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SOLAR DRYER FOR MEDICINAL PLANT- AN EXPERIMENTAL INVESTIGATION

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Abstract

In the drying methodology, a mass and warmth transfer happens to get rid of water from the product by evaporation.Solar drying of crops, fruits and vegetables, has been practiced around the world for centuries in the open air under the rays of Sun.This paper presents one of the methods for utilizing solar energy in drying. In an indirect forced circulation solar dyer, solar thermal energy is primarily used for drying the commodities while electrical energy is used for operating the blower/fan to force air through the collector and drying chamber.Medicinal plants used in dried form are taken for the experiment like Tulsi, Ashwagandha, Adulsa and Shatavari. These medicinal plants were used for different products in powdered form in many pharmaceutical industries. Moisture content was very much reduced from initial to final stage during time span on hourly basis and other medicinal plants also considered in future for further process. The calculations are done to calculate the final moisture content of the product on dry weight basis and temperature variation during experimentation is shown by the graphs.

Keywords: Open sun drying, Solar Energy, Medicinal Plants, Solar drying.

1. Introduction

The drying sector is a large energy consumer. A reduction in energy consumption in the drying sector using solar energy can be guaranteed. Solar energy is an important alternative source of energy and prefers to other sources of energy, because it is abundant, inexhaustible and non-polluting. Solar drying is a process of utilizing solar energy to reduce moisture content in agricultural products to a level where it can be safely stored for future use. The drying process involves the transfer of mass and heat to remove water from products by evaporation. One of the most commonly used conservation systems is conventional outdoor sun drying; this is associated with large losses of fruits due to inadequate drying, drying, fungal attacks, eating flying birds, domestic animals and the wind blowing the culture out of recovery.

Open Sun drying also causes physical and structural changes in agricultural products such as unnecessary shrinkage, corrosion, and loss of volatile substances and nutrients. It is, therefore, necessary to control the drying regime, which maintains nutrients and unnecessarily reduces agricultural output. One of these control modes includes a solar dryer design. Other types of dryers have been developed at different times and places around the world. Solar dryers also play an important role in the medical field. Nowadays, with a large investment in medicine and for this purpose, Ayurveda uses a daylight dryer to dry various medicinal herbs. Tulsi (OcimumTenuiflorum), a medicine used in the form of powders such as Tulsi, Ashwagandha, Adulsa, and Shatavari, is used to treat fever, respiratory diseases and damage to people and animals. Likewise, Ashwagandha (WithaniaSomnifera) is used to treat inflammation, ulcers and various bookkeeping. Adulsa (Malabar nut) treats asthma, piles, and Peoria, and Shatavari (Asparagus Racemosus) is used to treat the reproductive health of women and improve the body's immune system. These plants, with so many efficacy and curing properties, are the best way to reduce drying time for sun drying production requirements.




Fig.1.1 Tulsi **Fig.1.2 Ashwagandha** **Fig.1.3 Adulsa** **Fig.1.4 Shatavari**

2. Materials and Methods

2.1 Description of the solar dryer

The Solar collector was constructed using a galvanized iron sheet. The collector is made up of an absorber, transparent covering glass and heat storage material in one of the collectors. The galvanized iron sheet was painted matt black and used as an absorber for maximum absorption of solar heat energy. Transparent glass is the top cover of a solar collector. It was made of 4 mm thickness glass. Both the top of the collector and the heating cabinet sides were fitted witha transparent glass cover to provide heating through the greenhouse effect. Plywood and polystyrene were used toinsulate the air heater and the sides of the drying chamber respectively. The galvanized iron sheet was used to construct absorber plate and it was well insulated to prevent heat loss to the surrounding which could result in the decrease of the heating efficiency. The drying chamber consists of chimney, trays and connecting duct.

The drying cabinet alongside the structural support of dryer was built from a polystyrenesheet and mild steel which could withstand the unfavorable weather condition. Chimneys are used to generate buoyant forces on the air, thereby increasing the rate of air flow through the dryer. Galvanized iron wire mesh was used to construct the trays.The transparent top cover is a 4 mm thick clear glass with dimensions 650 mm by 450 mm. the distributing duct made out of 1 mm thick plastic material is 35 mm by diameter and wrapped by cloths and the drying chamber dimensions are 450 mm by 500 mm by 900 mm. The drying chamber was partitioned into three with acommon chimney. The Access door wasprovided to facilitate easy loading and offloading of the products respectively. The mixed-mode solar dryer is shown in figure 1.5.

2.2 Methodology of the solar dryer

The schematic of experimental set-up for a new type of solar dryer is shown in figure 1.6. The absorber plate of the solar air dryer consists of a thin box made of corrugated galvanized iron sheet on one side and plain galvanized iron sheet on the other and insulated with plywood on three sides. The solar dryer is a relatively simple concept. The basic principles employed in a solar dryer are:

Converting light to heat: Black surface on the inside of a solar dryer will improve the effectiveness of turning light into heat.

Trapping heat: Isolating the air inside the dryer from the air outside the dryer makes an important difference. Using a clear solid, like a glass cover, will allow light to enter, but once the light is absorbed and converted to heat, glass cover will trap the heat inside. This makes it possible to reach similar temperatures on cold and windy days as on hot days.

Moving the heat to the food: Both the natural convection dryer and the forced convection dryer use the convection of the heated air to move the heat to the food.

Then the heat is provided to another chamber where the medicinal herbs are kept on trays. Due to heat the herbs get dry. The controlled amount of heat is provided to chamber by using flow control valve.

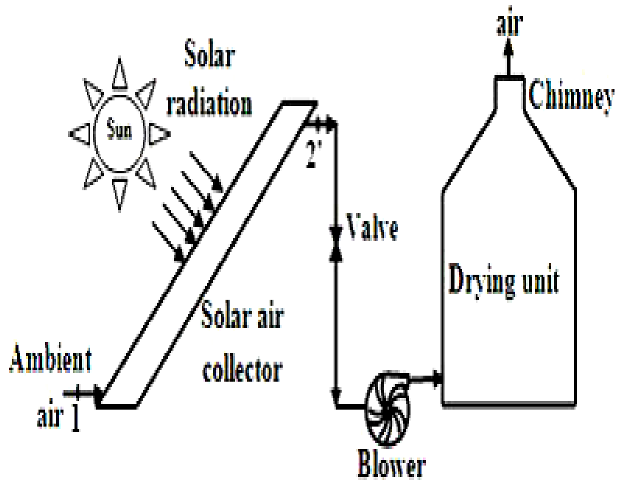


Fig. 1.5 Proposed View of Mixed-mode Solar Dryer

Fig.1.6 Actual View of Mixed-mode Solar Dryer

3. Instrumentation and experimentation

3.1 Instrument used for experiment

Temperatures at different locations are measured using thermocouples with the accuracy of ± 0.25%. Temperature readings were recorded on an hourly basis starting from 9:00 AM – 5:00 PM. Thermocouples were fixed at inlet and outlet of the collector (Tin, Tout), in open air for measuring ambient temperature (Tamb) and in the drying chamber (Td1) for drying temperature measurement. Instantaneous global components of solar radiation were measured using a solar meter with an accuracy of ± 10W/m2. Relative humidity was measured by hot wire anemometer (2% accuracy). For estimating the initial moisture content of thesample was measured on weight basis, Weight loss of sample during the experiment was measured using an electronic weighing balance of 20 Kg capacity.

3.2 Experimentation

Experiments were conducted to study the drying characteristics of various medicinal plants. In India, production of Ayurveda medicine is high and also has a substantial usage in medical field. Medicinal plants like Tulsi, Ashwagandha, Adulsa and Shatavari are having special characteristics to cure the disease. During the experiment, the weather was generally sunny. The experiments were conducted in the month of April 2018 at Imperial College of Engineering And Research, Pune, India.

Table 1.1 Experimental Observation for 08 hours

Plants	Quantity (gm)	Time (AM to PM)	Solar radiation (kWh/m^2)	Ambient Temperature (Tamb)	Collector temp. (Tc)	Drying chamber temp.(inlet)
Tulsi	6.37	09:00 AM	6.50	37	60.7	46.5
Shatavari	4.84	10:00 AM	6.50	38.6	62.3	48.2
Adulsa	15.98	11:00 AM	6.50	39.5	65	49.8
Ashwagandha	4.41	12:00 PM	6.50	40	69.8	50.2
-		1:00 PM	6.50	40	73.2	50.6
-		2:00 PM	6.50	40	66.5	47.5
-		3:00 PM	6.50	38	64.2	46
-		4:00 PM	6.50	35	48	39
-		5:00 PM	6.50	32	44	36

The reduction in moisture content was determined by weighing the sample at every hour. Experiments were performed with medicinal plants like Tulsi, Ashwagandha, Adulsa and Shatavari.For effective drying, Fresh plant leaves were used in the drying chamber. The leaves of medicinal plants were spread uniformly on three trays. 500 g of banana slices were used for drying in each tray. Three trays were placed inside the drying chamber. The door of the drying chamber was closed properly. While performing the experiment, the solar dryer was tested by measuring different temperatures and solar radiation for 1-hour interval of time.

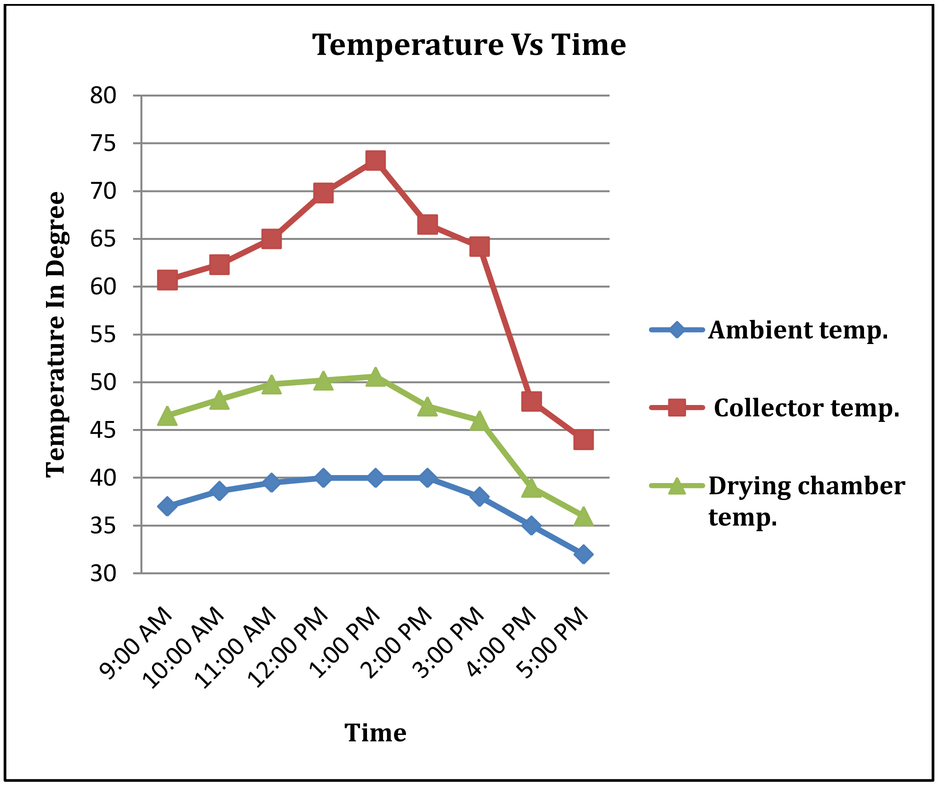
Fig. 1.7 Leaves in Solar Drying ChamberFig.1.8Leaves in Open Sun Drying

4. Result and Discussion

After conducting experimentation, the following results were obtained. From the result table, the moisture content is reduced in nearly uniform rate for different mass and different initial moisture contents. From the moisture reduction if we calculate the dryer efficiency it will be find same for day. The final mass of the medicinal plant were taken at where leaves are just reach to powdered form.

Sr. No.	**Plant**	**Initial Mass (gm)**	**Final Mass (gm)**	**Moisture Reduction, %**
1	Tulsi	6.37	1.50	76.45 %
2	Shatavari	4.84	1.21	75.00 %
3	Adulsa	15.98	3.93	75.41 %
4	Ashwagandha	4.41	1.15	73.92 %

The following graph shows the variation for experimentation of different temperatures like collector temperature, ambient temperature and drying chamber temperature with time.



The moisture content is reduced up to very much extent due to solar energy and quality of the product is very good. Due to its role in medicine field most of medicinal plant which are used in powdered form are generally dried using mixed type solar dryer.

Conclusion

From the test carried out, the following conclusions were made. The solar dryer can raise the ambient air temperature to a considerable high value for increasing the drying rate of medicinal plant. The product inside the dryer requires less attentions, like attack of the product by rain or pest (both human and animals), compared with those in the open sun drying. Although the dryer was used to dry maize and plantain, it can be used to dry other crops like tomato etc. There is ease in monitoring when compared to the natural sun drying technique. The capital cost involved in the construction of a solar dryer is much lower to that of a mechanical dryer. The collector and dryer efficiencies are very reasonable.

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