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EXPERIMENTAL STUDY OF THE INFLUENCE OF TEMPERATURE ON PASTEURIZATION OF *PÊRA RIO IN NATURA* ORANGE JUICE

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ABSTRACT

Heat treatment is one of the most used methods to preserve food, such as orange juices, which are an excellent source of ascorbic acid. To avoid vitamin C degradation and reduce loss, fast heating is recommended. This work aimed to determine the vitamin C content using the iodometric method and the convective heat transfer coefficient using the method of dimensionless numbers and the experimental method. Time and temperature were controlled throughout the experiment. In pasteurization, the solution was heated to 80 °C, heating lasted 50 minutes and cooling for 42 minutes. The convective heat transfer coefficient was evaluated in two regions of the cylindrical container: near the wall and in the central region. The graphic profile of the curve follows the same trend of the literature. The convective heat transfer coefficient is higher in the region near the wall. As time passes and temperature decreases, the central region tends to equilibrium, and the coefficient becomes more constant. The vitamin C content remained constant before and after pasteurization, so it was observed that the pasteurization did not cause ascorbic acid degradation since the heating step was fast in the heat treatment. As a result of the study, it was noted that studying the thermal behavior in the cooling of orange juice is extremely important to ensure its quality. It is pertinent to mention that in order to avoid this degradation and reduce its loss, it is necessary that in thermal treatments, fast heating is carried out and that the juice has low exposure to air and heat at the time of its preparation.

Keywords: *Heat Transfer. Pasteurization. Orange Juice. Convective Coefficient.*

1. INTRODUCTION

The citrus industry is an extremely important sector for the Brazilian economy, as the country is responsible for 34% of the fruits and 56% of the juice produced in the world. Furthermore, the orange is the most consumed fruit by the Brazilian population, and among the different cultivars is the *Pêra Rio* orange (*Citrus sinensis* L. Osbeck) (Leonello *et al.*, 2019).

Heat treatment is one of the most used methods to preserve food, such as orange juice, increasing its shelf life. However, little is known about the temperature and speed profiles during heat treatment of liquid food in commercial packaging (Ghani *et al.*, 2001).

Pasteurization is a process used in foods when the aim is to destroy pathogenic microorganisms and denature low heat resistance enzymes present in foods. In addition, another goal is to increase the shelf life of the food. The

process consists of heating the food to a certain temperature and time and subsequently cooling it to a temperature lower than the previous one (Potter; Hotchkiss, 1995). The literature presents three types of pasteurization, and for orange juice, HTST (High Temperature and Short Time) is used (Jing *et al.*, 2013).

Orange juice is an excellent source of ascorbic acid, commonly known as Vitamin C, and belongs to the water-soluble vitamins. The quality of the juice can be influenced when it is exposed to oxygen and light, which can reduce the Vitamin C content and sensorially modify the product. To avoid vitamin C degradation and reduce loss, fast heating and low exposure to air are recommended when preparing the juice. Proper storage of the juice, which should be at low temperatures, helps preserve vitamin C and does not darken the juice. If the juice is kept between 15 °C and 25 °C, there will be a significant loss of Ascorbic Acid (Cozzolino, 2012; Teixeira; Monteiro, 2006).

It is possible to find in the literature studies about heat transfer during pasteurization and about food cooling. Teruel *et al.* (2003), experimentally studied the cooling of *valência* oranges with forced air and water. In the chilled water system, cooling occurred uniformly and lasted about 57 minutes. Jing *et al.* (2013) carried out a theoretical study of temperature distribution through pasteurization for orange juice in a cylindrical container based on 3D CFD simulation. Pasteurization for orange juice was simulated at three different temperatures, and the temperature field in each was obtained. Data were compared, and an optimal computational model was obtained for this case.

Also, Maharramov (2021) studied the thermal conductivity of orange and tangerine juices in a non-steady state. The author states that all known experimental installations measure the thermal conductivity of liquids in a steady-state, even if in the production and processing of liquid food products, as a rule, the main substance is in a mobile state.

This work aims to determine the vitamin C content using iodometric method and the convective heat transfer coefficient using the method of dimensionless numbers and the experimental method in the pasteurization of orange juice.

2. MATERIALS AND METHODS

The juice was prepared and placed in a 200 mL cylindrical glass container, sealed. To control the temperature during the experiment, thermometers (Brax Tecnologia, model -10 + 110 °C) and a stopwatch were used. The vitamin C content was analyzed before and after the pasteurization using iodometric method.

Figure 1. Representation of the system used to control temperature and analysis regions

The juice was heated in a water bath, and the temperature was recorded every 2 minutes.

The water bath was already heated to 80 °C when the juice was placed in the bath. When

the central region of the container with orange juice reached 74 °C, heating was stopped.

Then, cooling was performed, where the sample was placed inside a stainless steel pan with ice. The variation in juice temperature was monitored using thermometers, which were already installed in the cylindrical container, and this was measured every 2 minutes. When the center of the juice container reached 6 °C, cooling was stopped. Next, the bath was cooled to 0 °C.

3. RESULTS AND DISCUSSION:

3.1. Temperature Profile in pasteurization

In this study, pasteurization lasted 92 minutes, where heating lasted 50 minutes and cooling 42 minutes.

It is possible to observe in Figure 2 that the two regions presented practically the same temperature variation. In the literature of Bhuvaneswari (2014) and Priest; Stewart (2006), the profile of the curve follows the same trend.

3.2. Convective Heat Transfer coefficient in pasteurization

In this research, heat transfer was analyzed in the cooling stage. Under these conditions, the concentrated capacity method is applied. In the wall region, heat transfer via conduction in a transient regime was used, where the concentrated capacity method was applied, given that the number of Biot was less than 0.1. In the central region of the container, Newton's theory of cooling was used. In both regions, the convective heat transfer coefficients were determined.

To determine the convective coefficient in the wall region, the thermophysical properties used in the calculations were those of glass. To determine the convective coefficient in the central region, the thermophysical properties of the fluid were used, in this case, the orange juice.

It is possible to observe in Figure 3 that the convective heat transfer coefficient is higher in the region near the wall, and there is a sharp drop in the convective coefficient curve in the wall region. This is because the temperature is very high at this moment, as it is the period when cooling starts, so the value is lower. As time passes and temperature decreases, the central region tends to equilibrium, and the coefficient becomes more constant. The standard deviation for the convective coefficient in the central region and in the wall region were 3.99 and 16.74, respectively.

Regarding the vitamin C content, it remained constant before and after pasteurization.

4. CONCLUSIONS:

It was possible to observe that both the region of the center of the container and the region of the wall have similar temperature variations, which agree with the profiles found in the literature. The convective heat transfer coefficient is higher in the wall region and tends to equilibrium over time.

It was observed that the pasteurization did not cause ascorbic acid degradation since the heating step was fast in the heat treatment. In order to avoid this degradation and reduce its loss, it is necessary that in thermal treatments, fast heating is carried out and that the juice has low exposure to air and heat at the time of its preparation. Therefore, studying the thermal behavior in the cooling of orange juice is extremely important to guarantee its quality.

5. REFERENCES:

1. Bhuvaneswari, E.; Anandharamakrishnan, C.; *Innov Food Sci Emerg Technol.*, **2014**, 23, 162.
2. Cozzolino, S.M.F.; *Biodisponibilidade de nutrientes*, 4th ed; Manole: São Paulo, Brazil, 2012.
3. Ghani, A.G.A.; Farid, M.M.; Chen, X.D.; Richards, P.; *Journal of Food Engineering*, **2001**, 48, 147-156.
4. Jing, X.; Yong-yan, L.; Jin-feng, W.; Yi, T.; Chen, M.; *Advanced Materials Research*, **2013**, 740, 245.
5. Leonello, E.C.; Esperancini, M. S. T.; Guerra, S.P.S.; *Citrus Res. Technol.*, **2019**, 40, e1043.
6. Maharramov, M.A.; *E3S Web of Conferences*, **2021**, 254.
7. Potter, N.N.; Hotchikiss, J.H.; *Food Science*, 5th ed; Chapman and Hall: New York, USA, 1995.
8. Priest, F. G., & Stewart, G. G.; *Handbook of Brewing*, 2nd ed; CRC Taylor and Francis Group: Boca Raton, USA, 2006.
9. Teixeira, M.; Monteiro M.; *Alimentos e Nutrição*; Araraquara, Brazil, 2006, ch.14.
10. Teruel, B.; Cortez, L.; Neves Filho, L.; *Ciênc. Tecnol. Aliment.*, **2003**, 23(2), 174-178.

Figure 2. Time-temperature behavior during pasteurization

Figure 3. Convective heat transfer coefficient in the cooling stage