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STUDIES ON DRYING CHARACTERISTICS OF PINEAPPLE

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ABSTRACT

In the present work, an attempt has been made to study the effect of inlet air temperature on the drying characteristics of beetroot pieces in microwave oven drying system. The results were compared with samples of beetroot dried in a tray dryer and microwave oven drying at the same temperatures. The inlet air temperatures selected were 65°C, 70^{0}C, 75°C and 80°C. Moisture content was measured at 10 minutes interval. It was also observed that the beetroot samples obtained from the microwave oven system had lower final moisture content than those obtained from the tray dryer system.

KEYWORDS: Drying, moisture content, Tray drying, microwave oven system.

1.0 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 of various feed stocks is needed for one or several of the following reasons: need for easy-to-handle free-flowing solids, preservation and storage, reduction in cost of transportation, achieving desired quality of product, etc. In many processes, improper drying may lead to irreversible damage to product quality and hence a non-stable product.

2.0 MATERIALS AND METHODS

The beetroot is the taproot portion of the beet plant, also known in North America as the table beet, garden beet, red or golden beet, or informally simply as the beet. It is several of the cultivated varieties of beet (Beta vulgaris) grown for their edible taproots and their greens. These varieties have been classified as B. vulgaris subsp. vulgaris Conditiva Group. Other than as a food, beets have use as a food coloring and as a medicinal plant. Many beet products are made from other Beta vulgaris varieties, particularly beet. The usually deep purple roots of beetroot are eaten either boiled, or roasted as a cooked vegetable, cold as a salad after cooking and adding oil and vinegar, or raw and shredded, either alone or combined with any salad vegetable. A large proportion of the commercial production is processed into boiled and sterilized beets or into pickles. In Eastern Europe, beet soup, such as borsch, is a popular dish. In Indian cuisine, chopped, cooked, spiced beet is a common side dish. Yellow-colored beetroots are grown on a very small scale for home consumption. The green, leafy portion of the beet is also edible. It is most commonly served boiled or steamed, in which case it has a taste and texture similar to spinach. Those selected should be bulbs that are unmarked, avoiding those with overly limp leaves or wrinkled skins, both of which are signs of dehydration. Beetroot can be peeled, steamed, and then eaten warm with butter as a delicacy; cooked, pickled, and then eaten cold as a condiment; or peeled, shredded raw, and then eaten as a salad. Pickled beets are a traditional food of the American South, and are often served on a hamburger in Australia, New Zealand, and the United Arab Emirates.

Drying of material is considered to occur in two stages, a constant rate period followed by a falling rate period. In the constant rate period the rate of drying corresponds to the removal of water from the surface of material. The falling rate period corresponds to the removal of water from the interior of the material. The rate in either case is dependent on flow rate of air, material characteristics and tray material. In tray dryers, the food is spread out, generally quite thinly, on trays in which the drying takes place. Heating may be by an air current sweeping across the trays, by conduction from heated trays or heated shelves on which the trays lie, or by radiation from heated surfaces. Most tray dryers are heated by air, which also removes the moist vapors. A typical drying procedure was applied with tray dryer to investigate properties of tray dryers, its advantages or disadvantages, drying kinetics of foods that are dried in tray dryers. For these purposes, equilibrium moisture content, drying rate, mathematical and experimental drying time were calculated with some engineering formulas. Beetroot was used as sample for this air.

Microwave Oven Drying

A microwave oven, commonly referred to as a microwave, is a kitchen appliance that heats and cooks food by bombarding it with electromagnetic radiation in the microwave spectrum causing polarized molecules in the food to rotate and build up thermal energy in a process known as dielectric heating. Microwave ovens are popular for reheating previously cooked foods and cooking a variety of foods. They are also useful for rapid heating of otherwise slowly prepared cooking items, such as hot butter, fats, and chocolate. Unlike conventional ovens, microwave ovens usually do not directly brown or caramelize food, since they rarely attain the necessary temperatures to produce reactions. Exceptions occur in rare cases where the oven is used to heat frying-oil and other very oily items (such as bacon), which attain far higher temperatures than that of boiling water. The boiling-range temperatures produced in high-water-content foods give microwave ovens a limited role in professional cooking, since it usually makes them unsuitable for achievement of culinary effects where the flavors produced by the higher temperatures of frying, browning, or baking are needed. However, additional heat sources can be added to microwave ovens, or into combination microwave ovens, to produce these other heating effects, and microwave heating may cut the overall time needed to prepare such dishes. Some modern microwave ovens may be part of an over-the-range unit with built-in extractor hoods.

3.0 Experimental Procedure

Tray Drying

- ✓ Tray dryer (TD) is popular for drying beetroot due to a relatively short drying time, uniform heating and more hygienic characteristics.
- ✓ The temperature ranges from 65 to 80^{o}C.This temperature range gives maximum color values and minimizes the loss of volatile oils and discoloration.
- ✓ Selected fresh beetroots (50 grams) were processed in a tray dryer and the beetroot 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 80^{o}C .
- ✓ Note down the weights at every 10min time interval up to 150mins.
- ✓ Tabulate the noted values.

Microwave Oven Drying

- ✓ The temperature ranges from 65 to 80^{o}C (approximately 20% of moisture content). This temperature range gives maximum color values and minimizes the loss of volatile oils and discoloration.
- ✓ Selected fresh beetroot (50 grams) were processed in a tray dryer and the beetroot were dried under controlled temperature and parallel air flow 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 and velocity.
- ✓ The response surface methodology was used to evaluate the optimum drying conditions. A factorial design, three level two parameter, was proposed to analyze the dried beetroot quality as function of air temperature.
- ✓ The drying tests were conducted at temperatures of 65, 70, 75 and 80^{o}C.
- ✓ Note down the weights at every 10min time interval up to 150mins.Tabulate the noted values.

Measurement of Variables

Air Temperature

The temperature of air was measured by using mercury in glass thermometer. The air temperature is controlled within $\pm$5 °C.

Weight: Weight of the sample is measured using electronic weighing machine.

Moisture Content: MC = $\frac{M_i - M_o}{M_o}$ x 100,Where, MC= Moisture content, M_i= Initial weight of moisture, gm, M_o= Final weight of moisture, gm

Drying Rate: N = $\frac{\Delta W}{A * \Delta t}$, Where ΔW =Weight Difference, $W_2 - W_1$, gm A = Surface Area of Sample, cm^2,Δt = Cumulative Time, Min

Moisture ratio: MR = (M-Me)/(M0-Me),where M, Me and M0 are, respectively, the moisture content at time t, the equilibrium moisture content and the initial moisture content, all expressed in dry basis (g water/ g dry solids)

4.0 RESULTS AND DISCUSSIONS

Drying Characteristics

Moisture content Vs time graphs were plotted from data obtained through experimental results and it is reveals that moisture content decreases with increase in time period for different temperatures of 65,70,75and 80°C. the figure portraits a negative slope behavior at beginning and constant behavior later on where it is concluded that moisture content could not be removed (bound moisture) further with increase in time period.

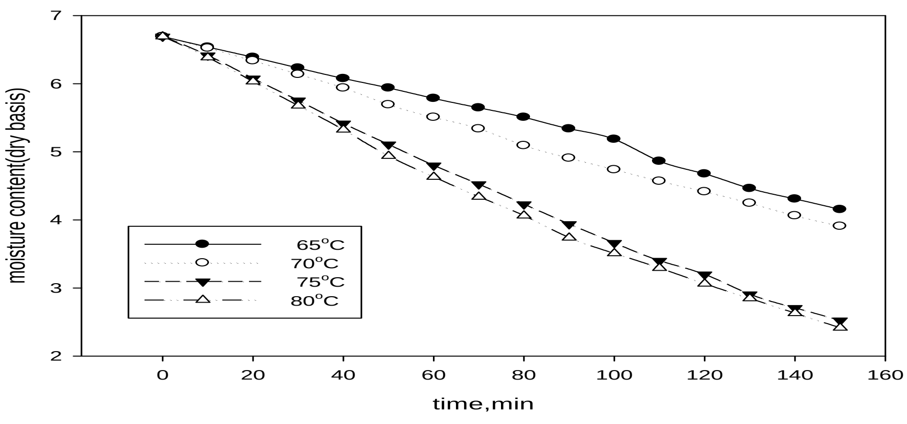


Fig 1: Moisture content vs Time graph for microwave oven

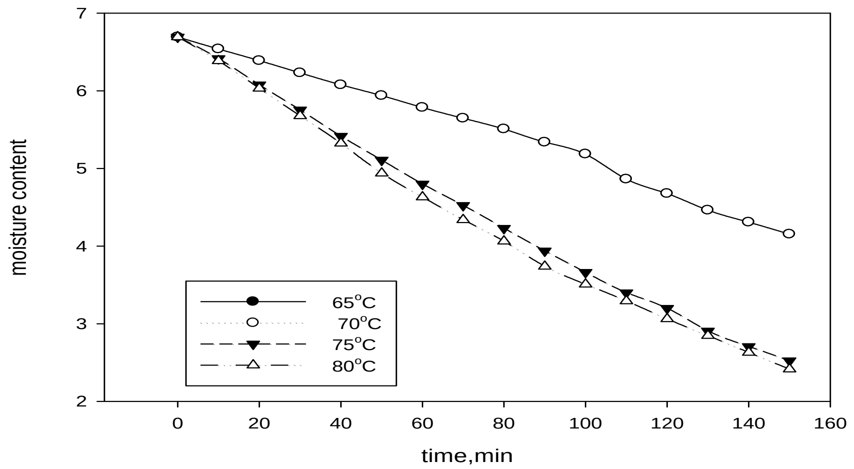


Fig 2: Moisture content vs Time for tray dryer

Comparison between Microwave oven and Tray drying:

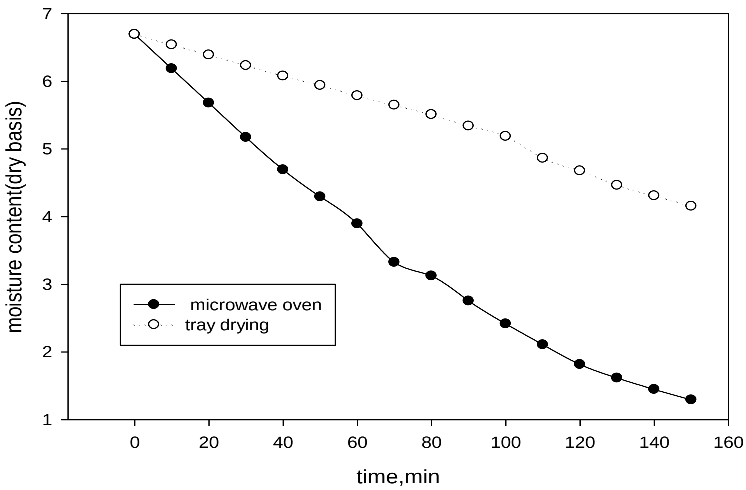


Fig 3: Moisture content vs Time for both oven and tray drying at temperature 65^0C.

From the above graph it is was observed that tray drier takes more time compared to oven drier i.e., 150min for drying, moisture content is mostly removed in oven drying at 65^0C

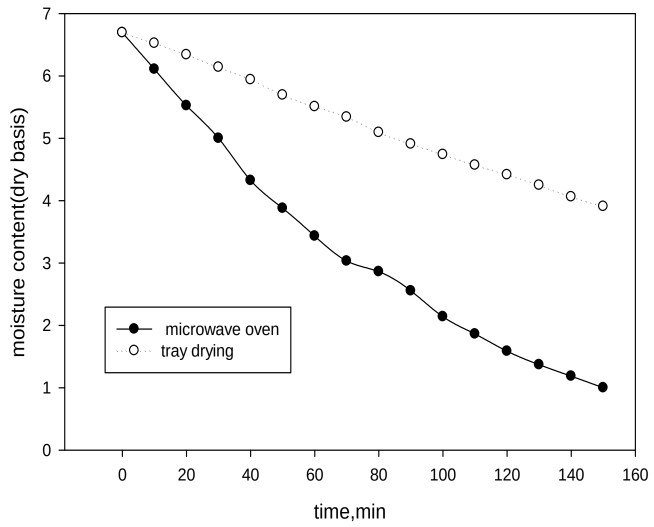


Fig 4: Moisture content vs Time for both oven and tray drying at temperature 70^{0}C.

From the above graph it is observed that Tray drier takes more time compared to oven drier i.e., 150min of drying, moisture content is mostly removed in oven drying at 70^{0}C.

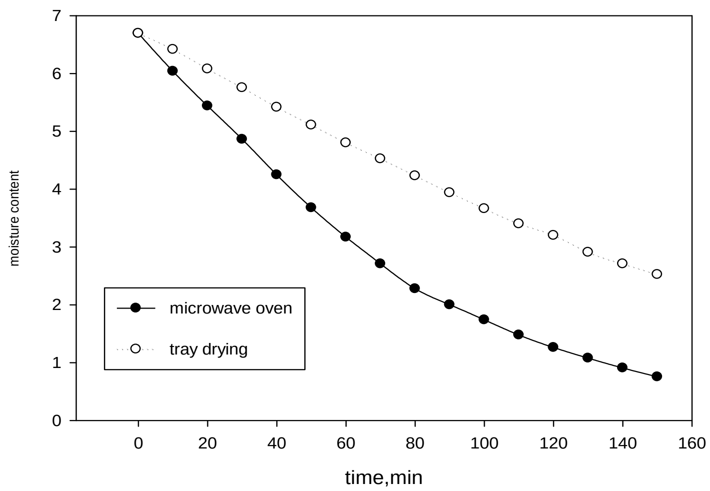


Fig 5: Moisture content vs Time for both oven and tray drying at temperature 75^{0}C.

From the above graph it is observed that Tray drier takes more time compared to oven drier i.e., 150 min of drying, moisture content is mostly removed in oven drying at 75^{0}C.

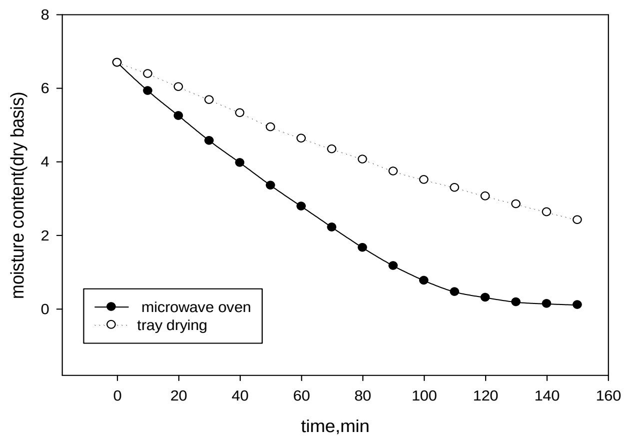


Fig 6: Moisture content vs Time for both oven and tray drying at temperature 80^0C.

From the above graph it is observed that Tray drier takes more time compared to oven drier i.e., 150min of drying, moisture content is mostly removed in oven drying at 80^0C.

From all the graphs plotted above it is evident that Oven dryer is best suited for drying of beetroot than Tray dryer as it takes less time for drying.

Drying Rate Vs Time

The graphs were plotted for drying rate vs time, from data obtained through experimental results. It can be seen from graphs that there are two regions representing constant rate and falling rate. Initial phase of drying is very slow in all the cases. On continuing the process, a point is obtained known as "critical moisture content" from where falling rate period starts. Further drying helps to attain equilibrium where further drying couldn't be achieved.

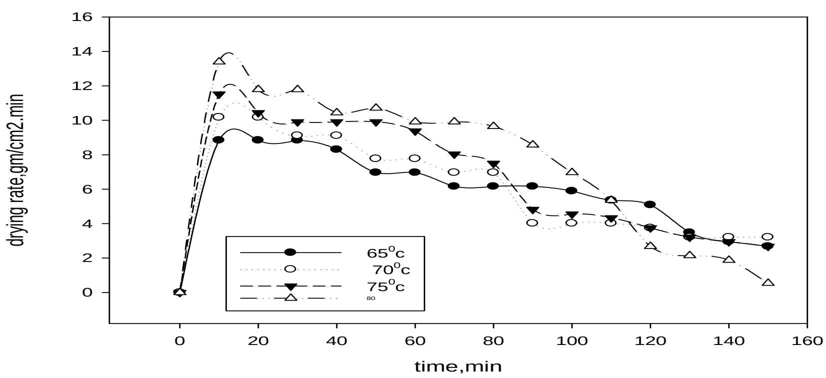


Fig 7: Drying rate vs Time for microwave oven drying

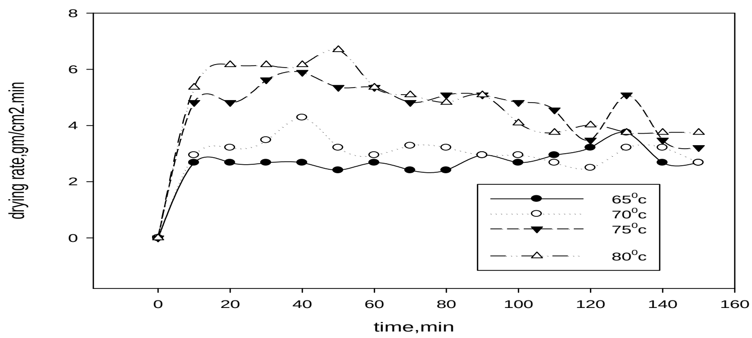


Fig 8: Drying rate vs Time for tray drying

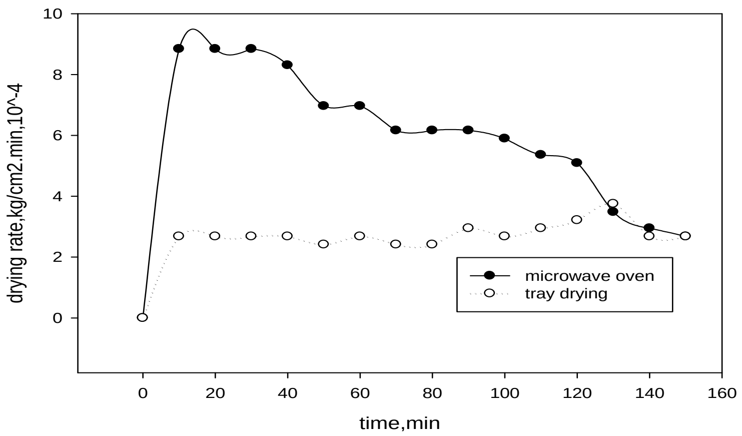


Fig 9: Drying rate vs Time for oven and try drying at temp at 65^{o}C

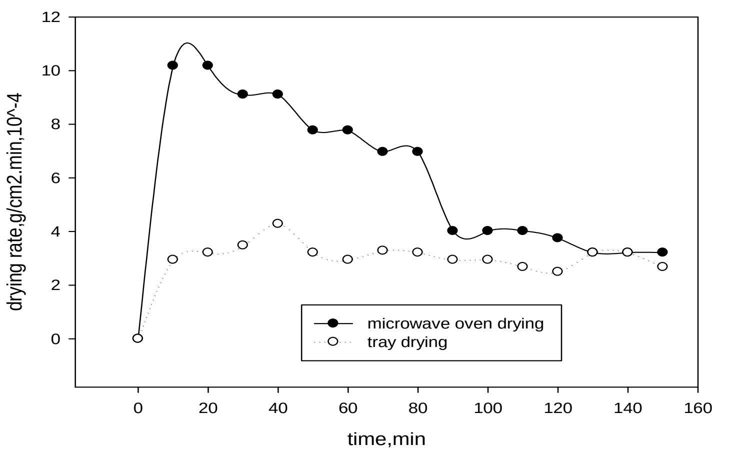


Fig 10: Drying rate vs Time graph for both oven and tray drying at temperature 70^{0}C

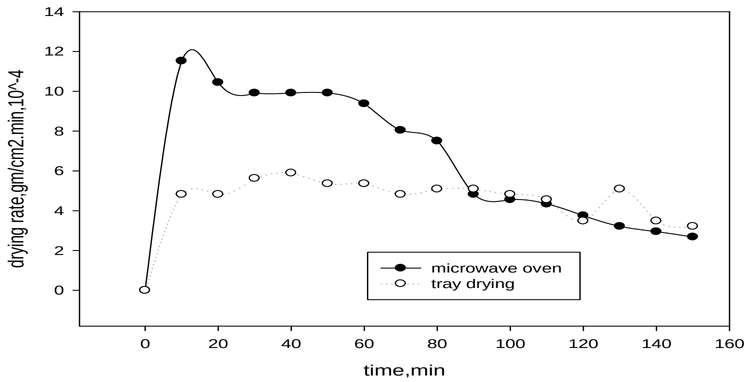


Fig 11: Drying rate vs Time graph for both oven and tray drying at temperature 75^{0}C

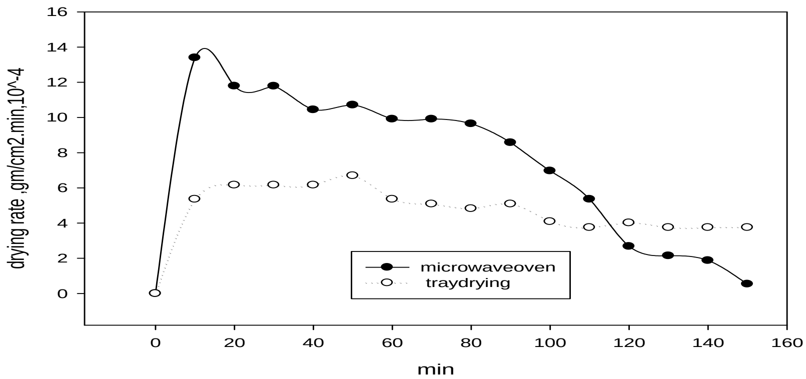


Fig 12: Drying rate vs Time graph for both oven and tray drying at temperature 80^{0}C

From the above graphs it is observed that drying rate goes on decreasing with increasing time. And also observed that drying rate is more in oven when compared with tray dryer at each temperature.

Drying Rate Vs Moisture Content

The graphs were plotted for drying rate vs moisture content from data obtained through experimental results. It can be seen from graphs that there are two regions representing constant rate and falling rate. Initial phase of drying is very slow in all the cases. On continuing the process, a point is obtained known as "critical moisture content" from where falling rate period starts. Further drying helps to attain equilibrium where further drying couldn't be achieved. Comparison of drying rate vs moisture content curves at different temperatures as shown below figures.

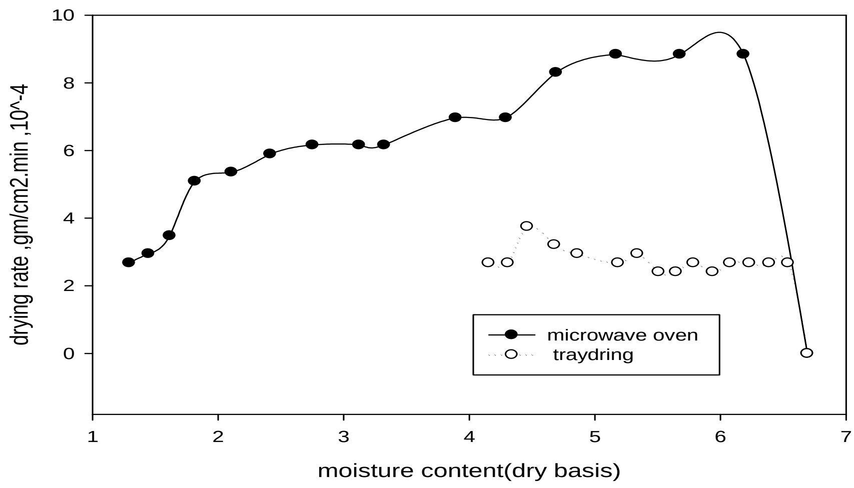


Fig 13: Drying rate vs Moisture content for both oven and tray drying at temperature 65^{0}C

From the above graph it is observed that the drying rate is more in microwave oven compared to tray drying of beet root at 65^{0}C.

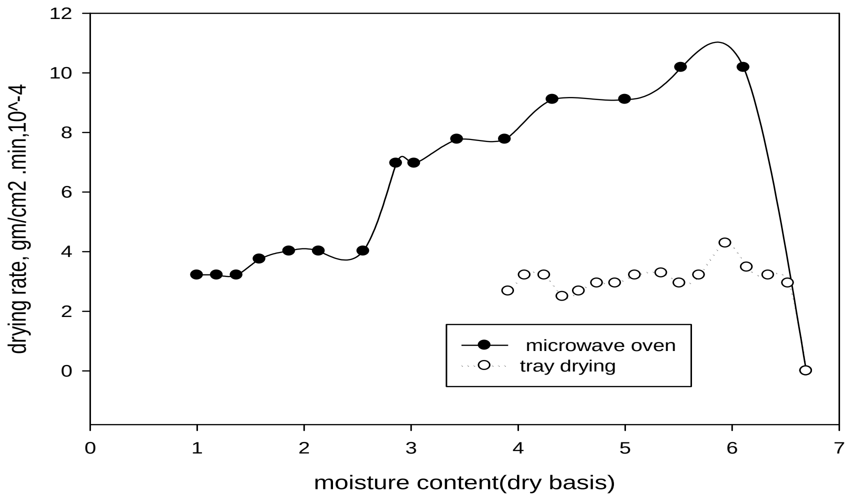


Fig14: Drying rate vs Moisture content for both oven and tray drying at temperature 70^{0}C.

From the above graph it is observed that the drying rate is more in microwave oven compared to tray drying of beet root at 70^{0}C.

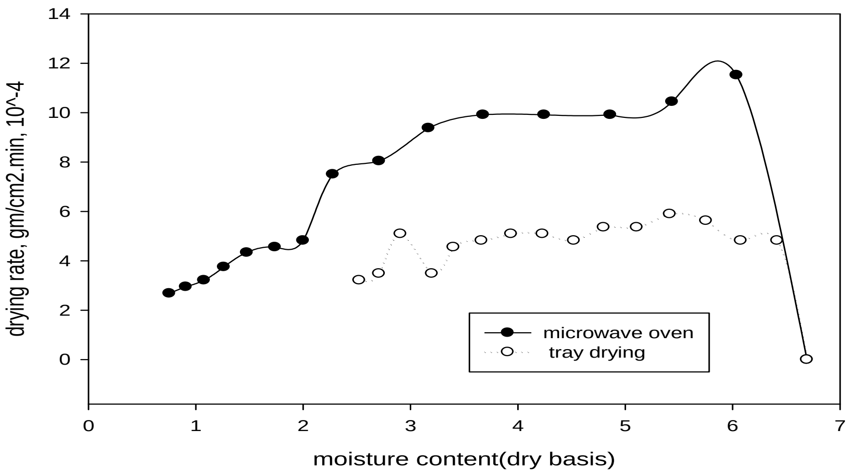


Fig 15: Drying rate vs Moisture content for both oven and tray drying at temperature 75^{0}C

From the above graph it is observed that the drying rate is more in microwave oven compared to tray drying of beet root at 75^{0}C.

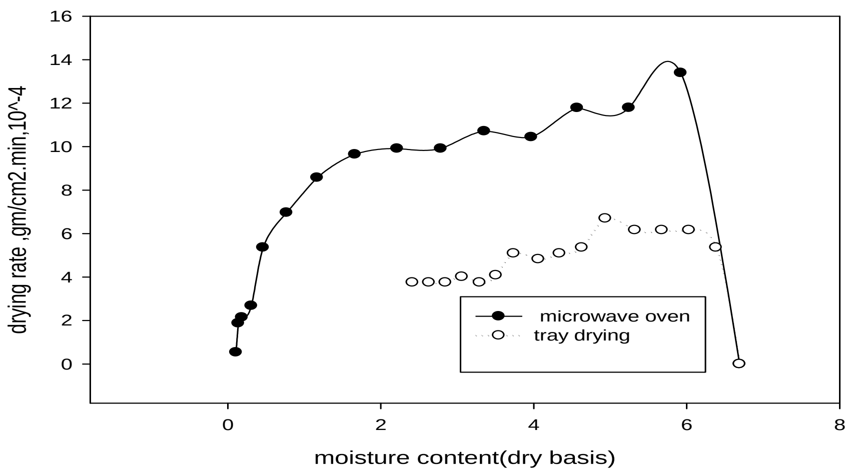
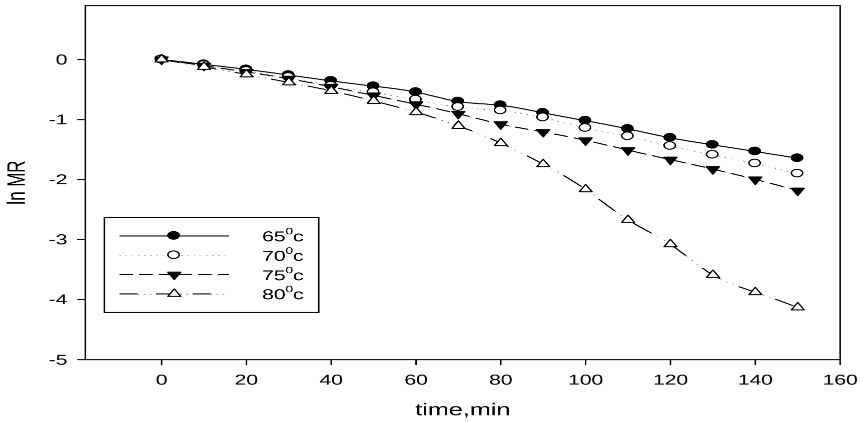


Fig 16: Drying rate vs Moisture content for both oven and tray drying at temperature 80^{0}C.

From the above graph it is observed that the drying rate is more in microwave oven compared to tray drying of beet root at 80^{0}C.

From the above graphs it is observed that drying rate goes on decreasing with decrease in moisture content. Here, graphs were plotted for ln M vs time from data obtained through experimental results.



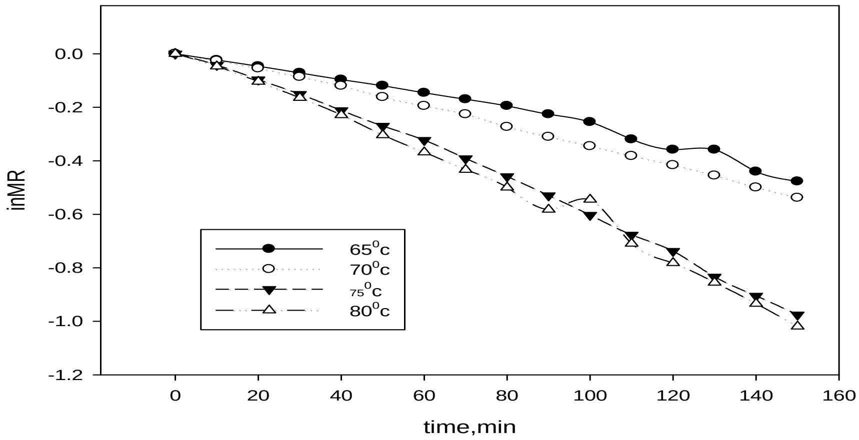


Fig 17 & 18: Moisture ratio vs Time graph for oven and tray drying

These are different drying curves are drawn by using the experimental data. From the above graphs plotted that weight loss takes place faster in Oven drier than in tray drier in less time. Hence, it is proved that oven drier is better compared to tray drier for drying of beetroot which helps in saving the drying time and energy requirement.

Optimum Temperature

From the drying characteristics results, it's seen that higher the drying temperature used for drying beetroot, the shorter the drying time. However, if the temperature increases beyond 80°C then beetroot gets spoiled. Hence, in order to have a faster drying and acceptable dried product quality of beetroot, it should be dried at an optimum temperature of 80°C.

5.0 CONCLUSION

- ✓ Drying characteristics of beetroot with the help of Tray drier and Oven drier are studied.
- ✓ Oven Dryer is effective method in drying of beetroot when compared with the tray dryer.
- ✓ Optimum temperature for drying of beetroot is found to be 80°C in Oven dryer.
- ✓ Weight loss takes place faster in Oven Dryer than in Tray Dryer.
- ✓ Drying Rate decreases with decrease in moisture Content.
- ✓ Drying rate is more in microwave oven when compared to tray drying at each temperature.
- ✓ Time of drying is more in tray drying when compared with microwave oven drying.
- ✓ The optimum drying temperature for drying of beetroot is 80^0C.

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