NUTRIENTS ANALYSIS OF AGRICULTURE PRODUCTS USING FORCED CONVECTION SOLAR DRYER

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Abstract - In *this modern developing world preservation of fruits and vegetable needed optimal post-harvest technologies so as to take care of their storage stability and extend shelf life. Drying may be a one among the water removal process from foodstuffs, used for preservation and storage purposes. Drying was also found faster in forced convection solar dryer. There are alternatives, but drying is best method for food preservation because it increases the storage life. Thanks to higher prices and shortages of fuels and to scale back consumption utilized in the drying process; more importance is given to solar energy sources because it's freely available. During this project work, a Forced convection solar dryer is designed and developed to review the performance of solar collector and dryer. Suction fan is employed at exhaust and runs on solar panel. It is wont to draw air and make sure the forced convection of air inside the dryer. This is often a price effective and economical alternative to the traditional drying procedures and also saving the running cost of traditional dryers. Color retention in forced solar dried powder found better in comparison to natural convection solar dryer.*

Key Words: **Solar dryer, Food, Preservation, Forced convection, Renewable energy resource.**

1. INTRODUCTION

Conventional open sun drying could also be a standard practice followed by small farmers for drying herbs and spices. Products dried under open sun lose their nutritional and medicinal values because of slow drying rate and improper heating. This paper focuses on the development of a low-price solar dryer for drying of unique medicinal value herbs like Curcuma zedoaria, curcuma caesia, and black cardamom. Study of drying kinetics helps in improving the planning aspects of solar dryer and optimization of the drying systems. Drying time of the Curcuma zedoaria dried within the developed dryer is about 60% but the open sun drying and thus the retention of color, antioxidant, and texture of the solar dried products is great. The developed solar dryer is getting to be suitable for small small-scale farmers and should be scaled up to any size. Drying is one among the methods to preserve food products for extended periods. The heat from the sun coupled with the wind has been wont to dry food for preservation for extended period of some time, within the past several hundred years. Drying is that the oldest preservation technique where the merchandise like fruits, vegetables, fish and meat are to be dried by exposing on to the sun. It's a simple process of removing the moisture contents from a natural or industrial product so on reach the standard specification. It's an energy intensive procedure. It has been used widely for this purpose from ancient times long back from 12,000 B.C. by inhabitants of the fashionable Middle East and Asia regions.

Open sun drying under hostile climate conditions leads to severe losses within the quantity and quality of the dried products whereas mechanical drying is an energy consuming operation within the post-harvesting. Therefore, a dryer working on solar energy may be considered as a feasible option during this context. Also, there's considerable shift from fresh to more and more processed foods with significant changes happening within the country and the rapid integration of Indian economy with global system. Since long large numbers of studies are conducted on varied techniques of drying, still there is no clear-cut evidence on which method of drying is best in terms of nutrient retention.

2. OBJECTIVES

- The main objective of this paper is to develop a forced convection solar dryer in which the fruits and vegetables are dried simultaneously by the heated air from the solar collector.
- Here to utilize renewable sources of energy with lesser power input.
- To develop v-corrugated Aluminum plate for solar collector.
- To develop an affordable and easy to use solar dryer so that it can be accessed in remote locations also.
- To study the performance of the developed forced convection solar dryer.

3. LITERATURE REVIEW

Design, Development and Performance of Indirect Type Solar Dryer for Banana Drying (2017) - Abhay Lingayat, Chandramohan V.P. & V.R.K. Raju thanks to higher prices and shortages of fossil fuels and to scale back the fuel consumption utilized in the drying process, more importance is given to solar power sources as it is freely available. For these type of purposes, an indirect solar dryer was designed and fabricated to dry agricultural products. It consists of solar flat plate, air collector with V-corrugated absorption plates, insulated drying chamber, and chimney for exhaust air. The total area of the collectors is 2 m^2. The size of the cabinet used for drying is 1 m × 0.4 m × 1 m in width, depth, and height format. An experiment was carried out to study the characteristics of banana after drying. The chemical analysis for drying of banana showed that moisture content of banana was reduced from initial value of 356% (db) to final moisture content of 16.3292%, 19.4736%, 21.1592%, 31.1582%, and 42.3748% (db) for 1st tray, 2nd tray, 3rd tray, 4th tray and open sun drying respectively. The average thermal efficiency of the collector was found to be 31.50% which of drying chamber was 22.38%. The temperature of drying air is that the most vital and effective factor during drying. The humidity of air also as air velocity is additionally a crucial factor for improving the drying rate.

4. METHODOLOGY

I. DESIGN OF THE SOLAR DRYER

The solar dryer is designed for 10 kg capacity for the drying of agricultural products. Basic parameters considered for the planning of the dryer were based on the planning considerations, preliminary investigations, assumptions and analysis of information on different agricultural products. The eco-friendly materials including plywood, corrugated aluminum sheet, copper pipes, angle iron, Perspex glass, low-carbon steel, stainless steel and an axial fan used for the Construction was locally sourced. The factors considered for the design of the solar dryer are as follows:

- The amount of water needed to be far away from the agricultural products.
- The size of the produce to be dried at a time Construction materials for the drying chamber and tray.
- Method of loading and unloading the material.
- Daily radiation to work out energy received by the dryer per day.
- The quantity of air needed for drying.

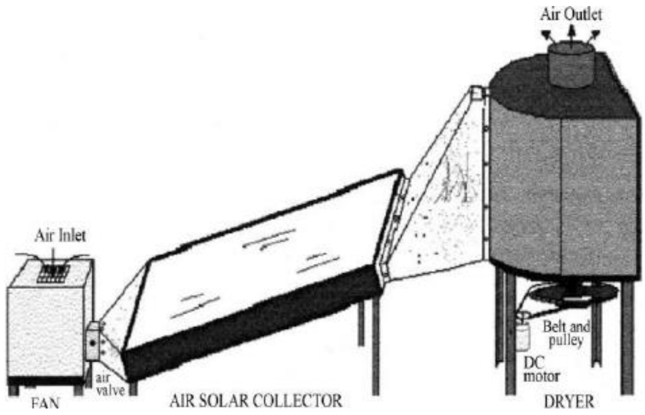

Figure 1: Forced convectional solar dryer.

II. COMPONENT USED

In forced conventional solar dryer the main components are

- **Solar Collector**

The solar dish was a top-open wooden box of size 2100 x 1100 x 120 mm made from 20 mm thick plywood. The wooden box covered with 4 mm thick glass was bent at about 15 degrees to the horizontal. A 2000 x 1000 mm black painted corrugated aluminum plat placed up of the air inlet copper pipes was insulated with 50 mm thick mineral wool to stop heat loss within the box.

- **Solar photo voltaic system**

The solar PV system consists of 1 200 W solar array, a charge controller, an inverter and 200 Amp battery. The photovoltaic system was in place to operate 30 W capacity axial fan (located ahead of the air passage to suck in hot air from the solar dish and circulate within the drying chamber), a thermostat and therefore the stirrer.

Figure 2: Solar PV cell.

- **Drying chamber**

The drying chamber comprised a Perspex glass cover full 1348 x 748 x 1239 mm, riveted to angle bracket structural frame and having within it two compartments, one for loading tray and therefore the other for warmth storage material. In the loading area, there was a drying tray located directly above the heat storage material area. This drying tray was fabricated from a stainless steel plate. The diameter of the opening perforated thereon was 6 mm and therefore the distance between the holes was 6 mm to permit drying air to undergo the products.

A thermostat was installed under the tray to manage the drying chamber temperature during drying process .The bricks were positioned in such a way that the free flow of convective heat to the merchandise within the drying chamber was not hindered.

III. EXPERIMENTAL SETUP

This forced convection solar dryer is designed for 10 kg capacity of fruit or vegetable storage, consists majorly of three units namely; solar collector box, solar photovoltaic system which consists of a solar panel, charge controller, inverter, and battery and drying chamber. All components are closely packed to minimize infiltration losses.

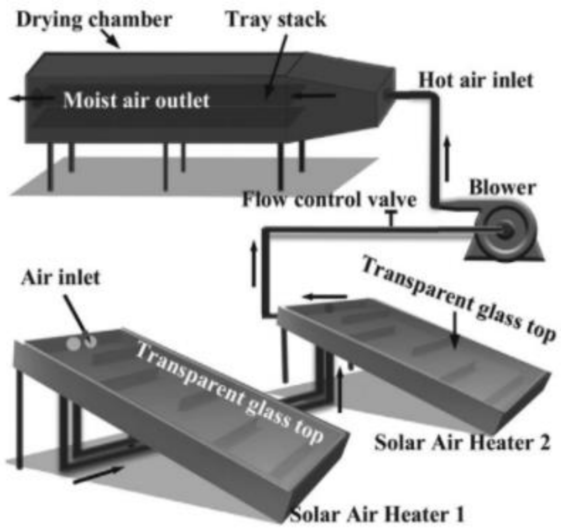

Figure 3: Flow diagram of solar dryer.

This solar powered forced convection dryer was designed and developed as per standard of "Society for Energy, Environment and Developed", Hyderabad. The dryer is developed in such way that it has very less thermal losses due to the direct penetration of solar radiation into the cabinet through the glass window. Solar Photo Voltaic fan is used for forced air circulation. Provision of trolley system is given for loading and unloading of trays containing material to be dried.

IV. WORKING PRINCIPLE

In Forced convection solar dryer the collectors are provided with duct. Normally, a duct of 2.5 cm depth is made. It is made out of two sheets welded together. The cold air is blown through a blower into the collectors, the air gets heated during the passage through duct the hot air which is available is then used for drying the products kept on the shelves of driers. This hot air removes the moisture of the products and is let loose through a properly located outlet.

1. Absorber with ducting
2. Blower with motor and
3. Drying bin

V. BENEFITS OF FORCED CONVENTION SOLAR DRYING

- Dried foods are tasty, nutritious as the nutritional value and flavor of food is only very less affected by drying
- Dried foods have high fiber and carbohydrates and low fat, which make food healthy choices
- Vitamin A is retained during drying
- Storage space required is less and easy-to-store
- Transportation costs are reduced; dried Products as weigh only about 1/6 of the fresh food product
- The input energy is less than what is needed to freeze in refrigerator.
- Easy to do as solar food drying is a very simple skill

5. RESULT AND CONCLUSION

The solar dryer can raise the surrounding air temperature to a comparable high temperature as well as increasing the drying rate of products taken place in it. The product inside the dryer is safe from insect and animals, compared with those in the open sun drying. Also, this method is highly efficient, inexpensive and uses renewable sources of energy as main input. Although the dryer was not only used to dry Apple slices, it can also be used to dry other products like grapes, guava, tomato, mango, potato etc. There is ease in monitoring when compared to the natural sun drying technique. The capital cost involved in the fabrication of a solar dryer is much lower to that of a mechanical dryer.

The simple and reasonable forced convection solar dryer was designed and developed using locally available materials therefore it will be cost effective.

The hourly variation of the temperatures inside the solar collector unit and drying cabinet air are much higher than the ambient temperature during the most hours of the day light. The temperature rise inside the drying cabinet was up to 28°C (76%) for about three hours immediately after 12.00h (noon). The dryer exhibited sufficient ability to dry food items reasonably rapidly to a safe moisture level and simultaneously it ensures a superior quality of the dried product without any minus of original taste, texture and nutrients.

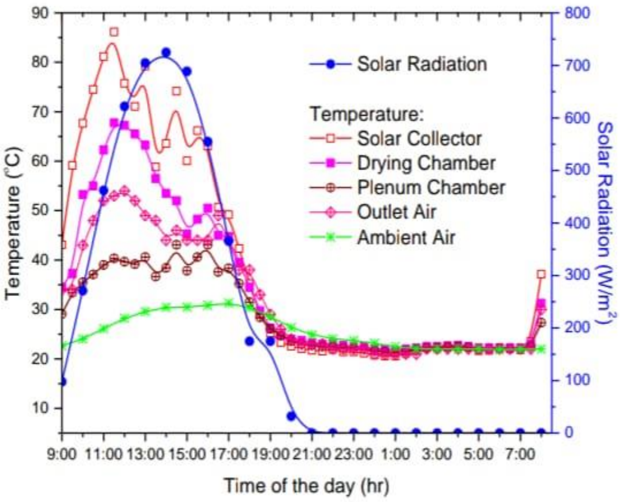

Figure 4: "Temp v/s time of the day" graph.

6. FUTURE SCOPE

Since the main source of heating the air is through the solar radiations, there is always a future scope to this device. The solar energy is renewable and inexhaustible source of energy which is freely available in nature. More advancement can be done on the solar dryer in terms of design, mechanism, working principle, etc.

Certain features can be included:

- Providing parabolic reflector on both sides of the collector.
- Increasing the absorptive of the absorber plate.
- Providing dehumidifier before the drying chamber for removing moisture in the air to get better result in drying rate.
- Fabrication of double slope passive solar dryer to attain higher efficiency.
- Increasing the air flow rates by providing a blower at the entrance.

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9. BIOGRAPHIES

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