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Experimental investigation on drying of tomato slices

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Abstract
Over open sun drying system, solar tunnel dryers are used for drying of fruits & vegetables. This research was focused on the experimental investigation on drying characteristics of the tomato slices & its effect on the organoleptic quality of dried tomato slices. Different pre-treatments applied were dipping of tomato slices in 5%, 10% & 15% salt solutions for 5, 10 & 15 minutes. The solar tunnel dryer maintained a temperature 10-22 °C higher than the ambient temperature, providing an optimal drying environment. It was observed that the drying time and organoleptic qualities for tomato slices varied significantly with pre-treatments. The sample treated with 10% salt solution for 10 min soaking time exhibited the best sensory attributes. These findings emphasize the importance of pre-treatments in reducing drying time and improving organoleptic qualities and provide valuable insights for optimizing pre-treatments parameters and enhancing the overall drying process to produce high-quality dried tomato slices.

Keywords: Tomato, pretreatment, drying time, drying rate, moisture ratio

Introduction
Solar energy is the most readily available renewable energy source in the world for drying various agricultural products. Open sun drying is the traditional method for drying various agricultural products but having some limitations. Solar tunnel dryer is a polyhouse dryer suitable for drying various agricultural products. In natural circulation type solar tunnel dryer, air is naturally heated inside the dryer due to greenhouse effect and this hot air inside the dryer removes the moisture from the product. Nowadays, drying fruits and vegetables have received a great attention from numerous of researchers worldwide because of its high nutrition value. Various methods of preservation of fruits and vegetables are being used across the world; however solar drying is the most attractive methods as it can eliminate wastage and improves the production of fruits and vegetables in term of quality and quantity [1].
Tomato (*Solanum lycopersium*) is the second largest cultivated vegetable (after potato) in the world with 4.8 million hectares area of land under cultivation, yielding 182 million tons and high in moisture with an average initial moisture content of around 90% or more [2]. Such high moisture makes it susceptible to post harvest deterioration. Drying of tomatoes has been useful to increase its shelf life. The purpose of drying is not limited to prevent deterioration and increase shelf life but also to reduce its shipping weight and volume, which improves the handling and reduces the economic cost involved in transportation. The dried tomatoes serve as raw materials in various processing steps e.g. ketchup, sauces, soup premixes, canned products, beverages and so on. In the culinary industries, dried tomatoes serve as toppings for various dishes. The market for the dried tomato products is estimated to grow in the years to come. Drying of tomato slices in a solar tunnel dryer may retains its quality, flavor and better shelf life, hence the present study was made with the objectives

1. To study the drying behavior of tomato slices.
2. To Study the effect of pre-treatments on organoleptic quality of dried tomato slices.

Materials & Methods
The experimental work was carried out at the department of Process and Food Engineering, Shriram College of Agricultural Engineering, Paniv in the year of 2023. For that, fresh and mature tomatoes available at local market were used for drying purpose and common salt was used for the pretreatment purpose. The developed mini solar tunnel dryer [3] used for experimentation (Fig.1) was of dimensions 120 cm x 60 cm x 30 cm.
Thermometer was used for measuring the temperature inside the developed mini solar tunnel dryer, while hot air oven was used to determine the moisture of product.

The purchased tomatoes were washed thoroughly, drained well and then sliced into thin slices of 9 mm average thickness.

Fig 1: Experimental Solar Tunnel Dryer

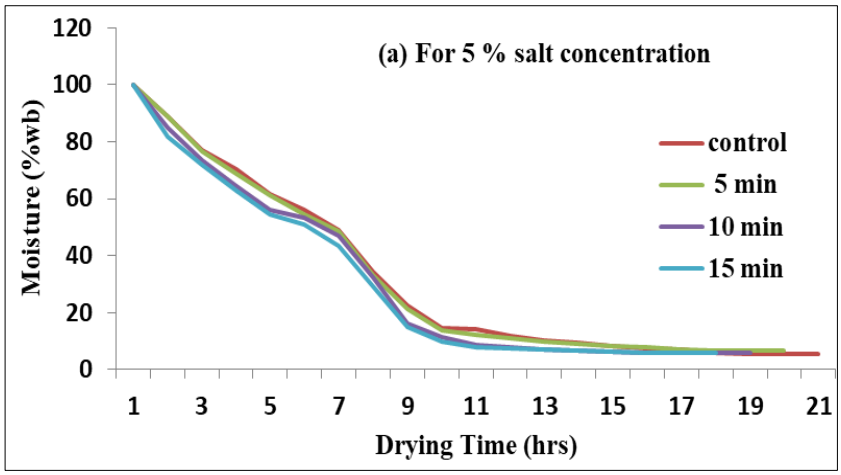
The initial dry basis moisture of tomato slices was determined by standard hot air oven method. Different pre-treatments (T_1: control, T_2: sample pretreated with 5% salt solution for 5 min., T3:sample pretreated with 5% salt solution for 10 min., T_4: sample pretreated with 5% salt solution for 15 min., T_5: sample pretreated with 10% salt solution for 5 min., T_6: sample pretreated with 10% salt solution for 10 min., T_7: sample pretreated with 10% salt solution for 15 min., T_8: sample pretreated with 15% salt solution for 5 min., T_9: sample pretreated with 15% salt solution for 10 min., sample pretreated with 15% salt solution for 15 min.) were applied for conduction of experiment. Drying characteristics like moisture content, drying rate and moisture ratio of tomato slices during its complete dehydration process were determined by using standard methods [4]. Organoleptic evaluation of dried tomato slices for each pretreatment was conducted with the help of 9 point hedonic scale.

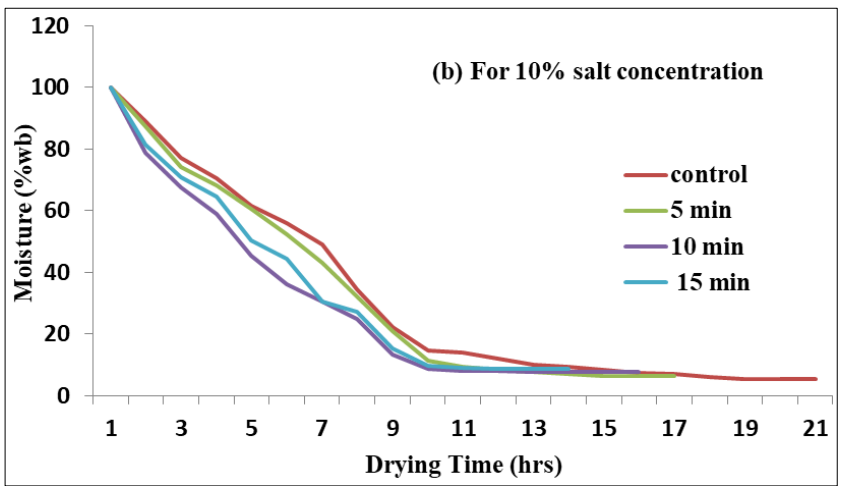
Results and Discussion

The average initial moisture content of the tomato slices was observed to be 93.5% (w.b). It was observed that initially moisture removal from tomato slices was rapid due to presence of higher amount of moisture at surface level.

Effect on drying time

For all the salt concentrations (Fig.2), it was observed that drying time of tomato slices decreased with increase in its soaking time in salt solution. Also it is seen that drying time of tomato slices significantly varied with soaking time. For all the soaking times (Fig.3), it was observed that drying time of tomato slices decreased with increase in salt concentration of solution. Also it is seen that drying time of tomato slices significantly varied with salt concentration.





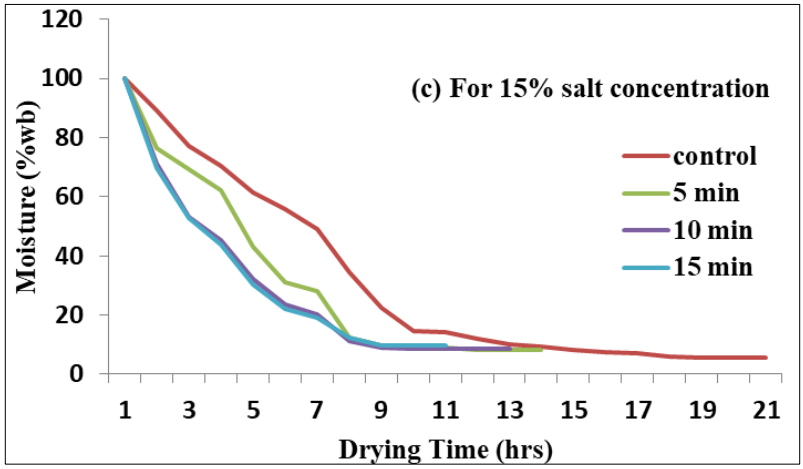
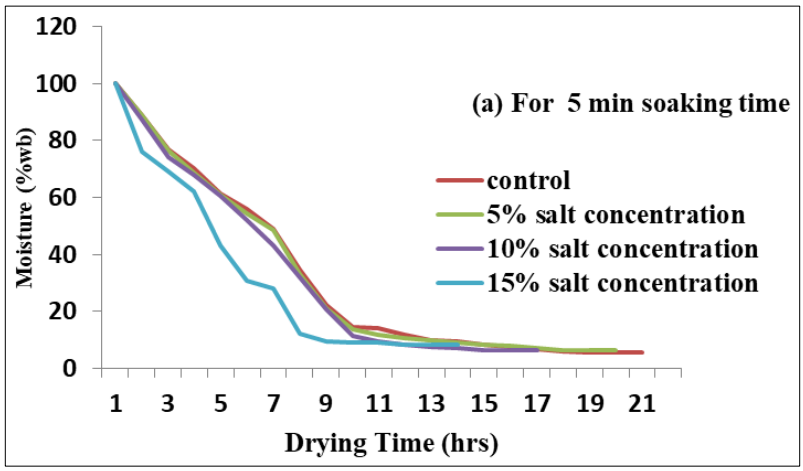
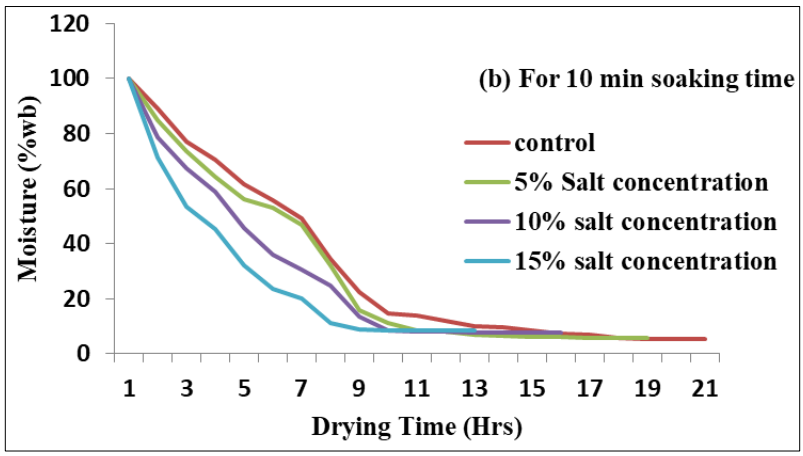


Fig 2: Effect of salt concentration on drying time of tomato slices





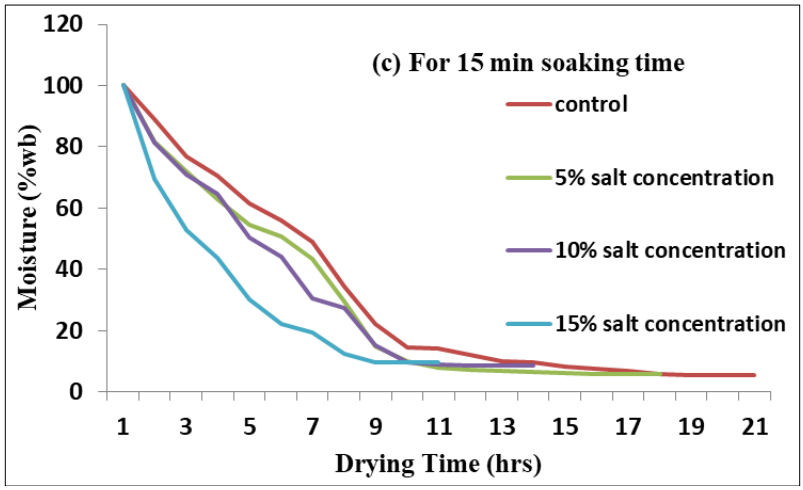


Fig 3: Effect of soaking time on Drying Time of Tomato Slices

In case of drying time, sample without any pretreatment took maximum hours to dry, whereas the sample treated with maximum content of salt concentration and maximum soaking time exhibited minimum time to dry. This is due to the initiation of osmotic process by salt concentration which fastens removal of moisture from the product.

Effect on drying rate

From the drying curve (Fig.4), it was seen that for all the salt concentrations, drying rate of tomato slices decreased with increase in its soaking time in salt solution. Also it is seen that drying rate of tomato slices significantly varied with soaking time. For all the soaking times (Fig.5), it was observed that drying rate of tomato slices decreased with increase in salt concentration of solution. Also it is seen that drying rate of tomato slices significantly varied with salt concentration.

At the beginning of drying process, surface moisture was evaporated and hence the drying rate was high. Due to evaporation of free moisture from the outer layer, drying rate gets reduced afterwards due to internal moisture migration from inner layer to surface. The drying rate decreased with an increase in the drying time [5].

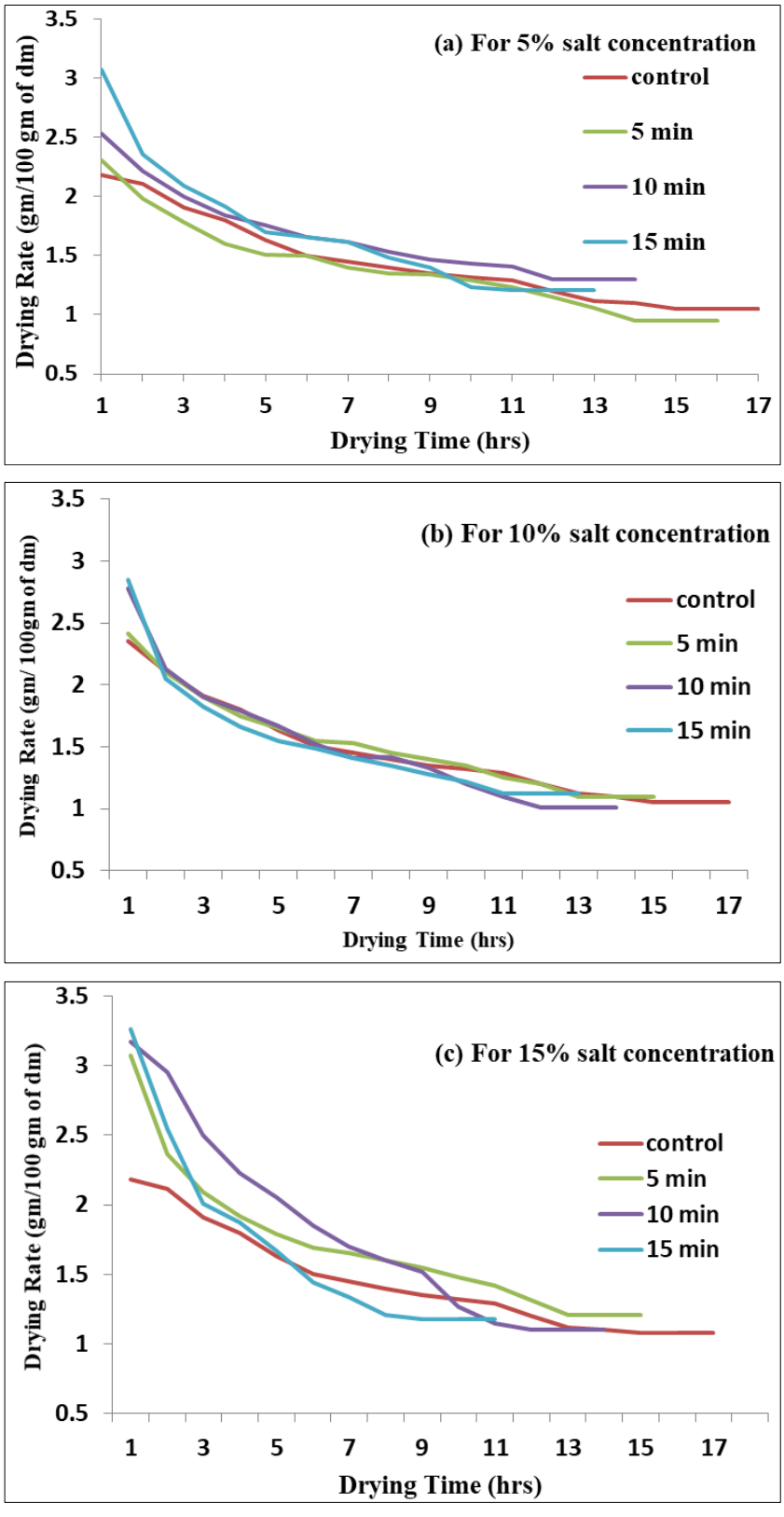
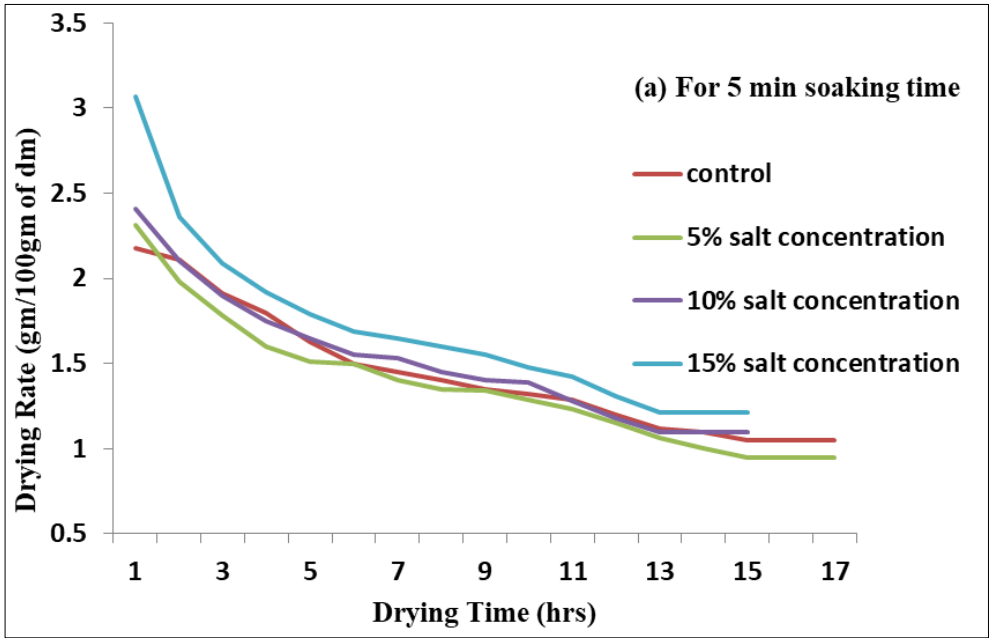
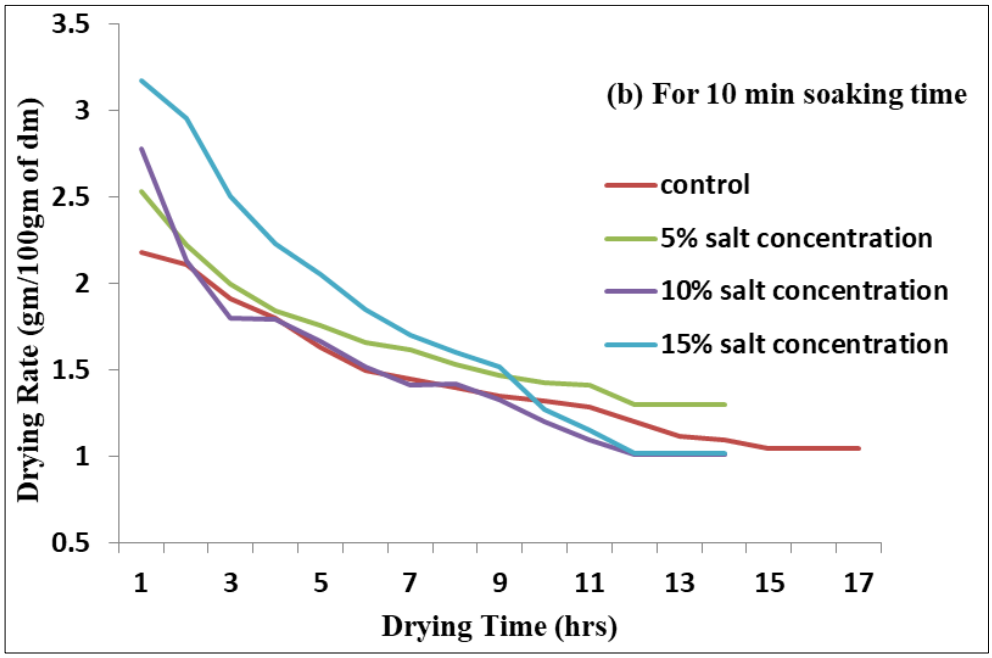


Fig 4: Effect of salt concentration on Drying Rate of Tomato Slices





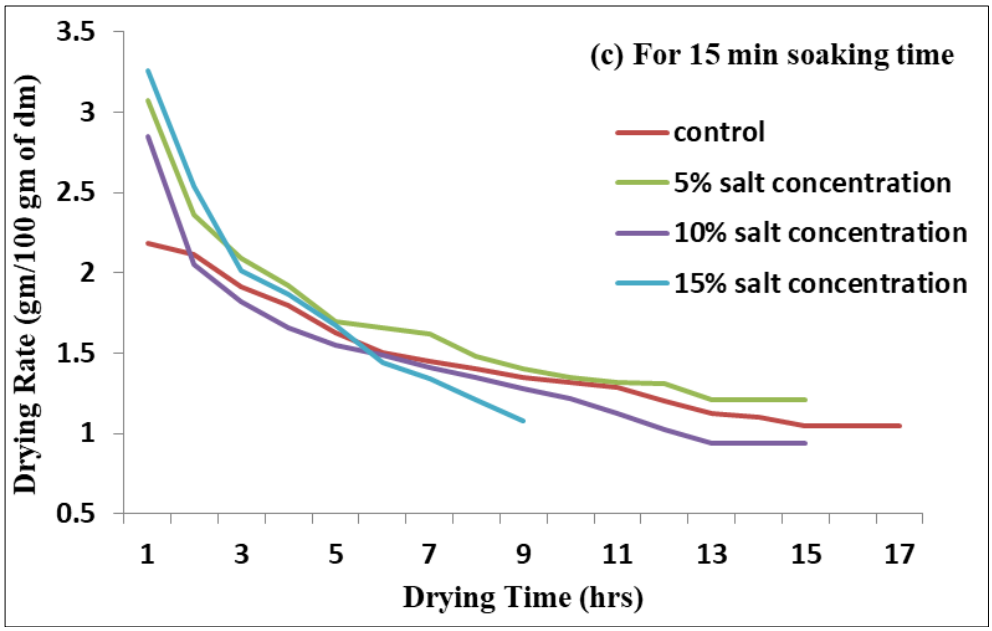


Fig 5: Effect of soaking time on Drying Rate of Tomato Slices

Effect on moisture ratio

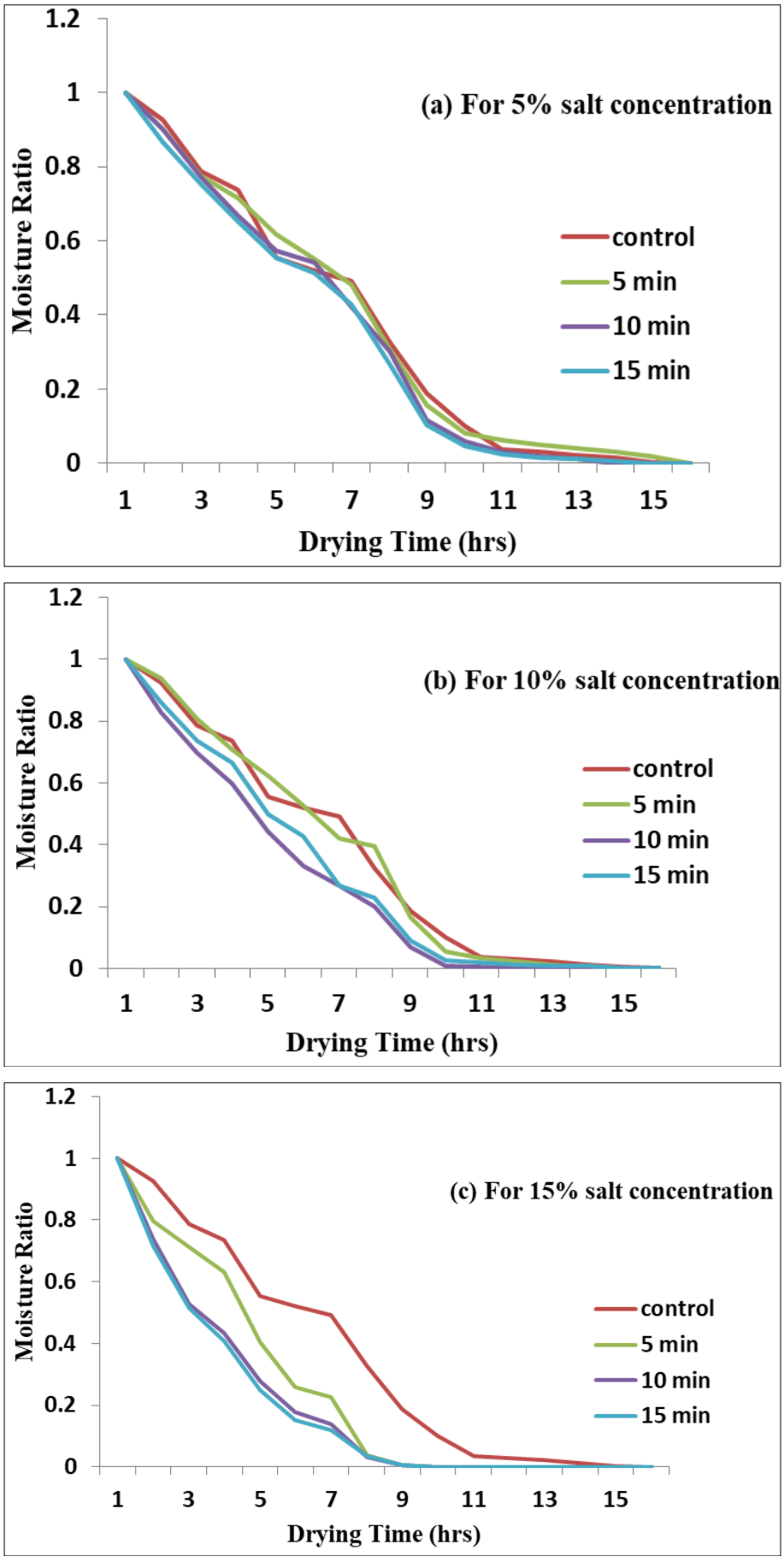


Fig 6: Effect of salt concentration on moisture ratio of Tomato Slices

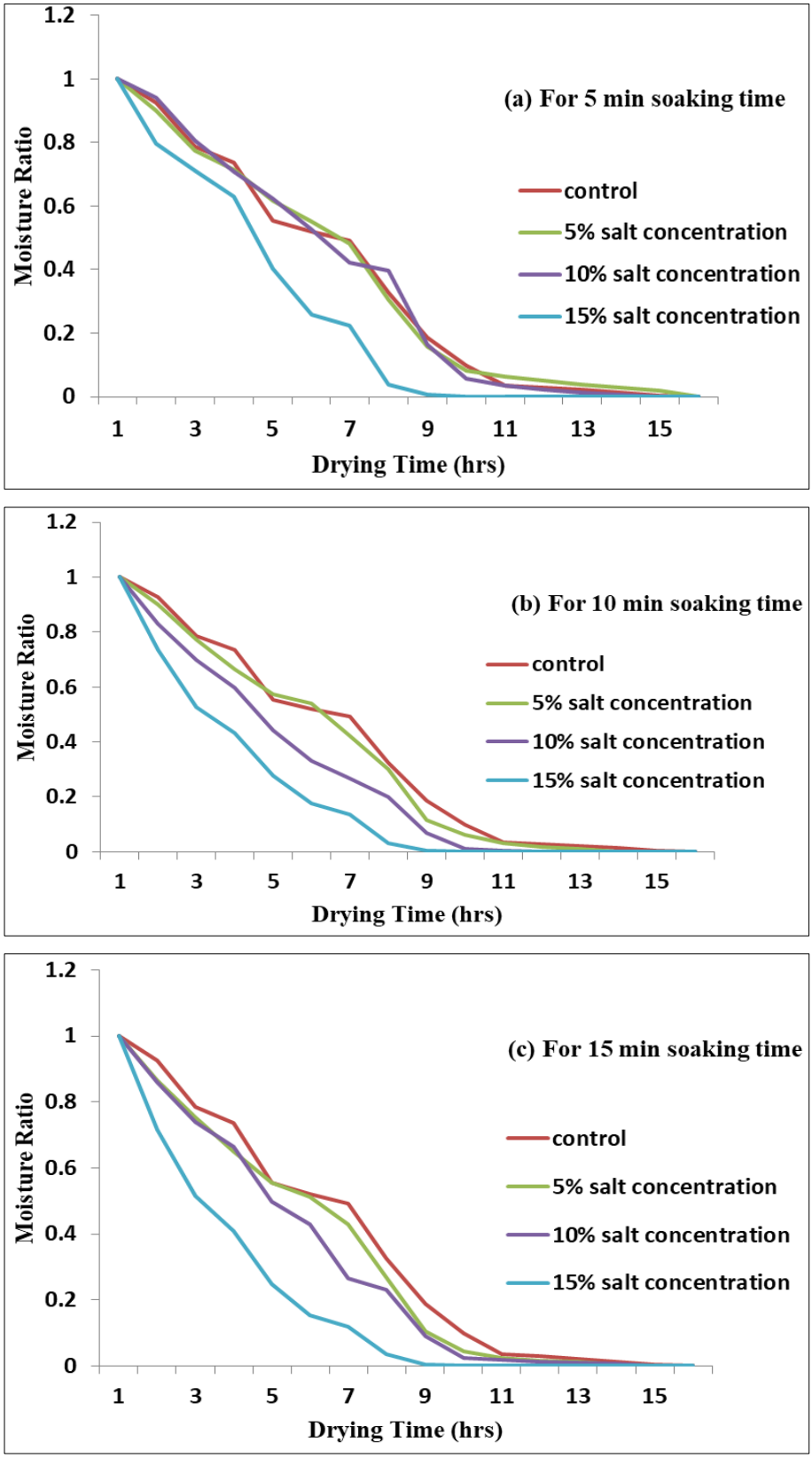


Fig 7: Effect of soaking time on moisture ratio of Tomato Slices

The effect of salt concentration and soaking time are shown in Fig.6 & Fig.7 respectively. It was observed that at the beginning of drying process, surface moisture was evaporated and the moisture ratio was high i.e.1. As the drying period is increased, moisture ratio decreased significantly. For the sample without any pretreatment, the moisture ratio reached to zero after 15 hours of drying period, whereas for all the pretreated samples it took 9 to 15 hours to reach to zero, indicating complete drying of product.

Based on the organoleptic evaluation, it was observed that the sample treated with 10% salt concentration and 10 min. of soaking time (Fig.8 and Fig.9) exhibited the best among the other samples. It is possible that the pretreatment with salt enhanced the flavor and overall acceptability of the dried tomato slices making them more appealing to the sensory panels.

Fig 8: Most liked Tomato Slice sample (Dried at 10% salt concentration for 10 min soaking time)

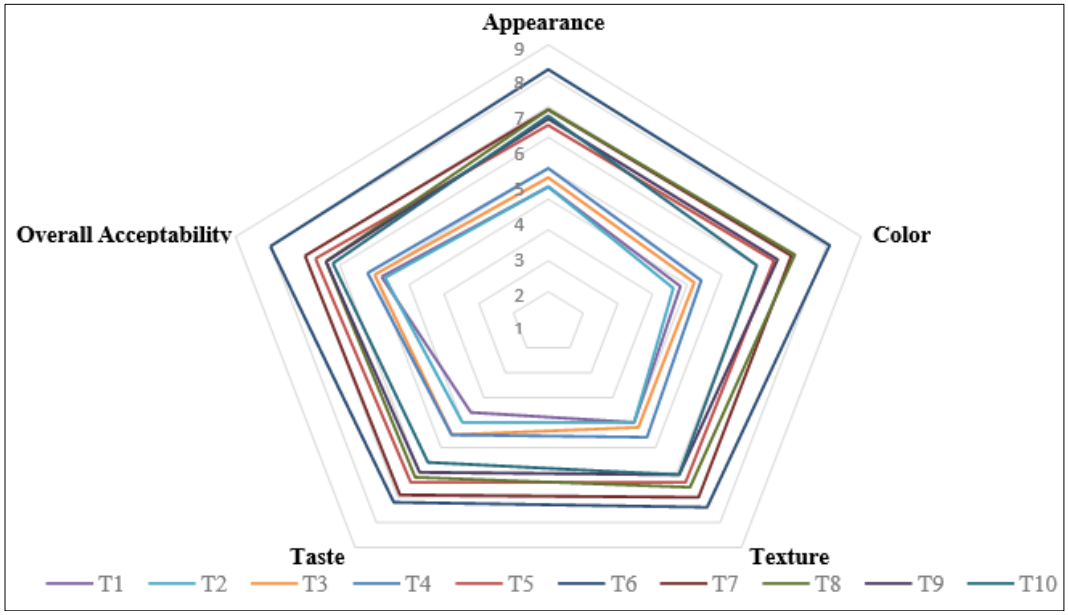


Fig 9: Overall acceptability data for various dried Tomato Samples

Conclusions

1. The solar tunnel dryer maintains a temperature approximately 10-22 °C higher than that of ambient temperature, creating an optimal drying environment for tomato slices.
2. Pre-treatment with salt significantly reduced the drying time of tomato slices. The drying time decreased to 16 hours with 5% salt pre-treatment, 14 hours with 10% salt pre- treatment, and the lowest drying time of 11 hours was achieved with 15% salt pre- treatment.
3. The pre-treatment process not only affected the drying time but also had a significant impact on the organoleptic qualities of the dried tomato slices.
4. Among the pre-treatment samples, sample treated with 10% salt concentration for 10 minutes of soaking time exhibited the best organoleptic attributes.
5. A significant correlation has been observed between salt concentration, soaking time and the drying characteristics of tomato slices.
6. Higher salt concentrations exerted a pronounced influence on the moisture content and moisture ratio of the tomato slices, resulting in lower values for both parameters, indicating that salt concentration plays a crucial role in facilitating the desiccation process and enhancing moisture removal during drying.
7. Prolonged drying time leads to decreased moisture content and moisture ratio of the tomato slices, indicating a progressive dehydration process over time.
8. Extended drying duration allows for more effective water evaporation from the tomato slices, resulting in reduced moisture content and moisture ratio values.
9. Salt concentration and soaking time are the significant key factors affecting the drying behavior of tomato slices.
10. The findings provide valuable insights for optimizing the drying process of tomato slices in various applications, such as food preservation and production of dried tomato products.

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