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COMPARATIVE STUDY OF SOLAR DRYING OF VEGETABLES AND SPICE MATERIALS WITH OPEN SUN DRYING

Ramesh Pal, Sakshi Pal

ABSTRACT

Generally farmers of India dried food and spices for preserving them for a long time, earlier they used to dry the product in open sun drying by spread the product on the ground. They are during it for a long decade but this method is not good or hygienic and that result in significant loss in product, specially dist, dirt, insect, animal, and human interference affect the produce. For saving the products from these kinds of losses and problem many different technologies are developed like different kind of solar dryer. In this research we are comparing three different methods of drying these are direct radiation solar dryer, indirect radiation solar dryer and open sun drying of the product. This research was conducted in Centre of Excellence, Solar energy Research & Utilization Gyan Vihar University Jaipur (raj.). In this research mainly we dried the spices and comparing the drying rate and dryer efficiencies in all three kind of drying methods. This research was conducted in May – June 2014.

In this research we use a wooden box with glass cover and three aluminum trays for loading the product, these trays work as absorber plate and it is completely black painted. During the observation the maximum temperature of absorber plate in direct radiation solar dryer is 95.8°c at 43°c ambient temperature and the maximum inside air temp. is 87 °c at 42 °c ambient temp. And in case of open sun drying the maximum surface or floor temperature is 68°c at 44 °c ambient temperature. For the indirect dryer the maximum expose absorber plate temp. is 112 °c at 43 °c ambient temp, and maximum inside surface temp. is 65.9 °c at 44 °c ambient temp, The max inside air temp 84 °c at 42 °c ambient temp.the drying rate is depend on the moisture present in the product and the type of product. The complete comparison shows by the graphs in the result section.

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1. INTRODUCTION

For preserving the food spices and vegetables for a long and short time, people dried the product and stored them. India is famous for it's spiceand for preserving these items Indian farmer dried them and supply in different countries. Indian farmers usually dried the spices& vegetables like coriander, mint, chilies, potato, cauliflower, etc. Drying is very old and famous method of preserving food and spices. Vegetables and spices are of large dietetic significance as they make a important part in supplying wealth of necessary, minerals,vitamins, carbohydrates, antioxidants, fibers that advance the quality of the diet.Most of the vegetables are seasonal,they only produce in a particular session . They are available in specific regions that many times it creates market excess. Due to unpreserved nature of system, huge amount of vegetables is wasted within a short time. The harvest loss in vegetables and row spices has been expected to be about 30-40% because of deficient post harvest treatment, be deficient of processing, infrastructure marketing and inventory. Than the food handing sector can play a huge role in reducing the losses in harvest by processing the product.

Solar drying is one of the most popular methods of drying and preserving the vegetables and spices. In India chilies and some other spices are dried at a major scale and India is a big producer of spices in world. In India spices are traditionally sun dried by open sun drying it is a very old and very much used technique to dry the product and mostly used technique in India in which producer or farmer expose there product to open sun on the field or concrete floor or on a met. By this process the product drying process takes long time and the quality of product is very low in this case. In this method we can not control the loss in product flown in the air and the rain and air is also affect the product, and the weather condition also affect the drying process. In open sun drying or traditionally drying process the dist, dirt, animal, birds, rodent and insects affect the product very badly so the loss of the product quality increases.

For reducing the product loss and improving the quality of product we need a alternative method of drying the product, and the alternative of conventional sun drying is solar dryer. It is used for drying the product without being waste and quality of product in this method is very good as compare to open sun drying, and it can be in small and big firms both. It has a huge impact on the quality of product it improve the quality.

The solar energy is used in this method which is freely available and environment friendly and economically supporting the country. It is suitable for a small level or as household level for drying 10-15 kg product, because when it is used at a huge level than the risk of wasting or spoilage of product during bad weather condition, And adverse weather condition also affect the quality of product so the natural convection solar dryer is world wide accepted for drying process. The drying process by the solar is mainly done by mainly two methods natural convection and force convection. Drying is takes place through the convection method in solar dryer.

The Solar energy is one of the cheap and easily available energy source in the world and it is most capable renewable energy sources in the world because of its large quantity, and its non-pollutant behavior, and infinite source as compared to highly costly and scarcity of fossil fuels. The concept of solar dryer in which solar energy is used for drying reduce the fossil fuel and the price of solar collector and the cost of equipment is very less and it produce no pollution working on green house effect and because of no pollution it is very much environment friendly provide a healthy environment with low cost drying and provide good quality of product with no loss in the product and the shape and the color of the product is very good. Solar radiation drying can be well thought-out as an explanation of sun drying and it is a very much efficient method of utilizing solar energy. The products dried from the solar dryer have superior color and quality as compared to the products which is dried in openly. The validation for cabinet solar dryers is that the product dried in this is takes very lass time approx half time as compare to the open sun drying, and dried product equally and hygienically, and it is very useful and essential for economical for industrial process or industrial food drying. Since it is more effective than open sun drying and has very low operating cost than mechanical operative dryer.

The sun is the main source of energy in the solar system. The sun produce energy by the fusion reaction which is a continuous process at the surface of the sun and the sun is situated at the centre of the galaxy. The energy produce in the sun is spared in the galaxy and in the same manner it hits to the earth and provide the life cycle eth energy present in each and every thing on the planet is because of the sun. The solar radiation provide the life on the earth it derive the life cycle on the earth and helps in different processes like rain, flow of wind, photosynthesis, and many more thins which is required for the life cycle. All the conventional and non-conventional fuels are developing by the help of the sun.The radiation at the surface of the sun is about to 70000-80000 kw/m2. Except that the earth receive a very less amount of radiation but the energy received by the earth in a year is about to 200000000 billion kWh which is 10000 times more than required in the whole world. The intensity of radiation outside of the atmosphere 1360w/m2 average value. When that radiation enters in the atmosphere some of the radiation is lost or absorbed by the ozone and other gasses present in the environment so in the clear sunny days of summer the global radiation is recorded 800-1000 w/m2. Solar dryer utilize that energy for drying the product.

2. CONSTRUCTION AND DESIGN OF SOLAR DRYER

In the construction of solar dryer first we made a wooden box which is 135 cm long and 75 cm wide in size that 135x75 area box has 20 cm depth. One side of the box is not fixed it can be easily open and close for feeding the product in the dryer for drying. For passing the air through the dryer 6 holes of 3.7cm diameter is made for perfect natural convection or passing the air. These holes are made on both side of the length of box as shown in the figure blow. But on the other side of length the holes are half circle of same diameter.And a 3 mm transparent glass is used to cover the box and that glass is fixed in the box. A thirty gage aluminum sheet is used as a absorber plate in the bottom of the box and aluminum tray is used for storing the product or loading the product in the dryer is also work as a absorber plate these plates are three in size and of equal area of 18x30 bxh, and storing the equal amount of material or product on each and every tray.For indirect dryer we use 30 gauge aluminum sheet for making a closed cover which is 4 cm blow the glass cover. A 2 cm thick thermocol is used as a insulation cover the box from the outer surface of the box to reduce the heat transfer from the box. And a stand is used to support the setup and help to tilt the box at 27 degree angle south facing. The stand of 20cm height is used to support the box and help to support the box at 27 degree.

3. EXPERIMENTAL PROCEDURE

For performing that experiment first we design the setup or the solar dryer box and than construct the box with appropriate dimension. The thickness of box 1cm from each side and aluminum trays are used as the absorber plate on which the product for drying is loaded and a transparent glass cover is used in the dryer. the thickness of glass is 3 mm. This setup is for direct solar drying in which the radiation is directly fall in the product after passing through the glass cover. And providing the natural convection 6 holes of 3.5 cm diameter from both length side of the box. And for indirect radiation solar dryer we use aluminum cover box 5 cm blow the glass plate and divide the box in two portions half portion is covered and other half portion is open for direct radiation. Then load the product at both portions and put same amount for open sun drying at the floor. And take the observations at the particular interval. The experiment is conducted from 10am in the morning till to 3 pm, the experiment started from the 27/5/2014 to 30/6/2014.

In this experiment for taking observations the thermocouples are used to find the temperature of absorber plates, inside air, and the temperature at glass plate and surface temperature. Thermometer is used to find the ambient temperature. Hygrometer is used to find the value of relative humidity. Instant Pyrenometer is used to get intensity of solar radiation. We take the observation in each one hour in this experiment.

3.1 DATA ANALYSIS

3.1.1 Drying rate

Drying rate is the rate of moisture removal from the wet product in a particular interval of time. For calculating the drying rate the initial and final moisture contain of product is require and the time interval for which we calculate the drying rate. In this we take the half and one hour interval for calculating the drying rate.

Drying rate = initial weight - final weight / time interval

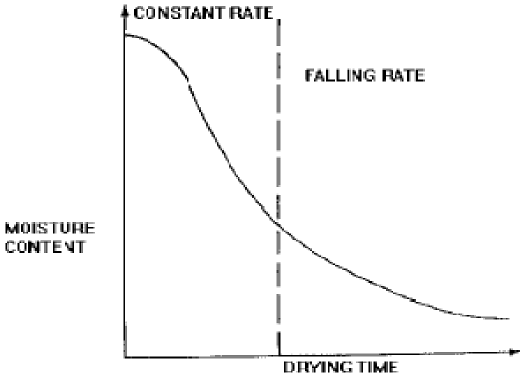

Figure 1: Moisture content vs drying rate

3.1.2 Moisture content (%)

Moisture content is the percentage of moisture present in the product. That reduces during drying period, the moisture removed from the drying product at the level till the equilibrium condition between the humidity of air or the moisture content in air and the moisture in the product.

Moisture content (%)- initial weight – final weight *100 / initial weight

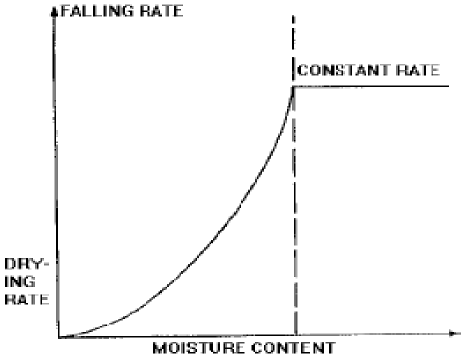

Figure 2: Drying rate vs moisture content

4. RESULT AND CONCLUSION

In this study the results are shown by the graphs, the comparison of temperature variation, drying rate is shown by the help of graphs. The drying rate is depending on the type of product and the moisture content present in the product. The drying rate is shown by the weight loss in every hour by the product. For these products the total moisture content present in the simla chili is 81%, in red chilies 75.63, in raw mangos 67.47%, in mint 85.66%, in green chilies 86.22%. And the drying rate is varies day vise, first day when the moisture is maximum then the drying rate is higher and than reduces as the moisture in the product is reduces.

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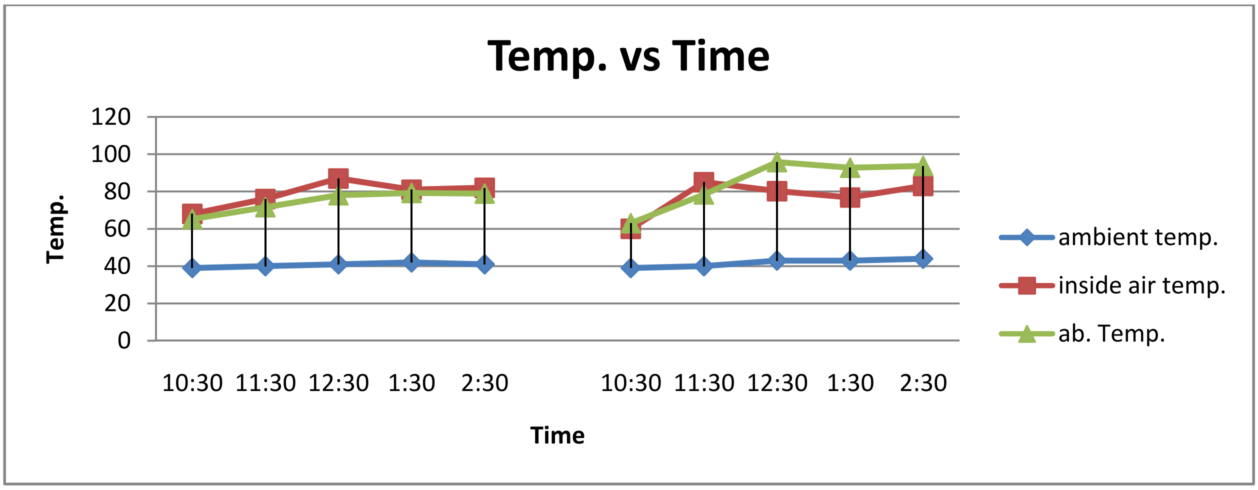
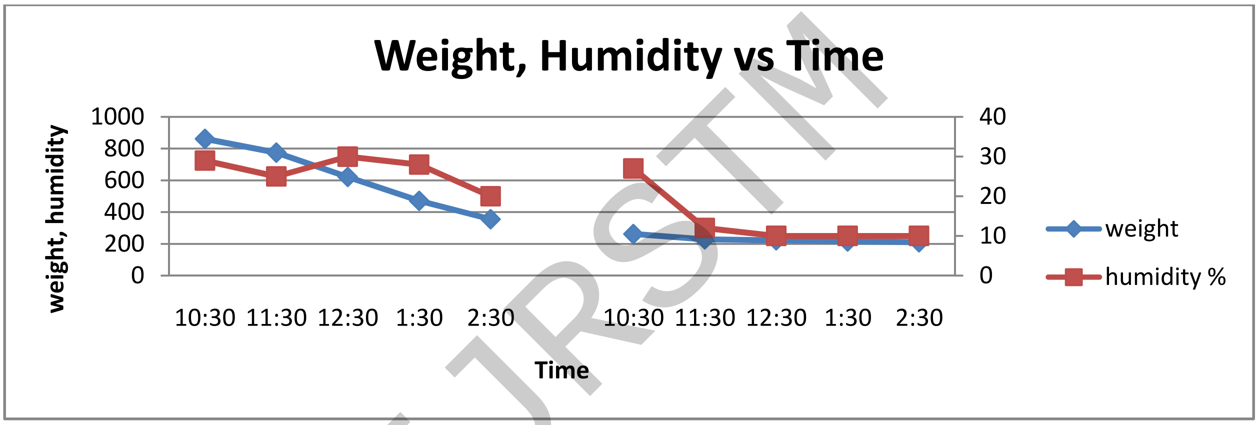
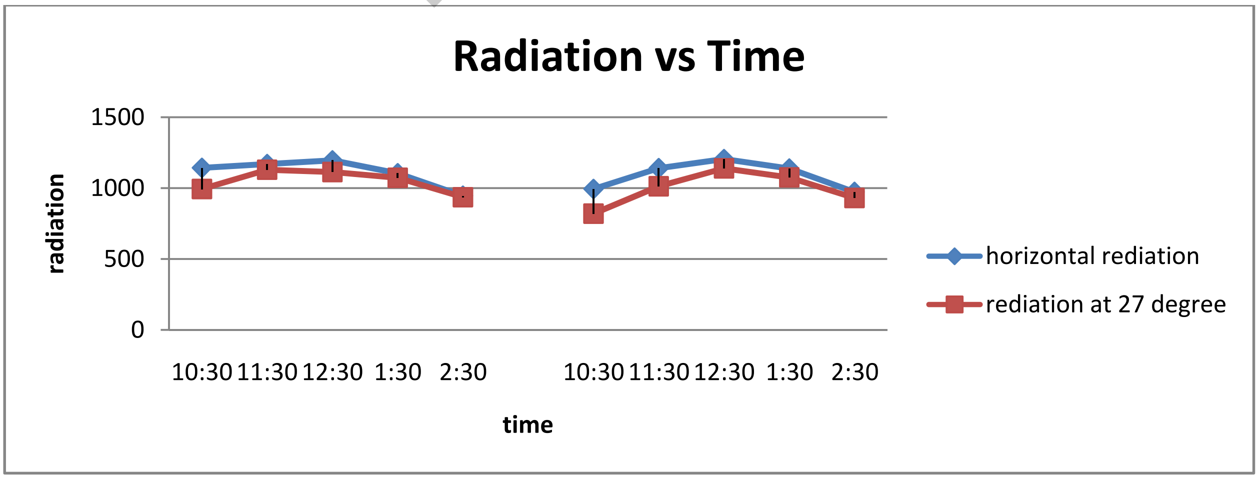
4.1 COMPARISON OF ALL PARAMETERS IN ALL THREE CONDITIONS

4.1.1 Direct radiation solar drying

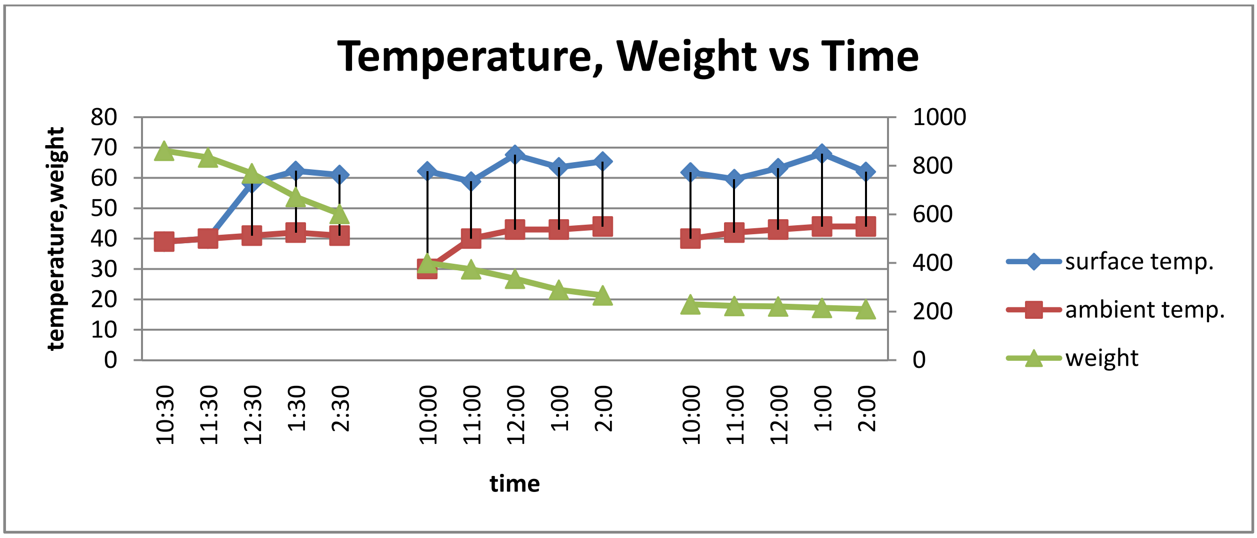




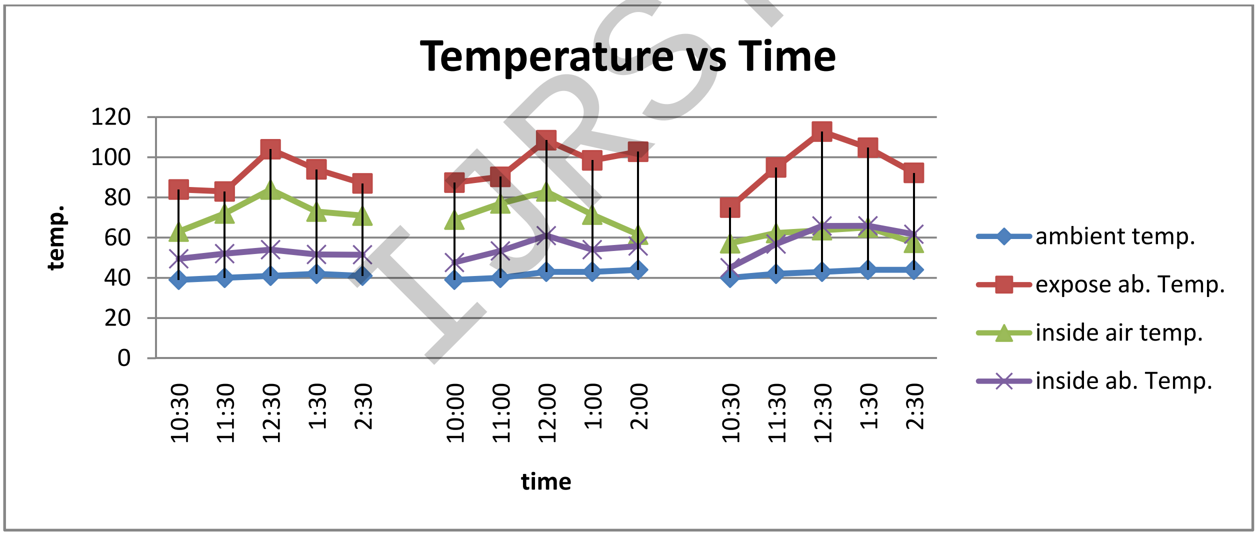
4.1.2 Common radiation for all three conditions

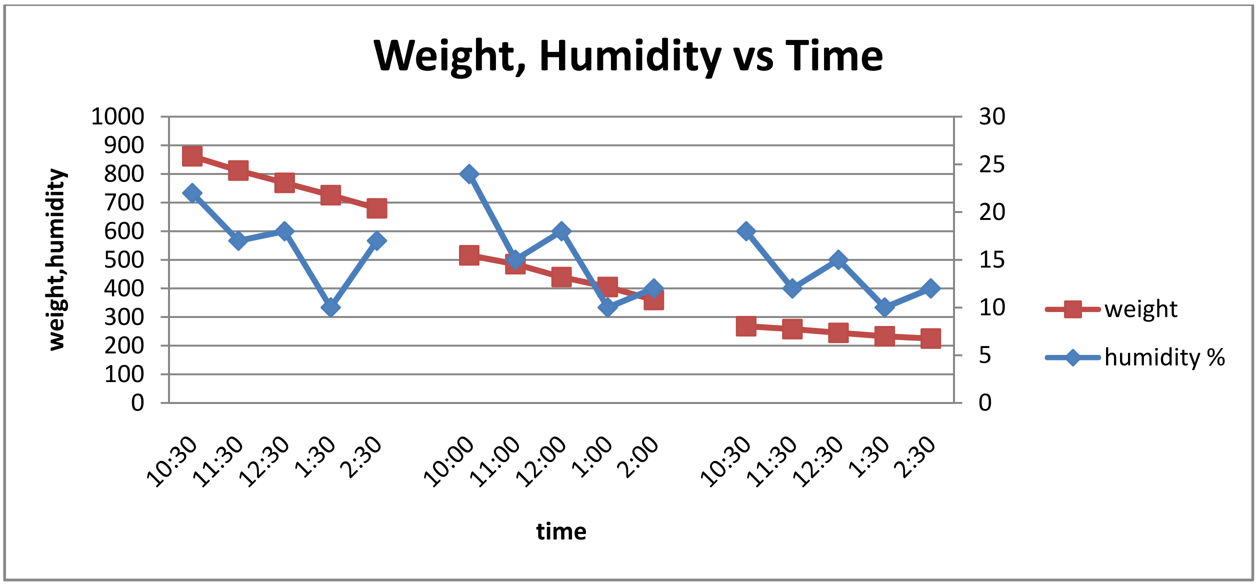


4.1.3 OPEN SUN DRYING



4.1.4 INDIRECT SUN DRYING





These graphs results shows that the direct radiation drying is highly efficient in drying, the drying rate in this condition is higher but due to the high temperature inside the box the product is start burning so the product quality and taste is decreases. And drying is a slow process it depend on the type of product mostly the good quality product is produced by drying a product slowly the maximum temperature for drying is 65 required or less than that.

In second case for open sun drying process the product quality is good because of good temperature but it is affected by the environment conditions, dust, dirt, insects, animals, human interface than the product quality is decreases.

In indirect solar the product quality is best because of good drying rate and not affected by any other source and the temperature in this condition is good enough for drying process as shown by the graphs.

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