Experimental Studies of Drying of Potato Chips with a new Design of Solar Dryer

Varun Kumar[1*]& Dr. S.K Agrawal[2]
[1*]M.Tech Student, [2]Sr. Professor
[1,2]Shri Ram College of Engineering& Management,Gwalior (M.P)

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ABSTRACT: *Drying process removes moisture and helps in the preservation of any product specially perishables.The disadvantages associated with open direct drying are overcome by the way of solardrying.The drying rate is faster and leads to the saving in power consumption in solar dryer. A new type of solar dryer is designed, fabricatedand used in the present research work. The results are comparable with the published work of similar nature.*

Key Words: *solar Dryer, Insolation, Radiation, Drying of potato slices*

1. INTRODUCTION

Drying is a process of removal of moisture due to simultaneous heat and mass transfer. It has a vital role in postharvest processing. Agricultural products like tea, coffee, fruit, tobacco, nuts and timber generally require drying through a consistent application of relatively low quality heat. Drying leads to preservation of food, fruits and seasonal vegetables for long time with good quality and longer availability. Agricultural products like fruits and vegetables require temperature range from 45-60 degree Cfor safe drying. Because when products dried under controlled condition at specific humidity as well as temperature it gives rapid drying and improved quality of product. It involves in removal of moisture in form of water vapour using heat supplied. The removal of moisture also prevents the growth and reproduction of microorganism like bacteria, yeast etc. because of reduction of weight and volume, also minimizing packing, storage and transportation cost. Extensive use of fossil fuels, which are limited resourcesare forcing us to go for solar option as this does not have adverse effect on environment and is economical also. Open sun drying of various products is most common and conventional method for food preservation in many urban and rural area of developing countries. The major disadvantages of this technique is hygienic and quality problems of product.The product gets contaminated from dust, insects and other animal that can harm our food product and decrease the degree of quality of our food items. It also require long time drying (2-3 day) and more labour requirement So to preserve food product with quality and hygiene we need affordable drying methods. Now a days many types of mechanical and electrical energy driven dryers are available for drying but that is neither economical nor eco-friendly.
Commonly used drying techniques are:

- Forced convection drying
- Fluidized bed drying
- Heat pump drying
- Microwave drying, and other many more types.

Vijyavenkataraman S et al (2012) compared different type of solar dryer made by different research scholars for different crops like fruit vegetable etc. for vegetable the performance of new designed double pass solar dryer were compared with cabinet dryer and open sun drying for red chilli in Vietnam. Double pas solar dryer found Technically suitable.Deshmukh A.W et al(2014) investigated on mix mode solar cabinet dryer for commercially important and export oriented ginger. In this ginger slices dried successfully and the moisture content got reduced from 621.50 to 12.19% (d.b.) and quality parameters were also analysed.Sontakke M S et al (2015) presented the performance of direct, indirect natural, indirect forced convection and mix mode solar dryer, they found time required for mix mode is less than other.
Hegde V.N et al (2015) conducted an experiment in an indirect active solar dryer on banana slice, dryer having flat plate solar heater so because of it the Bottom flow Temperature was 2.5 degree higher than Top flow in same dryer. The efficiency was 27.5% for top flow drying and 38.21% for bottom flow drying.

2. DESIGN AND FABRICATION OFNEWSOLAR DRYER:-

The design adopted for experimentation is based on the cabinet dryers having multi rack (3 Perforated trays) with a provision of putting the solid storage material like gravels or Brick/stone pieces in the bottom.This was fabricated In the workshop of Shri Ram College of Engineering & Management,Banmore,Gwalior (M.P) and fabricated by locally available materials. The sketch is given as under with the dimensions. The absorber plate was painted black,a good absorber as well as a good emitter for radiation.This was oriented as south facing to get the maximum radiation.The experiments were performed in the month of June 2018 during day time (roughly from 8 am to 5 am,for duration of 9 hour of sun-shine was available at Gwalior during the said period). The instrument needed are:-

1. Solarimeter {MEGGER PVM 210}
2. Digital thermometer with least count 0.5°C
3. A electronic weighing machine

Various trials were made initially to have the confidence.First of all, the drying through the dryer was compared with open drying and it was found that the rate is much higher when dryer is used.The effect of different variables like thickness of the chips, distribution density and the presence of energy storage material were studied through extensive experimentation.The effect of thickness of potato chips on the drying rate was investigated and it was found that the thinner is the chips, faster is the drying rate.But it was felt later,that for commercial purposes the thickness of the potato chips has to be same for the whole lot so it was unnecessary to try chips of different thicknesses.

The distribution density on the trays was varied from 75% -90% area wise and the effect of the variable was seen to be negligible however the effect of hole size on the perforated trays was not taken into consideration.The drying was tried for 5 days at a stretch.As the drying rate was almost negligible after 3 days so the results are presented here only for first three days.As the number of trays is three, so it was planned to shift the material from Tray 1 to Tray 2 on the second day and to Tray 3 on the third day .In this way the same materials was put on each tray during one trial of 3 days.

The presence of the solid storage material in the bottom of the device led to rise in the drying rate substantially.

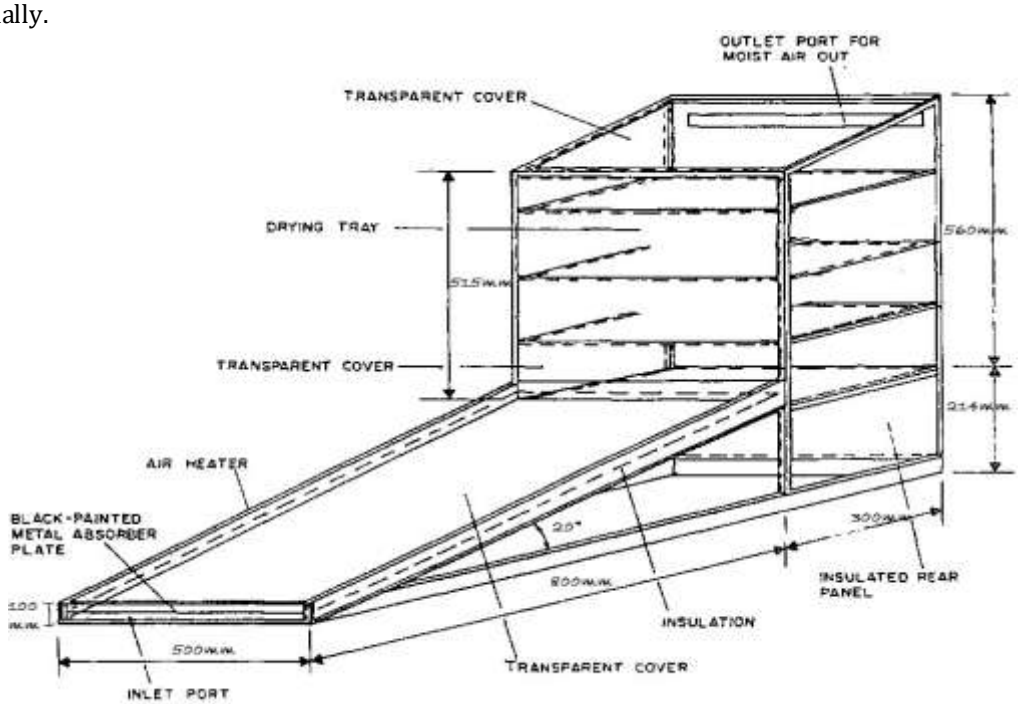


Fig. 1 Sketch of solar dryer

3. MECHANISM OF DRYING AGRICULTURE PRODUCTS:-

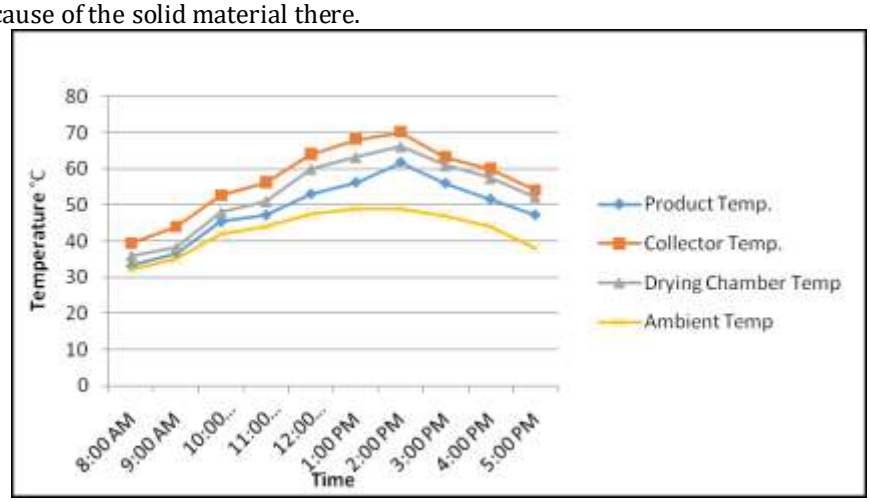
Drying is most cost effective application of solar energy. There are manyproducts which are dried by solar dryer like various fruits, vegetables, timber, fish. Food products are preserved by drying. Now In developing nations, open to the sun drying methodis used for drying agricultural products. Open to the sun drying means products are exposed directly to sun, allowed to absorbed solar radiation for drying. This method has

many disadvantages like poor quality, contamination of product. Following are merits and demerits of solar drying:-

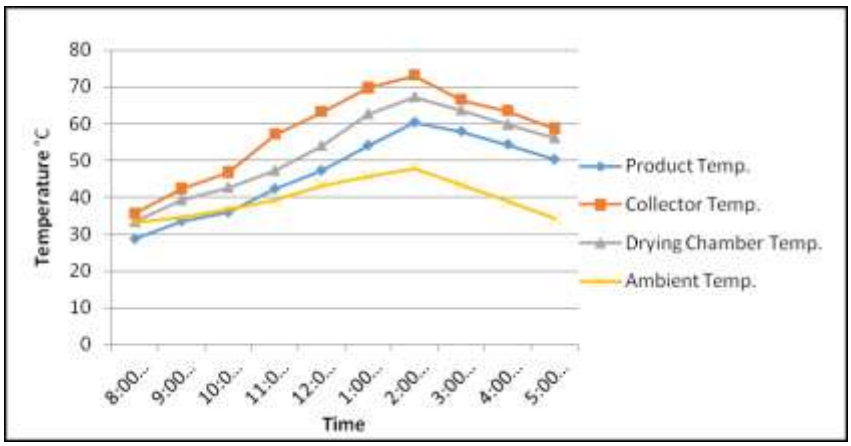
Advantages:
a. It reduces environmental impact.
b. Easily managed.
c. Prevent fuel dependence.
d. Often less expensive.
Disadvantages:
a. Requires adequate solar radiation.
b. Hot and dry climate preferred (relative humidity below 60% needed).
c. Requires more time.

4. EXPERIMENTATION AND DISCUSSION OF RESULTS:-

The initial moisture content in potato is assumed to be 80% based on the information available in the literature. The experiment on drying potato chips is conducted in solar dryer to evaluate the performance of solar dryer. The dryer was loaded at 08:00 am with 700g of potato sliceby spreading slices inside it on three different Trays and 700g is spread in sun in open air. The process is continued till required moisture is achieved. The result pertaining to potato slices drying in solar dryer are presented in following Graphs. The ambient temperature during drying varied from 32.3°C to 49°Cwhen experiment conducted without Storage material and 33°C to 47.9°Cduring next experimentation conducted with Storage material. The maximum temperature observed was 19.4 °C and 17.3 °C higher inside the dryer at 02:00 pm with the presence of heat storage material and without it. The higher temperature is due to the fact that the heat loss from the bottom got reduced because of the solid material there.

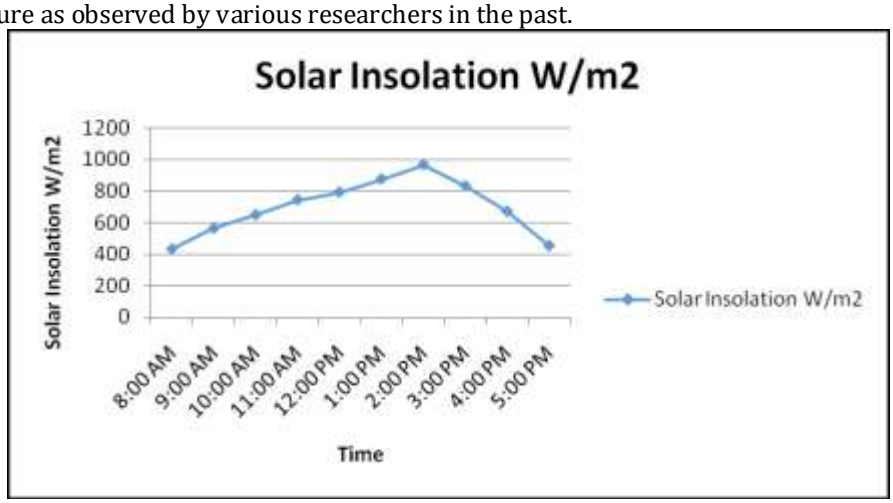


Graph 1. Distribution of (I)Product Temperature(II)Collector Temperature (III)Drying Chamber Temperature (IV)Ambient Temperature(Without Storage)



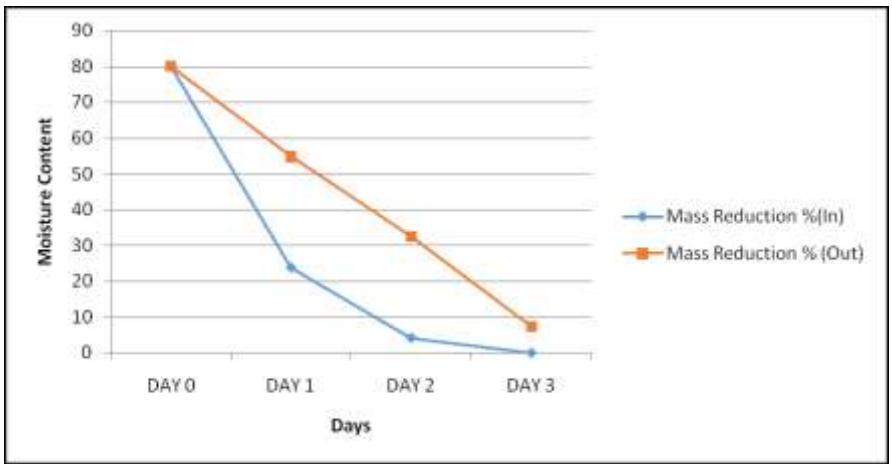
Graph 2. Distribution of (I)Product Temperature(II)Collector Temperature (III)Drying Chamber Temperature (IV)Ambient Temperature(With Storage)

Ambient temperature, Product temperature, Collector temperature, Drying Chamber temperature variations are shown in Graph 1 &Graph 2 for the case of without storage material and with storage material respectively. In both the cases the collector temperature is having higher value 73.1°C around 2:00 pm. Product temperature,Drying chamber temperature and ambient temperature variations were found to have the similar nature as observed by various researchers in the past.

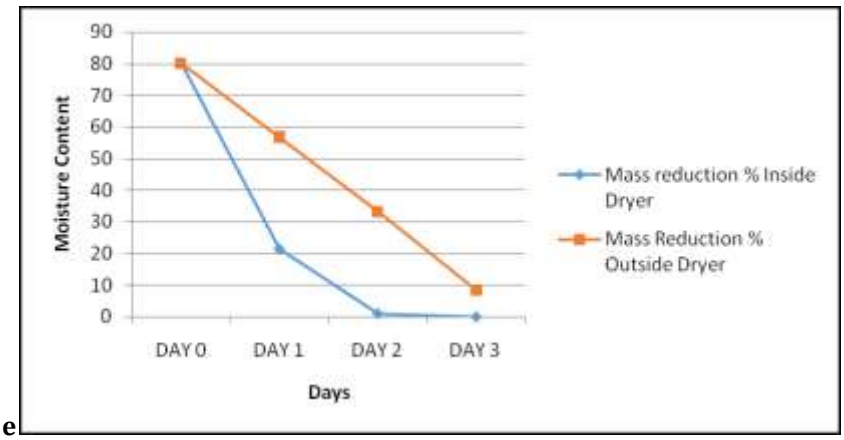


Graph 3. Solar Insolation variation

Graph 3 shows the solar insolation variation on a typical day at Gwalior .The variation is from 435 W/m2 around 8:00 am and goes on increasing upto 966 W/m2 around 2:00 pm,at the time of highest temperature in the dryer.



Graph 4.Comparison of Solar Drying with Open sun drying Without Storage material



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Graph 5.Comparison of Solar Drying with Open sun drying With Storage material

Graph 4 & Graph 5 represent the moisture loss variation for subsequent days of experimentation. Compared with open drying in case of without storage and with storage respectively and found that drying with storage material gives faster drying rate because in case of drying without storage material the moisture content remains at the end of second day is 4.23% but in case of drying with storage material only 1% moisture remains in potato slices that is acceptable for storage.

From both the curves it is observed that the slope of curve for open sun drying is almost linear, where as in case of drying through dryer the drying rate is very fast for first day and after second day it reduces drastically. It is also observed that the effect of the presence of solid storage material results in the better drying rates.

5.CONCLUSION:-

The general conclusion of this study is that solar drying is preferable to open drying. The drying of potato chips was studied with the help of solar dryer fabricated with locally available material.As expected the solar drying is faster and better technique along with the advantages of clean and better quality product compared to open drying.From the study it is concluded that such tests may be conducted on different food stuffs and appropriate database may be generated for different places. It is also suggested that a large size of such a dryer may be tried for items like drying of papadwhich may lead to employment generation also.

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