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An Experimental Study of Solar Tunnel Dryer for Drying Onion Slices (*ALLIUM CEPA, L.*)

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Abstract:

Drying is a most important method to reduce the moisture content from product to increase the self-life and quality of the product, which can be used for medicine purpose and non available purpose. During experiment different parameters for onion slices was calculated under this study such as variation of temperature, collector efficiency, moisture content and solar intensity. In this study was used semi transparent polythene as a collector with size of 200 micron. During *experiment with in six days air velocity was varies .53 to 1.22 m/s and average relative humidity was varies 46 to 53 % and exhaust fan speed was constant during this study that means it was 500 rpm. The average temperature inside solar tunnel was varies 54 to 59 °c. Finally moisture content in onion slices was 10 % and it's observed that relative humidity decrease with increase temperature and moisture content also decrease. Collector efficiency was varied from 45% to 55%.*

Key words: Onion slices, solar tunnel dryer, Color value, Onion dehydration, infrared.

INTRODUCTION

India (21%) and China (19.3%) are the largest producers of onion (*Allium cepa L.*) by area as well as by total production. Onions compared with other fresh vegetable are relatively high in food energy, intermediate in protein content and rich in calcium and riboflavin. The post harvest losses of this vegetable are quite serious in our country so drying or dehydration should be carried out to increase its shelf life but challenge in fruits and vegetables drying are to reduce the moisture content of the product to a level where microbiological growth will not occur and simultaneously keep the high nutritive value. Onions are dried from initial moisture content of about 82 per cent to 6 per cent or less sufficient for storage and processing (**Sagar V.R. 2001) Onion (*Allium cepa,* L.)**.

It possesses a strong, characteristic aroma and flavor, which makes it an important ingredient during food processing. There are many onion varieties with diverse characteristics. The varieties vary in color from white to yellow to red and range in flavor from sweet to bitter. Onion is highly valued for its therapeutic properties such as antibiotic, antidiabetic, antioxidant, anticancer, and fibrinolytic (**Augusti, 1996).**

It is commonly processed in the dried form that lacks fresh onion flavor. Onion puree is one such product that is convenient to use and could retain the original color and flavor in a semi–solid form. Color is an important sensory attribute because it is usually the first property the consumer observes. **(Saenz et al., 1993)**, and minimizing pigment losses during processing is of primary concern to the processor. The optimization requires determination of the kinetic parameters (reaction order, rate constant, and activation energy) for color degradation (**Weemaes et al., 1999**).

Drying involves the application of heat to vaporize moisture and some means of removing water vapor after its separation from the food products. It is thus a combined and simultaneous heat and mass transfer operation for which energy must be supplied. The removal of moisture prevents the growth and reproduction of microorganisms like bacteria, yeasts and molds causing decay and minimizes many of the moisture-mediated deteriorative reactions. It observed that reduction in weight and volume, minimizing packing, storage, and transportation costs and enables storability of the product under ambient temperatures. These features are especially important for developing countries. (**F. Zhang, M. Zhang, A. 2011**).

Drying process takes place in two stages first one happens at the surface of the drying material at constant drying rate and is similar to the vaporization of water into the ambient and second stage is according to properties of drying product with decreasing drying rate.(**A. Can 2000).**

Previously open sun drying is used for drying product. In this method, the crop is placed on the ground or concrete floors, which can reach higher temperatures in open sun, and left there for a number of days to dry. Capacity wise, and despite the very rudimentary nature of the process, natural drying remains the most common method of solar drying. This is because the energy requirements, which come from solar radiation and the air enthalpy, are readily available in the ambient environment and no capital investment in equipment is required. The process, however, has some serious limitations. The most obvious ones are that the crops suffer the undesirable effects of dust, dirt, atmospheric pollution, and insect and rodent attacks. Because of these limitations, the quality of the resulting product can be degraded, sometimes beyond edibility. All these disadvantages can be eliminated by using a solar dryer. **(S. Jegadheeswaran, S.D. Pohekar, 2009).**

Anthocyanin is the major pigment responsible for color in red onions, and the major compounds identified were cynidin–3–glucoside, cynidin–3–laminariobioside, cyaniding–3–diglucoside, peonidin– glucoside, and peonidin–3–glucoside **(Kalra, 1987).**

Onions contain reducing sugars and amino acids that enhance non–enzymatic browning during thermal processing **(Bajaj et al., 1979; Berk, 1980)**

MATERIALS AND METHODS

The experiment was conducted in the department of farm machinery and power engineering SHIATS Allahabad on the effect of drying on the storage and dried quality of onion slices. The fresh gradients onion was collected from local market.

Table: 1 Selection of product

SI NO:	PRODUCT	ENERGY (Kcal)	PROTEIN (gm)	Fats (%)	Sugar (%)	PRESENT WATER (%PER 100gm)
1	ONION SLICES	40	1.10	0.5	4	89.1

Drying process of solar tunnel dryer

Solar drying experiments were carried out for onion. Fresh onion is cut into thin slices of 4 mm and the initial moisture content is measured by oven-drying method, maintained at a temperature of 105∘C for 24 hours by taking 200 g sample (1). Total of 8000 grams of onion slices is spread uniformly on eight trays for solar drying equally in all eight trays. The exhaust fan is then switched on. The air that is passed through inlet gets heated up and is made to flow into the drying chamber, where onion slices is loaded in eight trays. During the experiment, ambient temperature, relative humidity and wind velocity, solar insulation, inlet and outlet temperatures of the collector, and temperature of all the trays inside the chamber were recorded by digital instruments on hourly basis from 8.00 am to 5.00 pm. During the experiment, all the drying trays are weighed on hourly basis until the product acquires constant weight, that is, equilibrium moisture content.

Fig.1 Photograpics view of solar tunnel dryer

Fig. 2 Photograpics view of product samples before and after drying

Moisture Content

The initial mass (mi) and the final mass (mf) of the sample are recorded at an interval of every one hour till the end of drying using the balance. The moisture content on wet basis (Mwb) is given as

$$\text{Moisture content } M_{wb} = \frac{Mi - Mf}{Mi}$$

Moisture Ratio (MR)

The instantaneous moisture (M) at one hour interval is calculated from the drying data, the initial moisture content (Mo), and equilibrium moisture content (Me) are calculated from the drying data. Then the moisture ratio at any time interval is given by

$$\text{Moisture ratio MR} = \frac{M-Me}{Mo-Mo}$$

Efficiency of Collector

The inlet temperature (Tin) and outlet temperature (Tout) of the Evacuated tube collector are recorded at one hour time interval. The mass flow rate (mc) of the air is recorded. The solar insulation (I) is recorded at one hour time interval. With aperture area (Ap), Specific heat of air (Cpc) and number of Evacuated Tubes (N) are known; the efficiency of the evacuated tube is given by

$$\text{Evacuated collector Efficiency} = \frac{\text{Mc Cpc (Tout}-\text{Tin)}}{\text{NApI}}$$

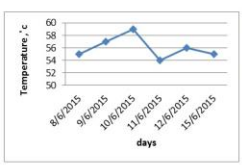
Table: –2 Day by Day Variation of Solar Isolation, Wind Velocity, and Temperature for onion slices

Sl.No	Days (8am-5pm)	Average Solar Isolation W/m2	Average Wind Velocity m/sec	Average RH in %	Average Ambient Temp °C	Average Drier Inlet °C	Exhaust Fan Seed (rpm)
1	8-06-2015	1285	.56	54	42.7	57	500
2	9-06-2015	1288	.57	46	44.8	59	500
3	10-06-2015	1290	.77	56	41.6	61	500
4	11-06-2015	1292	.98	42	43.9	64	500
5	12-06-2015	1291	1.23	51	45.3	63	500
6	15-6-2015	1287	1.15	42	44..2	62	500

DISCUSSION

Experimental Evaluation of Collector Performance of solar tunnel dryer

For the evaluation of Collector Performance of solar tunnel dryer, the minimum wind velocity was found .53m/sec and maximum wind velocity 1.22 m/sec is selected for actual drying experiment according to the need of the onion slices drying requirement since at low flow rates the exit encounters higher temperature. The ambient temperature of the air varied from a minimum of 40.5^{o}C and the maximum of 44^{o}C. The relative humidity of air was varied from a minimum of 46% to a maximum of 53%. The inlet temperature of air to the collector varied from 54^{o}C to 59^{o}C.This shows that the atmospheric temperature in the solar tunnel drier. The data used to determine the solar tunnel dryer efficiency corresponding to solar radiation varied from 1285 W/m2 to 1292 W/m^2. The average collector efficiency varied from a minimum of 45% and a maximum of 55%. The collector efficiency increases with increase in solar radiation and it attains a maximum of 66% at end of the day. The moisture content was observed varied from a maximum 89.1% and minimum 10%. The moisture content also decreases with increase drying temperature. The average moisture ratio was found from a maximum 1 and minimum 0.



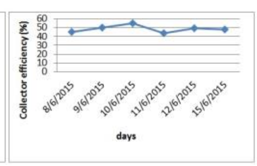
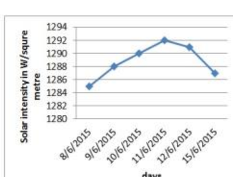


Figure: 3 Variations of Temperatures **Figure: 5 Variations of solar Collector Efficiency**



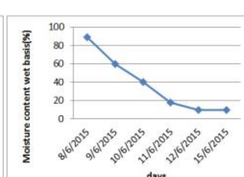


Figure – 4 Variation of Solar Intensity **Figure: 6 Variation of Moisture Content**

Thin Layer drying of Agriculture Products

The temperature rises that can be obtained with this solar tunnel dryer are appropriate for agriculture product drying. The Solar tunnel dryer Collector under study connected to a drying chamber. The drying chamber consists of eight trays which are loaded with onion slices for drying. The dried products of solar drying were obtained after 6days.

Onion Drying

The product loaded was onion slices having an initial moisture content of 89.1 % (wb). The final moisture content of 10 % was obtained in 6 day of solar tunnel dryer, whereas. The experimental conditions of onion slices are shown in Table-1, while the variation of moisture content (MC) (Figure 6) is illustrated. It is observed that the moisture removal is high initially and then gets reduced exponentially (1), this may be because of the moisture removal first from the surface and followed by the movement of moisture from internal part of product to its surface. Before solar drying the weight of onion slices was 8kg and after solar drying was .880 g.

CONCLUSION

Dehydrated onion slices have the potential to become an important value added product because of relatively inexpensive, easily and quickly solar tunnel dryer and rich in several nutrients, which are essential for human health. The solar tunnel dryer used in the present study reduces the drying period of onion slices considerably. Solar drying of onion slices takes nearly half the time as compared to sun drying. The minimum drying period of 6 days is required for onion slices to achieve equilibrium moisture in solar tunnel solar dryer. The solar tunnel drier collector efficiency varied from 44 % to 56 %. This dryer can be used to dry different products simultaneously and products that cannot be dried in natural sun drying. The most important advantage of using solar tunnel dryer is that it can be used to dry products even during no sunshine and winter season as it makes use of semi transparent polythene.

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