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Development on Mixed Mode Solar Dryer for Ginger

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Abstract:-- **In most developing countries, food preservation is a major problem. Farmers fulfill all food requirements, by giving good quality of products to the end users. But they fail to preserve the food for long time. Preservation is the technique in which food can be saved for a long time. Generally farmers prefer open sun drying for drying the agricultural products. In the rural areas of our country there is a very large amount of production of food, but because of lack of facilities there is no any special provision for drying. So they prefer the conventional open sun drying, but this method is not so effective, because it requires more time for drying. Also quality of the product gets hampered. In order to avoid such difficulties in preservation of food, solar drying is to be introduced. In this paper we made a solar dryer for ginger. Solar dryer have shown a very good result in preservation of the ginger from wastage, poisoning and other contaminants. The solar dryer is solely depending upon the renewable energy of sun. It does not use any fossil fuel for burning.**

Keywords: **Food Problems, Renewable Energy, Solar Dryer.**

I. INTRODUCTION

In developing countries like India, there is no problem of food production. But there is a very big problem of preservation of it. In rural areas of Maharashtra state like Sangli, Miraj, there is a large production of agricultural products like ginger, grapes, turmeric etc. In this paper work had been done on ginger. The assessment of preservation of ginger using solar dryer is in Sangli. The climatic condition in Sangli is dry and arid, the temp is near about 28-30°C in day time, the relative humidity is about 69-70%. Its elevation is of about 549m above from sea level. In this area there is production of ginger in a large amount. Ginger is a flowering plant whose roots are widely used as a spice or folk medicine. It is in the family Zingibiraceae, to which also belongs the turmeric.

II. NEED OF SOLAR DRYER

The problems involved in freezing and other conventional preservative methods for preservation of food are removed by the solar dryer. In the conventional method other than that of freezing is open sun drying, it is mostly preferred by the farmers in the rural area. In this conventional method, the ginger comes in contact with sun openly in the atmosphere, but because of which it get contaminated with dirt and dust particles contained by the flowing air. And during this open sun drying the ginger gets spoiled due to get in touch with birds, animals and other insects. The solar dryer overcome all these drawbacks of conventional open sun drying method, and assures a good quality of preserved gingers.

Mostly there are three major types of solar dryer and these are:

1) Direct mode solar dryer.
2) Indirect mode solar dryer.
3) Mixed mode solar dryer.

1.Direct mode solar dryer

In this type of dryer the setup is simple in construction; it consists of a cabinet which is covered with a piece of glass placed at a specific angle. It is purposefully given for incident rays. These solar dryers expose the products to direct sunlight. The inner surface is painted black which helps to absorb the radiations coming from the sun. The product to be dried is placed directly on this surface. These dryers may have enclosure, vents in order to increase efficiency. [1]

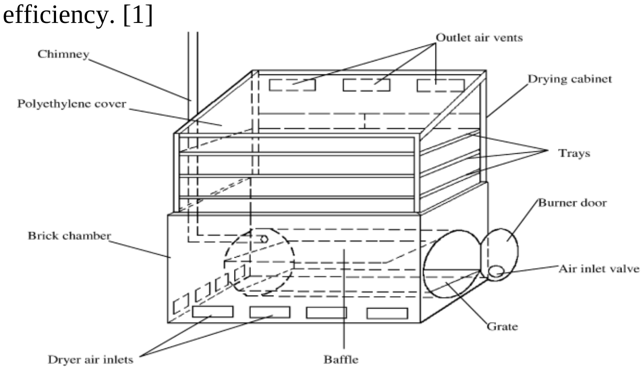

Fig. (1) Direct mode solar dryer.

2) Indirect mode solar dryer

The construction of this type of dryer is little bit different than that of the direct mode solar dryer. Rather than here the products are not introduced directly to the sun radiations they are preferred to be heated indirectly. Here the air coming from the inlet vent at the bottom is heated by the black surface and then passed on to the cabinet where the products are preserved. Here due to the heating of the incoming air, the products get dehydrated without the direct contact with sun radiations. Then after this the heated air exits from the chimney, taking the moisture content released from the product with it. The most important advantage of this indirect mode system is that it makes the protection of product easier. It helps to prevent contamination of the product from windblown or by birds insect or animals; also the direct contact to sun radiations may alter the properties chemically.[2]

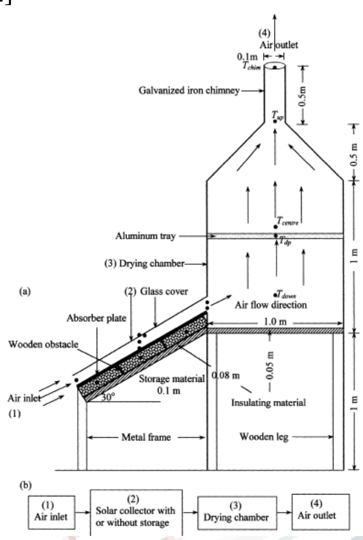

Fig. (2) Indirect mode solar dryer.

3) Mixed mode solar dryer

Mixed mode solar dryer is a combination of both the direct type and indirect type solar dryers. Here the product is heated with both the medium that are direct contact to sun radiations and also heating with the hot air from the heating chamber. It allows more amount of moisture to be removed from the products. This setup consists of a cabinet having a glass enclosure to open sun radiations and a chamber exactly below the cabinet attached with the blower to blow the heated air towards the products contained in the cabinet. Hence the setup consists of both the fundamental structures of direct and indirect type of solar dryers. [3]

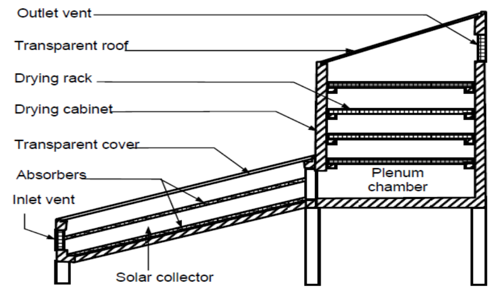

Fig. 1. Sectional view of the mixed-mode solar dryer.

Fig. (3) Mixed mode solar dryer.

II. LITERATURE REVIEW

[1] Avesahemad Sayyadnaimutulla Husainy[4], Designed and fabricated forced convection dryer using thermal energy storage for grapes in Miraj area. It dries a batch of 30 kg in 10-12 sunshine hours. But the sun radiations are at peak position only at the noon and it remains only for 3-4 hours. So it requires 5-6 days for drying, but this time is also reduced by the thermal energy storage. The initial moisture content in the grapes is 79% and after the drying the moisture content reduced to 20%. The average ambient temperature during the drying period is 33°C and 69% of relative humidity.

Fig. (4) Forced convection solar grape dryer with thermal energy storage [4]

[2] F.K. Forson and F.O. Akuffo[5], Designed a mixed-mode natural convection solar crop dryer and used for drying cassava and other crops in an enclosed structure is presented. A prototype of the dryer was constructed to specification and used in experimental drying tests. This paper outlines the systematic combination of the application of basic design concepts, and rules of thumb resulting from numerous and several years of experimental studies used and present the results of calculations of the design parameters. A batch of cassava 160 kg by mass, having an initial moisture content of 67% wet basis from which 100 kg of water is required to be removed to have it dried to a desired moisture content of 17% wet basis, is used as the drying load in designing the dryer. A drying time of 30–36 h is assumed for the anticipated test location (Kumasi; 6.71N, 1.61W) with an expected average solar irradiance of 400W/m2 and ambient conditions of 25 1C and 77.8% relative humidity. A minimum of 42.4m2 of solar collection area, according to the design, is required for an expected drying efficiency of 12.5%. Under average ambient conditions of 28.2 1C and 72.1% relative humidity with solar irradiance of 340.4W/m2, a drying time of 35.5 h was realized and the drying efficiency was evaluated as 12.3% when tested under full designed load signifying that the design procedure proposed is sufficiently reliable.

[3] Bukola O. Bolaji and Ayoola P. Olalusi [3], Built a simple and inexpensive mixed mode solar dry locally source materials. The temperature rise inside the drying cabinet was up to 24°C (74%) for hours immediately after 12.00(noon). The drying rate, collector efficiency and percentage of moist removed (dry basis) for drying yam chips were 0.62 kg-h, 57.5 and 85.4% respectively. The dryer sufficient ability to dry food items reasonably rapidly to a safe moisture level and simultaneously it superior quality of the dried product.

[4] Arpita Mehta, Sudhir Jain [6], Developed An indirect forced convection solar drier with thermal storage has been developed and tested its performance for drying ginger under the metrological conditions of Udaipur, India. Agricultural food materials can be dried at late evening, while late evening drying was not possible with a normal solar dryer.

III. DESIGN SPECIFICATION AND ASSUMPTION

Sr. No.	Content	Condition And Assumption
1	Location	Miraj, India Latitude 16.83^{0}C
2	Crop	Ginger
3	Drying period	October
4	Loading rate [kg/day]	3 kg
5	Initial moisture content [%]	79%
6	Final moisture content [%]	20%
7	Ambient air temperature[°C]	32°C
8	Incident solar radiation[W/ m^2]	800-1200 W/m^2
9	Wind speed[km/hr]	5km/hr
10	Drying time(sunshine hours)	8 hr (considering sunshine hr)

Table 1: Design specification & assumption.

IV. CALCULATION

The various parameters that relates to the dryer are-

1) Amount of moisture removed from ginger

$$M_w = \frac{M_p(M_i - M_f)}{100 - M_f}$$

2) Final relative humidity or Equilibrium Relative Humidity

$$a_w = 1 - e^{(-e^{(0.914+0.5693\ln(m))})}$$

Where,

$$M = \frac{M_f}{100 - M_f}$$

3) For collector area

$$A_c = \frac{E}{I \times T_d \times n}$$

4) Air flow rate calculated by

$$Q = C_d \times A\sqrt{2gH}$$

V. MATERIAL AND METHODOLOGY

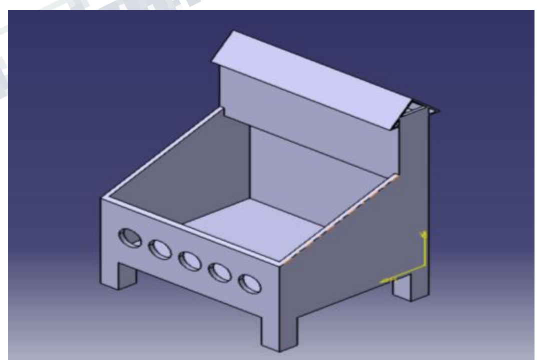

Fig.(5) Schematic diagram of ginger dryer.

The schematic diagram of solar ginger dryer is shown in fig (5) The mixed mode solar dryer consists of metal perforated heated plate having area of 0.47m^2 fitted inside the dryer cabinet. It also consists of 4 mm thick glass mounted over the dryer cabinet.

The dryer chamber was well insulated with the help of glaswool of thickness 5 mm, 23° slope is maintained between dryer and glass surface. The digital temperature

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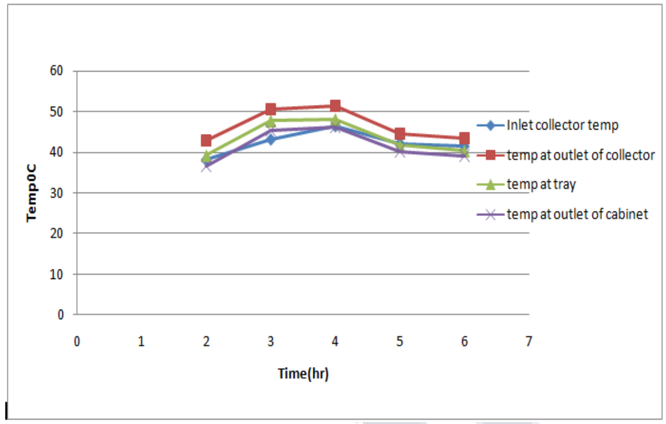
indicator having range (-20 to 80°C) is used to measure the temperature at dryer cabinet. A digital electronic scale is used to measure the weight of ginger. The accuracy of digital at pan is ±0.025 gm. Solar flux meter are used to measure solar radiation in terms of W/ m^2. The accuracy of solar flux meter is ±15 W/ m^2.

VI. EXPERIMENTAL PROCEDURE

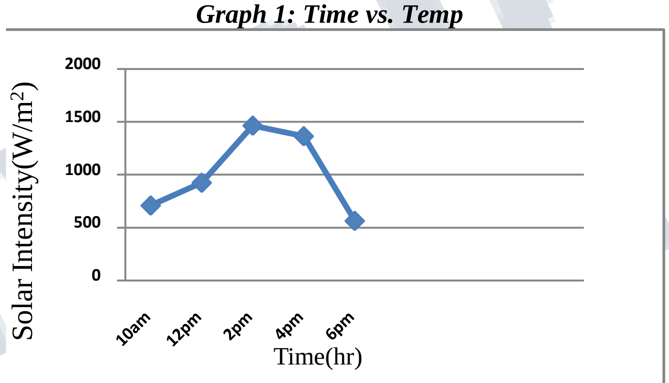
Only good quality of gingers is used in this experiment. A batch of 3 kg of fresh ginger was taken from the farm with water washing treatment. This includes the only the removal of mud particles from the crop. After this the initial moisture content and nutritional values of ginger were determined in a laboratory testing. The information was used for various purposes. Then the experimental procedure was started. Firstly the trays of dryer cabinet were loaded with ginger and then the setup is closed. This setup is then kept in the sunshine area. As the setup is having the air vents, the air passes through it and also the sun radiations incidents on it. The incident sun radiation evaporates the moisture content and the flowing air drives it out from the cabinet. The temperatures at various sections of dryer were taken from digital thermometer at regular interval of time. At the same time the sun radiations were measured with digital pyranometer. This procedure was carried until we obtained the good quality of dried gingers. The dried gingers were again tested in laboratory.

Table 2: Average temperature variation in different location of collector and cabinet (one day)

Time	Collector inlet temp °C	Collector outlet temp °C	Cabinet outlet temp °C
10:00 am	38.3	42.8	36.3
12:00 pm	43.2	50.5	45.5
2:00 pm	46.2	51.3	46.2
4:00 pm	42.2	44.5	40.3
6:00 pm	41.5	43.3	39.2



Graph 1: Time vs. Temp



Graph 2: Time vs. Intensity

VII. CONCLUSION AND RESULT

In this system we have utilized the maximum amount of solar radiation. The maximum temperature obtained by this system is 48°C in the cabinet. As we provided the air vents in the setup, it makes the drying more effective. As air passes through it, it flows out the evaporated moisture content with it. We require 2 days (16 hrs considering sunshine hr) for drying the ginger and also we obtain good quality of dried gingers, where the conventional method takes 6-7 days for the same. With our system 43°C temperature can be obtained easily at any location where the ambient temperature is about 30°C. As our experimental procedure is located in Miraj (India), the maximum temperature available for drying is 48°C. This system is best suited for the farmers with smaller production rates of ginger. This system can be utilized for other product like chilies, tomato and other food stuff with some small modification.

REFERENCES

[1] Benon Bena and R.J. Fuller, "Natural convection Solar dryer with biomass back up heater," Solar Energy, vol. 72, no.1, pp.75-83, 2002.

[2] El-Sebaii AA, S Abdul Enein, Ramdan MRI, H.G. ELGohary, "Experimental investigation of an indirect type natural convection solar dryer," Energy conversion and management, 43(2002), 2251-266.

[3] Bukola O. Balaji and Ayoola P. Olalusi, "Performance evaluation of a mixed mode solar dryer," AU J.T. 11(4): 225-231(Apr.2008).

[4] Avesahmad Sayyadnaimutulla Husainy and P.R. Kulkarni, "PERFORMANCE ANALYSIS OF SOLAR GRAPE DRYER WITH THERMAL ENERGY STORAGE BY PCM," IRJET, vol.2, issue 7, 2015.

[5] F.K. Forson and F.O. Akuffo, "Design of mixed mode natural convection solar crop dryer: Application of principles and rules of thumb," Renewable Energy 32, (2007) 2306-2319.

[6] Arpita Mehta and Sudhir Jain, "Performance of forced convection type solar dryer with thermal storage for ginger drying, vol.6, issue.1, April 2013, 14-19.