 128cm x 95cmx 47cm. It is insulated from inside with insulating foam to prevent loss of heat to outside environment. Three trays are used to place the charge mass like ginger slices. Tray size is 17cmx27cm. Trays are placed with distance of approx. 20 cm. 12 Thermocouples are used in combustion chamber for temperature measurement at different location.

(4) Data logger: - Data logger (Myko Make) with 16 channel and VFD (MakeCrompton Greaves) is used to control the blower velocity and temperature of heater during entire cycle of working. It is assisted with software to run the program for specific time.

(5) Weighting Machine:- It is HMT digital top pan balance (1000 ± 0.01 g) It is placed at the top of the box and each tray with charge mass attached with string is weighted before and after the drying.

2.3 The Drying Process

During the experiments, the ambient temperature, relative humidity, and inlet and outlet temperatures of air in the dryer chamber is recorded. Prior to the drying process, the samples need to be washed and slices of size 3mm to 5mm are prepared. Three trays are to be filled with ginger slices with each tray having 100 Gram charge mass. 9 Samples are taken for record purpose. 3 each sample is placed in the each tray diagonally. Blower is to be started and air velocity is to be set with hot wire anemometer. Data logger is to be started to run the program for specific time. The readings for the weight of dried ginger, inlet and outlet velocity, moisture content at inlet and outlet, atmospheric temperature and humidity is to be taken at time interval of 30 min. Total cycle time is 6 hr. Photos of samples before and after drying are taken for the record. Drying begin with runs at each experimental setting of air temperature, and air flow velocity repeated three times, and the average values recorded. Hot air passes from the heater surface through the drying chamber over product being dried interacts with the wet feed. This interaction causes removal of moisture from contact area to take place and resulting in the products being dried effectively. The product are then discharge through the exit port of the chamber and their weight is recorded.

2.4 Moisture Content, Moisture Ratio and Drying Rate

Moisture Content Determination: The moisture content of the ginger rhizomes was obtained according to ASAE Standard S358.2 (1983). The sample was dried in a drying chamber at different temperature for 6 hours and weighed using a weighing balance at every 30 min interval to obtain different levels of moisture content. The moisture content of the sample in percent dry basis was calculated using Equation 1 [3]

$$Ms = \frac{100\,(W_i - W_f)}{W_f} \qquad \text{---------------------- (1)}$$

Where, M_s is the Moisture Content of Ginger rhizome (in % dry basis)

Wi is the Initial Mass of ginger, rhizomes before drying (in grams)

W_f is the Final Mass of the rhizomes after oven drying (in grams)

For example, for constant temp.50°c and Reynold no. 10R, at Top tray

Moisture content = (206.26- 197.3)/206.26
= 3.650

Moisture Ratio (MR) :- MR represents the moisture ratio [6] . It is calculated according to the equation given below:-

$$MR = \frac{(M - M_e)}{(M_0 - M_e)} \qquad \text{---------------------------------(2)}$$

Where, M is the moisture content at any time,

M_0 is the initial moisture content

M_e is equilibrium moisture content.

For the present study MR is simplified to M / M_0 instead of (M –M_e) / (M_0 – M_e) because M_e is relatively small compared to M and M_0 .Hence, the error involved in the simplification can be neglected.

For example, for constant temp.50°c and Reynold no. 10R, at Top tray,

Moisture ratio = 206.26 /198.73
=1.037

Drying Rate:- The drying rates at different timing during solar drying is to be computed in all experimental conditions using following relationship:-

$$\frac{dM}{dT} = \frac{M_o - M_t}{t} \qquad \text{----------------------(3)}$$

where, dM/dT is drying rate (kg water/kg of material. min),

t is time (min),

M_0 and M_t are the initial and final moisture content, respectively.

For example, for constant temp.50°c and Reynold no. 10R, at Top tray

Drying rate = (206.26 -198.

= 0.251

3. RESULTS AND DISCUSSIONS:-

(1) Graph of Moisture Content

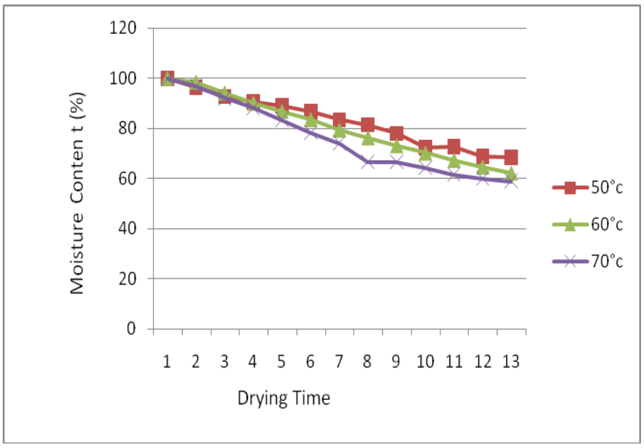

Fig. 2 for Top

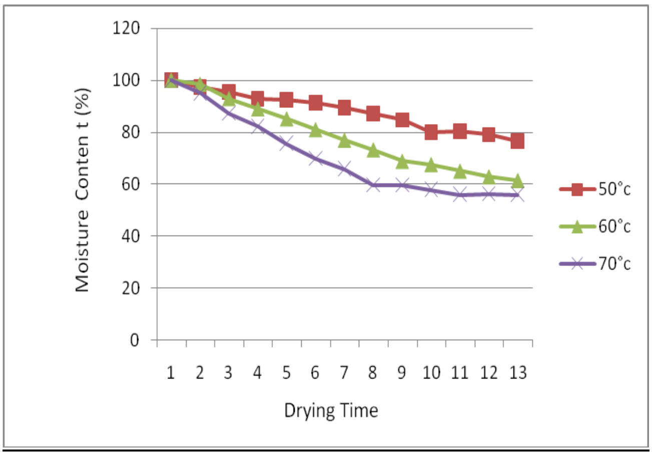

Fig. 3 for Middle

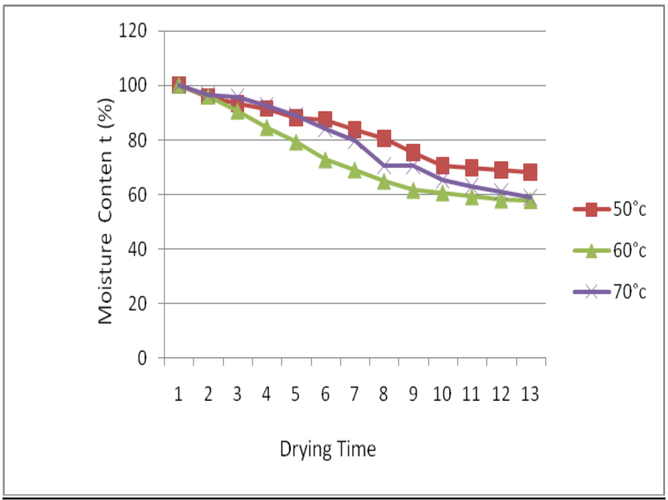

Fig. 4 for Bottom

(2) Graph of moisture ratio

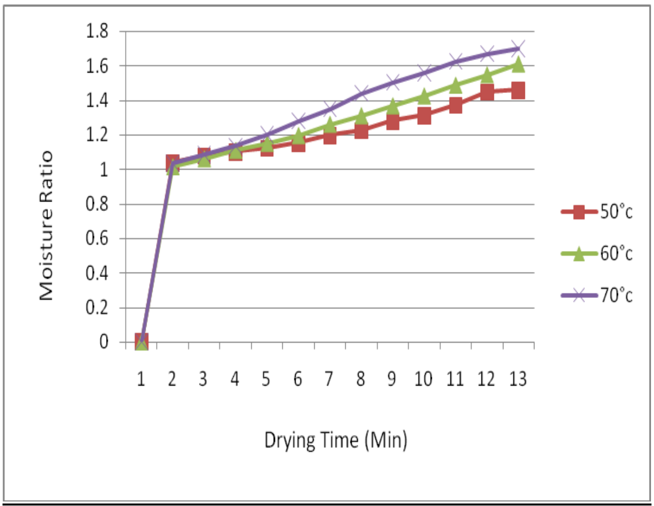

Fig. 5 for Top

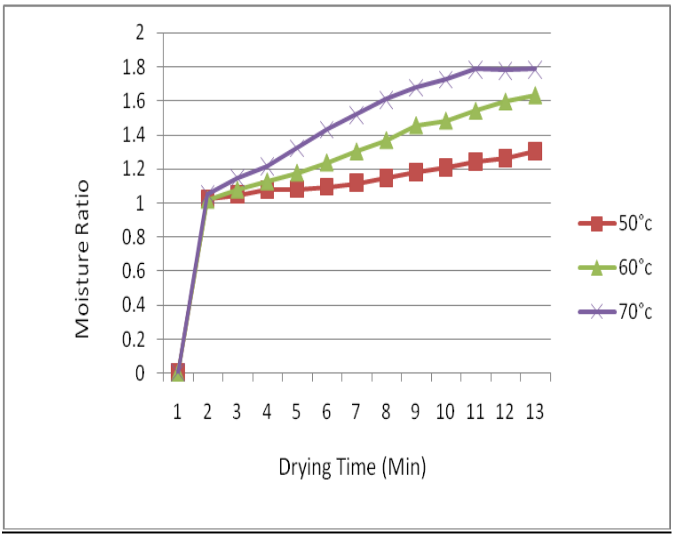

Fig. 6 Middle

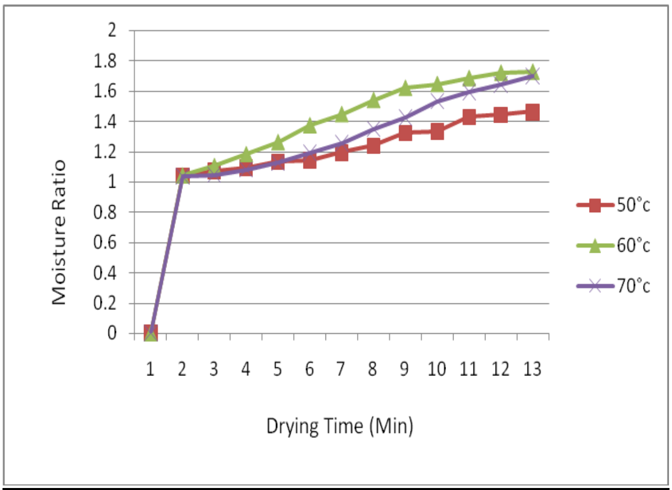

Fig.7 for Bottom

(3) Graph of drying rates

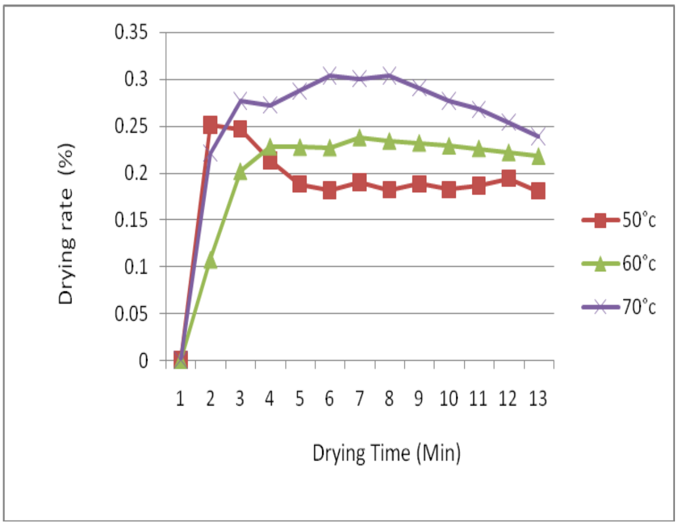

Fig. 8 for Top

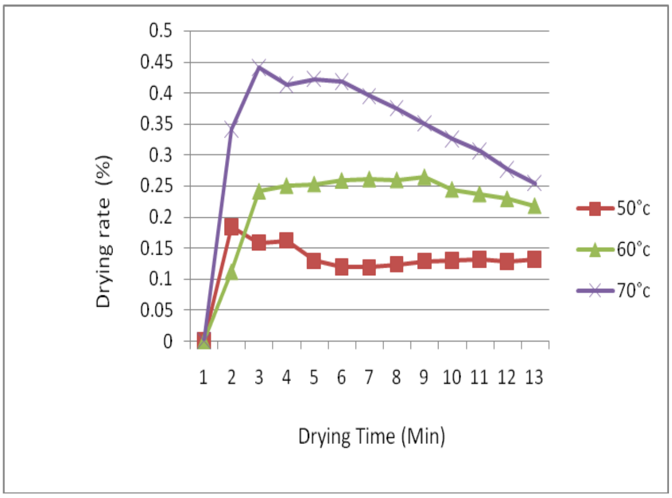

Fig. 9 for Middle

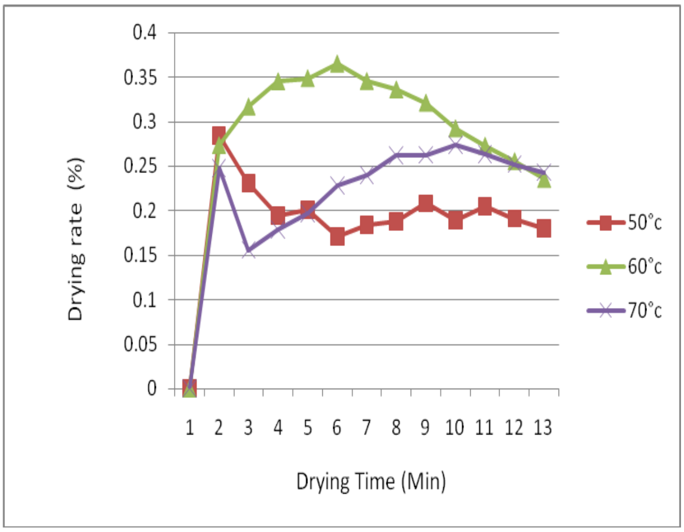

Fig. 10 for Bottom

4. CONCLUSIONS:-

1)Moisture Content:- for 10 R, better moisture removal at 70°C is observed, for 20R&30R, better moisture removal at 60°C is observed and for 40R, better moisture removal rate is observed for all 50°C, 60°C & 70°C.

2) Moisture Ratio:- Moisture ratio increases with increase in temperature. for 10 R, highest moisture ratio at 70°C is observed, for 20R&30R, highest moisture ratio at 60°C is observed and for 40R, better moisture ratio is observed for all 50°C, 60°C & 70°C.

3) Drying Rate:- Drying rate increases with increase in temperature. for 10 R & 40 R, highest drying rate at 70°C is observed, for 20R&30R, highest moisture ratio at 60°C is observed.

4) Though, better drying characteristics observed at 70°C, it is difficult to operate cycle because of high temperature. Also, performance of instrument reading is likely to be affected as we cannot hold the instruments for long time i.e. till stability of reading.

5) Also, for more Re value, heat removal rate more and power consumption also more. Also, middle tray drying rate found lower due to diversion of air in chamber.

6) It is concluded that, with Temp -60°C and Reynold no- 20r & 30r better drying characteristics are obtained.

5. REFERENCES:-

[1]K.J. Chua and S.K. Chou, Low-cost drying methods for developing countries, Trends in Food Science & Technology 14 (2003) 519–528.

[2]Jnyana R Pati, Santosh K Hotta, P. Mahanta :- Effect of waste heat recovery on drying characteristics of sliced ginger in a natural convective dryer; Procedia Engineering 105 (2015) 142-152.

[3]E. A Ajav & C. A. Ogunlade :- Physical Properties of Ginger (Zingiber Officinale); Global Journal of Science Frontier Research: D Agriculture and Veterinary Volume 14 Issue 8 Version 1.0 Year 2014.

[4]Olusegun S. Olaoye, and A. J. Ogunleye:- Experimental Study of Drying Parameters of Ginger at Different Temperature and Moisture Content: EJERS, European Journal of Engineering Research and Science Vol. 3, No. 9, September 2018.

[5]Ashok Kumar, Neha Kulkarniand Birendra Kumar Mehta:- Drying kinetics of ginger (Zingiber officinale) slices undergoing microwave drying: International Journal of Agricultural Engineering/ volume-6, Issue-2, October 2013, 317-322 International Journal of Agricultural Engineering |Volume 6 | Issue 2 | October, | 2013 | 317–322

[6]Chanchal Loha, Reeta Das, Biplab Choudhury and Pradip K Chatterjee:- Evaluation of Air Drying Characteristics of Sliced Ginger (Zingiber officinale) in a Forced Convective Cabinet Dryer and Thermal Conductivity Measurement; Loha et al., J Food Process Technol 2012.

[7]Akinjide A. Akinola, Osarhiemhen Azeta and Stanley N. Ezeorah :- Evaluation of the Dehydration Characteristics of Ginger (Zingiber Officinale) Root Slices Using Refractance Window Drying Technology; FUOYE Journal of Engineering and Technology, Volume 3, Issue 1, March 2018 ISSN: 2579-0625 (Online), 2579-0617 (Paper)

[8] Kukadiya, V. D.; Sharma, G. P.; Cholera, S. P. And Verma, R. C:- Thin-Layer Infrared Radiation Drying Of Ginger Slices; Agres – An International e-Journal , (201) Vol. , Issue 3: 291-300 ISSN 2277-9663

[9]A. Sangwan & A. Kawatra & S. Sehgal:- Nutritional composition of ginger powder prepared using various drying methods; J Food Sci Technol (September 2014)

[10]Jayashree E. & Visvanathan R. & John Zachariah T.:- Quality of dry ginger (Zingiber officinale) by different drying methods:, J Food Sci Technol (November 2014)

[11] M. A. Hoque, B. K. Bala, M. A. Hossain and M. Borhan Uddin, Drying Kinetics of Ginger Rhizome ,Bangladesh J. Agril. Res. June 2013International Journal of Agricultural Engineering |Volume 6 | Issue 2 | October, | 2013 | 317–322

[12] A. Waheed Deshmukh,Mahesh N. Varma,2 Chang Kyoo Yoo, and Kailas L.Wasewar2,3:- Investigation of Solar Drying of Ginger (Zingiber officinale): Emprical Modelling, Drying Characteristics, and Quality Study; Hindawi Publishing Corporation Chinese Journal of EngineeringVolume 2014,

[13] Ratiya Thuwapanichayanan, Charotorn Phowong, Donludee Jaisut, Jiři Štenc ,Effects Of Pretreatments And Drying Temperatures On Drying Characteristics, Antioxidant Properties And Color Of Ginger Slice; Acta Universitatis Agriculturae Et Silviculturae Mendelianae Brunensisvolume 62

[14] Bijaya B. Bag,Ginger Processing in India (Zingiber officinale): A Review; International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 7 Number 04 (2018)

[15] B Haryanto, R Hasibuan, Alexander, M Ashari and M Ridha,Herbal dryer: drying of ginger (zingiber officinale) using traydryer; International Conference on Agriculture, Environment, and Food Security IOP PublishingIOP Conf. Series: Earth and Environmental Science 122 (2018)

[16]R Hasibuan and M A Zamzami,The Effect of Operating Conditions on Drying Characteristics and Quality of Ginger (Zingiber Officinale Roscoe) Using Combination of Solar Energy-Molecular Sieve Drying System1st Annual Applied Science and Engineering Conference IOP Publishing IOP Conf. Series: Materials Science and Engineering 180 (2017) [17] Kawaljit singh, A.S.Bava , Jasim Ahmed:- Dehydration of Ginger Slices; Jounral of Scientific & Industrial Research Vol.60, Jun:2001,pp 510-512

[18] Gbasouzor Austin Ikechukwu, Member IAENG, Sam Nna Omenyi : Convective Drying of Ginger Rhizomes; Proceedings of the World Congress on Engineering and Computer Science 2017 Vol II WCECS 2017, October 25-27, 2017, San Francisco, USA

[19] Joseph ALAKALI, Simon Verlumun IRTWANGE,,,Adesola SATIMEHIN,Moisture adsorption characteristics of ginger slices. Ciência e Tecnologia de Alimentos

[20] M. A. Hoque, B. K. Bala, M. A. Hossain and M.Borhan Uddin Drying Kinetics Of Ginger Rhizome (Zingiber officinale):- Bangladesh J. Agril. Res. 38(2): 301-319, June 2013International Journal of Agricultural Engineering Vol. 6Issue 2 October 2013,317–322

[21] Jalal Bayati Zadeh and Nasroallah Moradi Kor Physiological and pharmaceutical effects of Ginger (Zingiber officinale Roscoe) as a valuable medicinal plant Pelagia Research Library European Journal of Experimental Biology, 2014, 4(1):87-90

[22] Sunil K. Sansaniwal1, M. Kumar, Rajneesh, V. Kumar:- Investigation Of Indirect Solar Drying Of Ginger Rhizomes (Zingiber Officinale): A Comparative Study; Journal Of Engineering Science And Technology Vol. 12, No. 7 (2017) 1956 - 1971 © School Of Engineering, Taylor's University.

[23] A.K.Srivastava, S.K.Shukla and Sandeep Mishra:- Evaluation of Solar Dryer/Air Heater Performance andthe Accuracy of the Result; Energy Procedia 57 (2014) 2360 – 2369 2013 ISES Solar World Congress.