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Comparison of Carrot Drying in Tray dryer and Infrared dryer

V. Sruthi [1], V. Bhasker [2], Shaik Ayesha Sulthana[1], A. Shailaza[1], V. Sandeep Goutham[1]

[1]Post Graduate Student ,Department of Food Technology, University College of Technology (A), Osmania University, Hyderabad, Telangana, India

[2]Associate Professor , Department of Food Technology, University College of Technology (A), Osmania University, Hyderabad, Telangana, India

ABSTRACT

Drying is a single operation employed to prolong the life of a large quantity of vegetables. Carrot (Daucus carota) drying has been the subject of many studies. In the present work, an attempt has been made to study the effect of inlet air temperature on the drying characteristics of carrot pieces in tray drying, infrared drying. The inlet air temperatures selected were 65°C, 70^{0}C, 75°C and 80°C. Moisture content was measured at 20 minutes interval. It was also observed that the carrot samples obtained from the infrared drying system had lower final moisture content than those obtained from the tray dryer system.

Keywords: Drying rate, Moisture Content, Tray drying, Infrared drying.

I. INTRODUCTION

The Drying is one of the most common methods used to improve food stability; it is a complex process involving simultaneous coupled heat and mass transfer phenomena. However, the theoretical application of these phenomena to food products becomes difficult due to the complex structure and to the physical and chemical changes that occur during drying. Drying is one of the oldest methods of food preservation and it is a complex process. The temperature, drying time, moisture diffusivity and drying rate are vital parameters in the design of process like for instance drying, storage, aeration and ventilation, etc. Different conventional thermal treatments are used in the drying of biological products such as, hot-air drying, vacuum drying, sun-drying and freeze drying result in low drying rates in the falling rate period which leads to undesirable thermal degradation of the finished products. Drying is one of the most important unit operations in the food process engineering, and represents a feasible way in order to extend the shelf life of foods with high moisture contents, especially fruits and vegetables, by reducing their water content to an extension at which the microbial spoilage and undesirable reactions are minimized. Additionally, drying of foodstuffs is intended to improve product stability, decrease shipping weights and costs and minimize packaging requirements. Because drying is an energy intensive operation, a better understanding of the drying mechanisms is important to optimize both the quality of the product and the efficiency of the process.

II. MATERIALS AND METHODS

Carrots (Daucus carota) are purchased from local market and located at Hyderabad(India) and stored at 5^{0}C prior to experiment. Because of high maturity level of carrot, it was always ensured that firm carrot were chosen for the dehydration experiments. The carrots were dehydrated as per process flow diagram as shown in fig 1.The carrot were first washed, peeled and then were cut into 10 × 10 × 3mm slices using sharp steel knife.

III. EXPERIMENTAL PROCEDURE

Tray Drying

Tray dryer is popular for drying carrots due to a relatively short drying time, uniform heating and more hygienic characteristics. The temperature ranges from 65 to 80^{0}C. This temperature range gives maximum color values and minimizes the loss of volatile oils and discoloration.

-Selected fresh carrots (50 grams) were processed in a tray dryer and the carrots were dried under controlled temperature until constant weight. The water removed during the drying process was determined by periodic weighing of the samples using an analytical balance.

- The weight loss was evaluated in each of these experiments separately and its value correlated with drying air temperature. The response surface methodology was used to evaluate the optimum drying conditions.

- The drying tests were conducted at temperatures of 65, 70, 75 and 80oC. The weight at every 20 min time interval up to 140 mins was noted.

Infrared drying

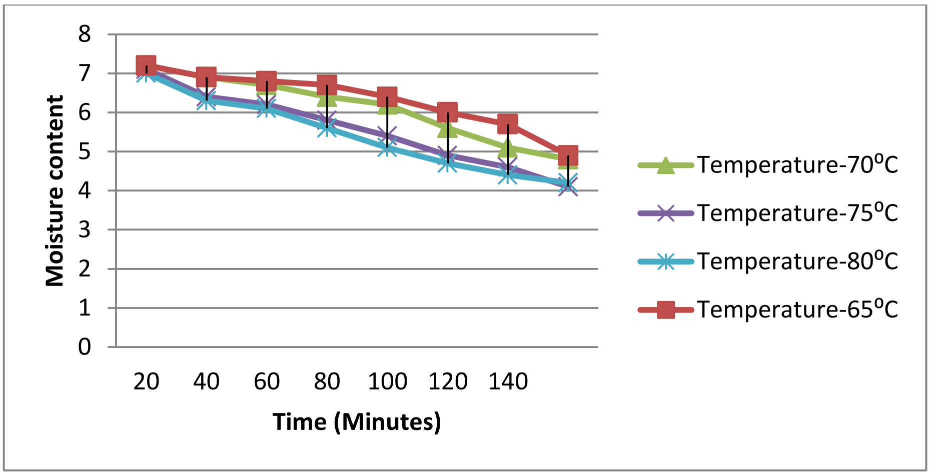
The advantage of drying with infrared (IR) is fast heating up of the surface. At the same time, the substrate is not heated. IR drying can be split into short, medium and long wave infrared spectrum. Short wave (Near-Infra Red, NIR) operates from 0.75 to 2.0 μm, medium wave from 2.0 to 4.0 μm and long wave operates from 4.0 to 15 μm. At short wave lengths, the intensity of the radiation is high and high temperatures on the surface can be reached without heating the substrate. Within short time the lamps reach maximum output. Medium wave length is known to be very effective to irradiate water and solvents and therefore enhances drying of both water and solvent borne coatings. Often, IR emitters are combined with convection drying to enhance drying further by incorporation of air velocity. These dryers are combinations of jets or air knives for high throughput flat panel lines or are applied in a tunnel for large 3D objects. IR emitters can be operated by electricity (Carbon Emitters, Tungsten Emitters) or by heating up a ceramic plate by combustion of gas.

Table 1. Infrared drying

	Advantages	**Disadvantages**
Process	• Compact drying equipment • Emitters can be adjusted in length	• Control of distance to object Performance
Performance	• Fast evaporation of solvents	• Too fast evaporation causes blisters Price
Price	• Low investment costs for electricity • Low operation costs for gas operated IR	• High investment costs for combustion • High operation costs for electricity operated IR

IV. RESULTS AND DISCUSSION

Drying Characteristics: Moisture content vs time graphs shows that moisture content decreases with increase in time period for different temperatures of 65,70,75and 80°C. The figure portraits a negative slope behaviour at beginning and constant behaviour later on where it is concluded that moisture content could not be removed (bound moisture) further with increase in time period.



Figutr 2. Moisture content Vs time for tray drying

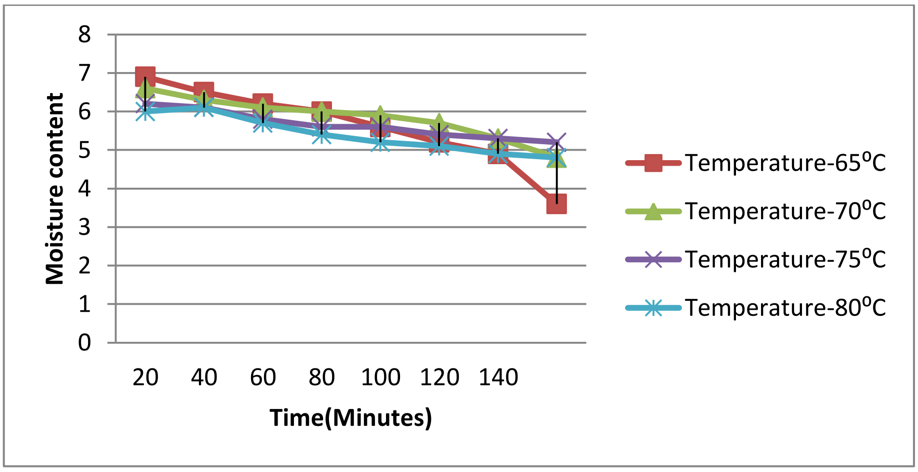


Figure 3. Moisture content Vs time for infrared drying

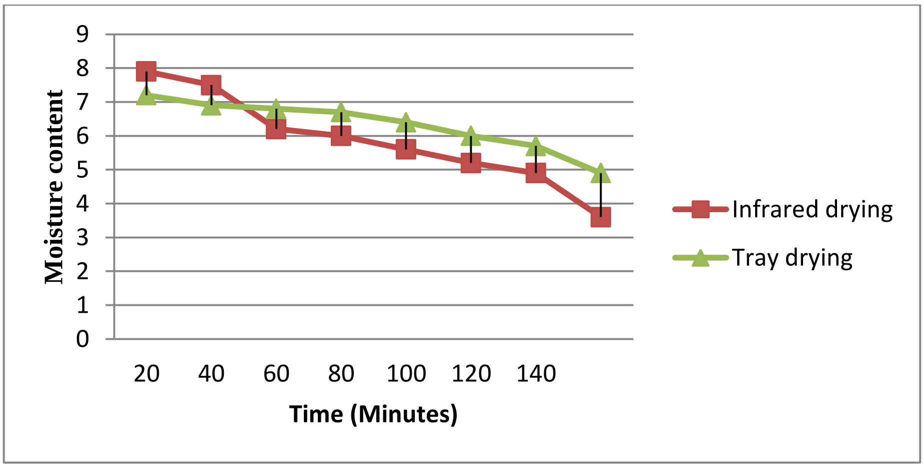


Figure 4. Moisture content Vs Time for Tray drying and Infrared drying at temperature 65^0C

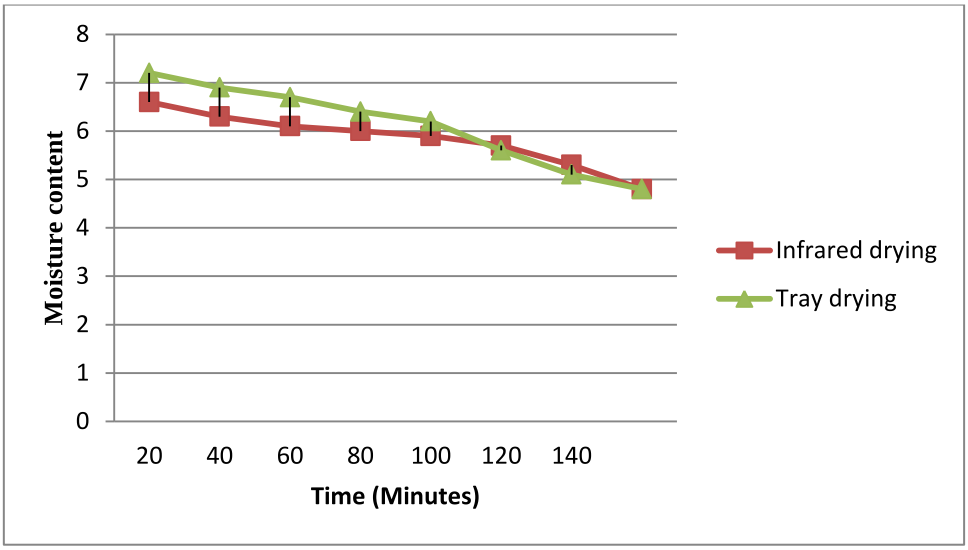


Figure 5. Moisture content Vs Time for Tray drying and Infrared drying at temperature 70^{0}C

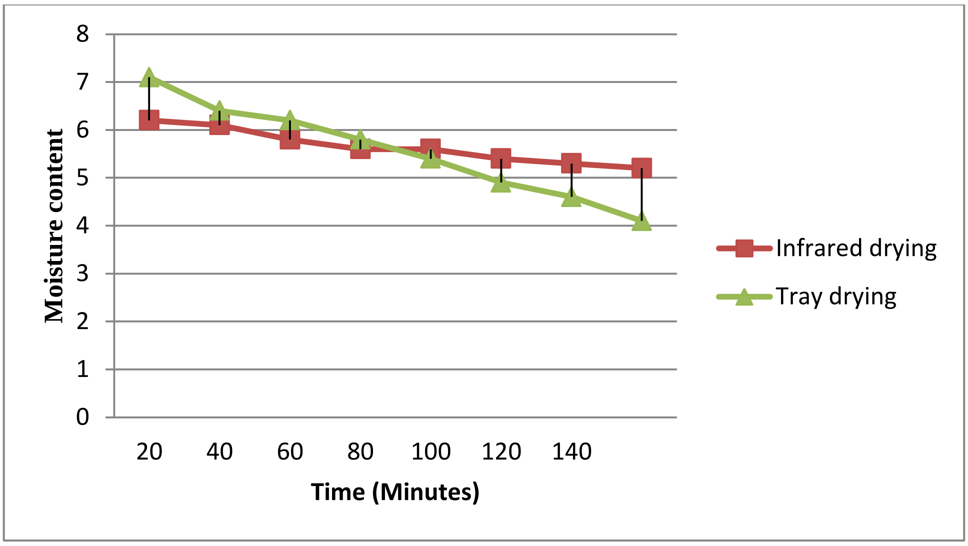


Figure 6. Moisture content Vs Time for Tray drying and Infrared drying at temperature 75^{0}C

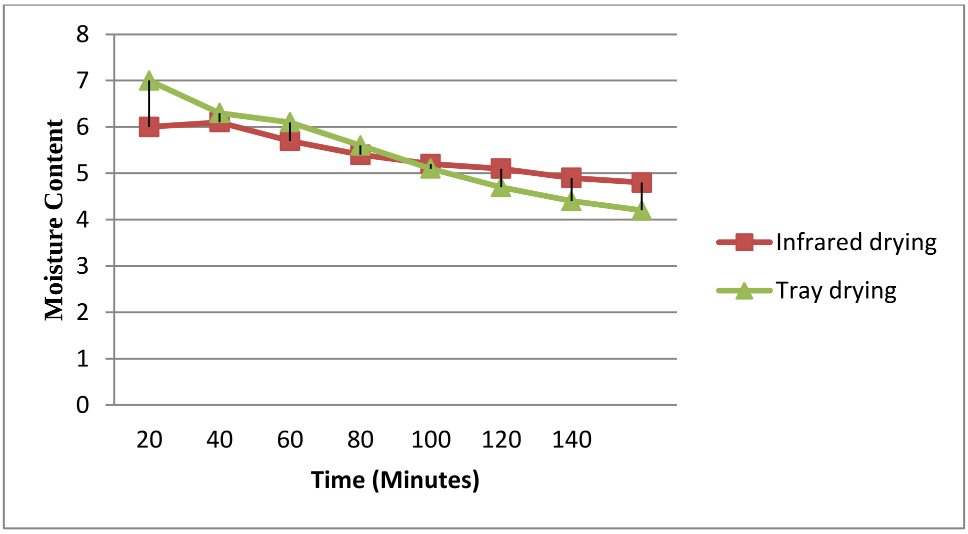


Figure 7. Moisture content Vs Time for Tray drying and Infrared drying at temperature 80^{0}C

From above figures shows that infrared dryer is best suited for drying of carrot than Tray dryer as it takes less time for drying.

V. CONCLUSIONS

The following conclusions were made from the experimental study:

- ✓ Drying characteristics of carrot with the help of Tray drier and infrared drying are studied.
- ✓ Infrared drying is effective method in drying of carrot when compared with the tray dryer.
- ✓ Optimum temperature for drying of carrot is found to be 80°C.
- ✓ Weight loss takes place faster in Infrared Dryer than in Tray Dryer.
- ✓ Drying Rate decreases with decrease in moisture Content.
- ✓ Drying rate is more in infrared drying when compared to tray drying at each temperature.
- ✓ Time of drying is more in tray drying when compared with infrared drying.

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