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Investigating the Influence of Blanching on the Drying Characteristics and Sorption Isotherm of Cherry Tomatoes (*Lycopersicum Esculentum Var. Cerasiforme*)

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ABSTRACT

Cherry tomatoes have a relatively short shelf life due to the high-water content and enzymes present in the fruit. Blanching is a common practice in food preservation that inactivates enzymes and can extend the shelf life of fruits and vegetables. This study investigated the effect of blanching on the drying rate and sorption isotherm of cherry tomatoes. Blanching was carried out at temperatures of 60 °C, 70 °C, and 80 °C for 15, 30, and 45 minutes. Following blanching, the samples were dried at 60 °C until a moisture content of approximately 12% was achieved. The dried samples were then stored in desiccators containing solutions of NaOH, MgCl2, K2CO3, NaNO2, and NaCl for 24 days. The results that the drying rate and moisture ratio (MR) of the blanched samples were found to be similar, indicating that the drying process was relatively consistent for all blanching treatments. However, the time required to reach a moisture content of 12% varied depending on the blanching temperature and time. The sorption isotherm analysis revealed that the control samples and samples blanched at 60 °C for 15, 30, and 45 minutes underwent two distinct processes: desorption (water release) at low relative humidity (RH) and absorption (water binding) at high RH. In contrast, samples blanched at 70 °C and 80 °C exhibited desorption at all RH values. These findings suggest that blanching at 60 °C for 15 minutes may be the most effective treatment for preserving the quality of cherry tomatoes during storage.

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1. INTRODUCTION

Cherry tomatoes are a type of tomato that is smaller than other tomatoes. They are classified as a horticultural vegetable that can grow in the tropics. Cherry tomatoes have a high selling price, but they require careful handling. The demand for cherry tomatoes in the market is increasing every day because people are becoming more knowledgeable about tomatoes. Cherry tomatoes are popular among middle to upper-class people because they are relatively expensive and small, making them easy to consume as snacks or food ingredients [1]

Cherry tomatoes are a crop that can be grown in any season, so people's demand for tomatoes is always met. In general, cherry tomatoes have different varieties when the morphological growth period is not optimal in the generative period, such as indigo sun, italian tree, black cream, and momotaro. These cherry tomatoes have a relatively short shelf life because the physiological, enzymatic, mechanical, and morphobiological changes in tomatoes always change after the harvest process and also the water content is quite high. In general, cherry tomatoes have a storage temperature of 10-15 °C

Extending the shelf life of agricultural products is one way that can be done by preservation. A widely practiced preservation method is drying, which reduces the water content in the material to prolong its shelf life. In addition to drying, blanching is another preservation method that can be used. This method is carried out by heating an ingredient to improve the quality of a good product when the material has not been dried and reduce the levels of microorganisms [2].

The blanching method serves two functions: it kills microbes in food ingredients, such as cherry tomatoes, to improve their quality and inactivates enzymes that can damage the quality of food ingredients, especially those that are still fresh and easily perishable [3]

One of the most crucial factors in the drying process is the equilibrium moisture content of a material. Equilibrium moisture content is reached when the water vapor pressure within the material equals that of the surrounding environment. The moisture content characteristics of a material can vary, and achieving a balance with the environmental moisture content is essential. Equilibrium moisture content significantly influences the long-term storage of materials, as a storage environment with high relative humidity (RH) can cause the material to adapt by absorbing moisture from its surroundings, resulting in a moisture content that matches that of its environment [3].

Given the aforementioned information, it becomes imperative to undertake research that explores the impact of blanching conditions on the adsorption isotherm properties of cherry tomatoes. This research aims to investigate how blanching conditions affect the isotherm properties of cherry tomatoes and to determine the optimal blanching temperature and duration necessary for achieving the best results in the blanching process. The ultimate goal is to extend the shelf life of cherry tomatoes.

The objective of this research is to investigate the impact of blanching conditions on the sorption isotherm of cherry tomatoes. This research holds practical significance in terms of prolonging the shelf life of cherry tomatoes and ascertaining the ideal blanching temperature for optimizing the isotherm properties of cherry tomatoes

2. MATERIALS AND METHODS

2.1 Research Material and tools

The tools used in this study were an oven-type drying oven, a batch dryer, measurement cup(500 ml), a water bath, a digital scale (0.1 g), a desiccator, a digital thermometer, a hygrometer , and a caliper.

The materials used in this study were cherry tomatoes, distilled water, NaOH, MgCl2, K2CO3, NaNO2, and NaCl.

2.2 Blanching

The blanching process carried out in this study uses a tool in the form of a water bath with a brand (B-ONE DWBC). Before carrying out the blanching process, the initial weight of the sample is measured first, then the desired temperature is set (60, 70, and 80°C). After the temperature has reached the setting, the sample is entered for 15 minutes, 30 minutes, and 45 minutes, and then the final weight is measured.

2.3 Drying Rate

The drying rate is obtained by comparing the drying time (minutes) to the difference in moisture content (% wet basis) over a certain period of time.

2.4 Sorption Isotherm

This sorption process can be done by using a desiccator containing salt from the lowest RH to the highest RH using NaOH, MgCl2, K2CO3, NaNO2, and NaCl. Before being put into the desiccator, the sample was dried first using a batch dryer until the moisture content was 12% at a temperature of 60°C and weighed every 30 minutes. After the sample is dried, it is put in a desiccator with each RH for 2 weeks and measured for weight. If the weight is not constant, the sample will be put back into the desiccator until it reaches a constant weight.

2.5 Treatments and Parameters

The parameters of this research are:

2.5.1 Moisture Content

In this research, the measurement of moisture content includes wet base (MCwb) moisture content and dry base (MCdb) moisture content. The measurement of moisture content is carried out to determine the mass of a sample and the mass of water that has evaporated. Calculation of the moisture content using the formula:

Wet basis moisture content

$$MC_{wb} = \frac{Wm - Wd}{wm} \times 100\% \quad (1)$$

Dry basis moisture content

$$MC_{db} = \frac{Wm-Wd}{Wd} + 100\% \quad (2)$$

where:
MC_{wb} = Wet basis moisture content (%)
MC_{db} = Dry basis moisture content (%)
Wm = Initial weight of material (g)
Wd = Weight of solids in the material (g)

2.5.2 Drying rate

The drying rate calculation is carried out to determine the drying rate given with an interval of time (minutes) with the following equation.

$$\text{Drying rate} = \frac{Wm-Wt}{Wd} \; X \; \frac{1}{t2-t1} \quad (3)$$

where:
Wm = Weight of water in the material (g)
Wt = Weight of material at time (g)
Wd = Weight of solid material (g)
t2-t1 = Change in time (hours)

2.5.3 Moisture Ratio (MR)

The moisture ratio calculation is done after calculating the moisture content of the material so as to obtain a constant moisture content value. Then the calculation is done using the formula:

$$MR = \frac{Mt-Me}{Mo-Me} \quad (4)$$

where:
MR = Moisture Ratio
Mt = Moisture content at t (time)
Mo = Initial moisture content of material (%)
Me = Moisture content obtained after a constant material weight (%)

2.5.4 Material Sorption Isotherm

The sorption isotherm of the material is determined by looking at the weight of the sample put into each desiccator that has a different RH of salt. The next step is to display the relationship between moisture content and water activity in the form of a graph, where water activity uses the equation:

$$Aw = \frac{P}{P0} \quad (5)$$

where:
Aw = water activity (%).
P = partial pressure of water.
P0 = saturated vapor pressure of water.

3. RESULTS AND DISCUSSION

3.1 Moisture Content

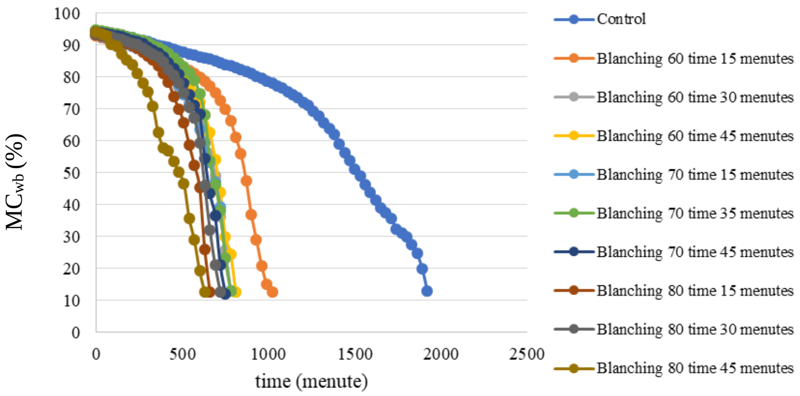

Figure 1. Decrease in water content of each sample.

Figure 1 shows that with almost the same initial moisture content in each sample, it takes longer for tomatoes without blanching treatment to reach a moisture content of about 14% (30 hours). Meanwhile, among tomatoes that received blanching treatment, tomatoes with blanching treatment at 60 °C for 15 minutes took the longest time, which is about 17 hours. And for other treatments, it ranged from 10 to 14 hours, with the fastest being blanching treatment at 80 °C for 45 minutes. This can be caused by the fact that this treatment causes the texture of the material to become soft and the pores on the surface of the material to open wider, so that the process of water transfer from the material to the environment is easier to occur. In general, during the drying process, the moisture content of each treatment decreases, due to the evaporation process that occurs during drying. This is in accordance with the statement of [4] which states that, in the drying process, the moisture content of the sample affects the amount of water that can evaporate on the surface of the sample and affects the length of time the material dries

3.2 Drying Rate

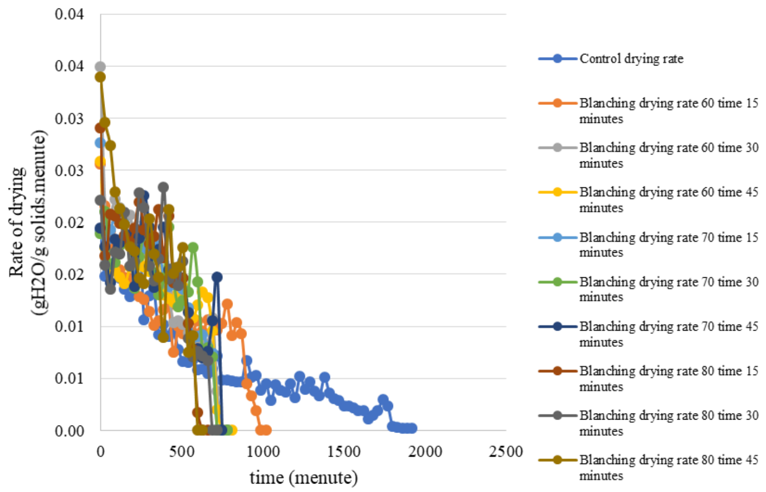

Figure 2. The drying rate of each treatment.

The change in the amount of water remaining in the material to the total solids, as shown in Figure 2, indicates that at the beginning of the drying process, the volume of water evaporated is greater than at the end of the drying process. For tomatoes that received blanching treatment, the volume of water evaporated became 0 g in less than 17 hours, while for tomatoes without blanching treatment, the process continued for up to 30 hours. For blanching treatment (except 60 °C for 15 minutes), during the first 6 hours, the average amount of water evaporated was 2% of the solids. Even for the treatment of blanching 80 °C for 45 minutes, the value was 3% during the first hour. Meanwhile, for control, it was only 2% for the first 2 hours and continued to decrease by about 1% after that. In general, the drying rate is high at the beginning of the process and then slows down until the end of the process. This is in line with the opinion of [5], which states that the drying rate is very high at the beginning of drying. As time goes on, the drying process of the material will become drier, so that only the remaining water that is bound to the material will remain. The bound water will decrease in accordance with the decrease in the moisture content of the material until it reaches a constant value.

3.3 Moisture Ratio

Figure 3 shows that the remaining water in the tomatoes decreases as the drying process progresses. This is because the water that can be evaporated decreases as the moisture content of the material decreases. Moisture Ratio (MR) is a measure of the amount of remaining water in the tomatoes at a given time compared to the amount of remaining water at the end of the drying process. The MR value decreases as the drying process progresses.

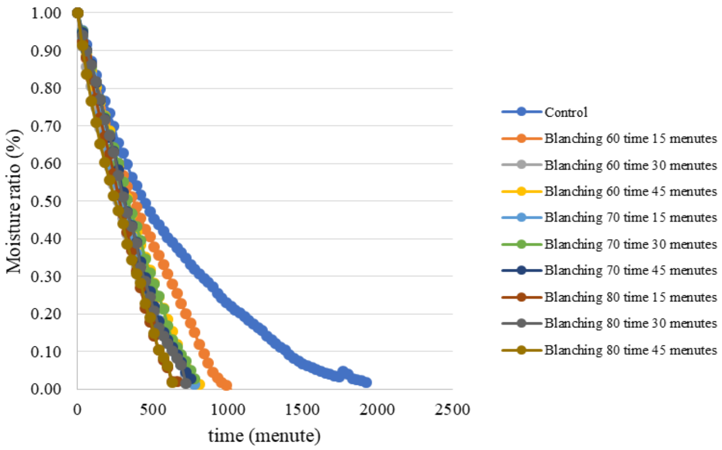

Figure 3. Mouisture Ratio (MR) decrease with time for each treatment.

The decrease in the MR value is faster at the beginning of the drying process and then slows down gradually. This is because the initial moisture content of the tomatoes is high, so there is a lot of water that can be evaporated quickly. As the drying process progresses, the moisture content of the tomatoes decreases, so there is less water that can be evaporated. This is in line with the statement of [6], which states that the amount of time needed to obtain each moisture ratio decreases with increasing air temperature due to the increased capacity of the drying chamber for heat transfer. This is because the higher the air temperature, the faster the water will evaporate from the tomatoes

3.4 Sorption isotherm

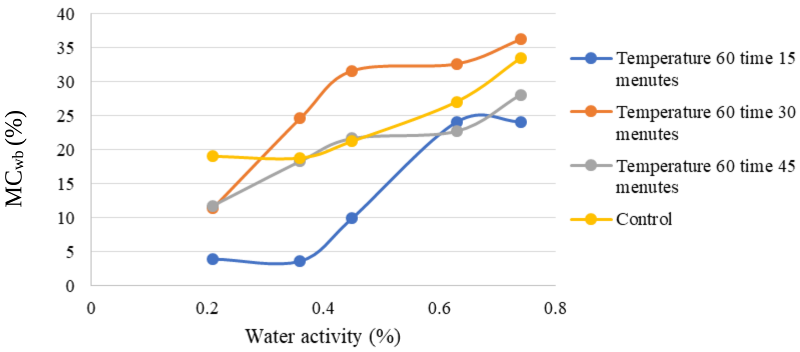

Figure 4. Equilibrium moisture content of cherry tomatoes at 60 ºC temperature blanching.

In Figure 4, it can be observed that the blanching treatment stored at low relative humidity (RH) undergoes a desorption process (water release), while at high RH, it undergoes an absorption process (water binding). The control sample, on the other hand, only undergoes an absorption process (water binding). The control sample exhibits a Flory-Huggins curve shape at times 15 and 30, a Langmuir shape at time 45, and a sigmoid shape at later times. It is well-known that the value of water activity (aw) is influenced by temperature; the higher the storage air temperature, the lower the water activity. This aligns with the statement of [7], which states that the higher the relative humidity (RH), the faster the equilibrium process between the material and its environment

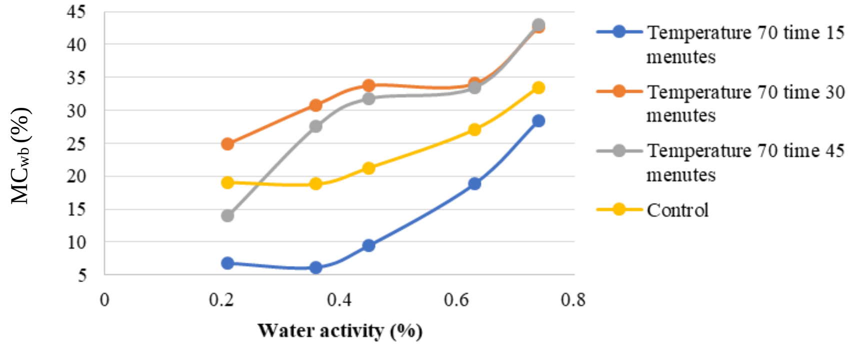

Figure 5. Equilibrium moisture content of cherry tomatoes at 70 ºC temperature blanching.

Figure 5 shows that samples that experience the process of desorption (water release) only occur in blanching with a time of 15 minutes at the lowest 3 RH and the rest of the samples experience the process of asorption (water binding). It is known that the value of water activity (aw) is influenced by temperature, the higher the storage air temperature, the lower the water activity. The control sample and 45 minutes have a flory-huggins curve shape at times 15 and 30 have a langmuir shape. This is in accordance with the statement of [7] which states that, the higher the relative humidity (RH), the faster the equilibrium process between the material and its environment.

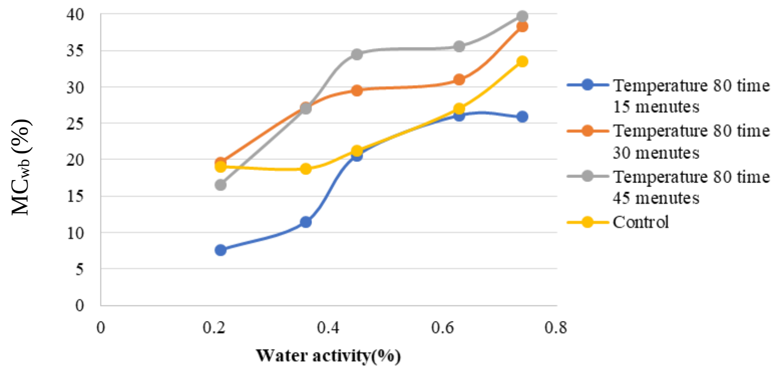

Figure 6. Equilibrium moisture content of cherry tomatoes at 80 ºC temperature blanching.

In Figure 6, it can be seen that in the blanching treatment with a time of 15 minutes, the lowest 2 RH experienced a desorption process (water release) and the rest of the sample experienced an absorption process (water binding). It is known that the value of water activity (aw) is influenced by temperature, the higher the storage air temperature, the lower the water activity. The control sample has a flory-huggins curve shape at times 15 and 30 has a langmuir shape and time 45 has a sigmoid shape. This is in accordance with the statement of [7] which states that, the higher the relative humidity (RH), the faster the equilibrium process between the material and its environment.

CONCLUSION

Based on the results of the study, the following conclusions were obtained:

1. The blanched sample of cherry tomatoes exhibits a faster decrease in water content compared to the unblanched sample, resulting in a quicker drying rate
2. Temperature and the length of the blanching process provide different isotherm sorption patterns for cherry tomatoes.

3. Blanching at 60 °C for 15 minutes may be the most effective treatment for preserving the quality of cherry tomatoes during storage.

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