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"Influence of Break Temperature on Rheological and Physical-Chemical Behaviour of Tomato Paste (Lycopersicon Esculentum)"

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Abstract

Consistency constitutes one of the main quality traits of tomato purees, considered to be suspensions of insoluble particles (pulp) in a solution watery. The main factors determining the consistency of tomato paste and puree are: total solids content and solids content insoluble solids; the particle size and shape of the insoluble particle; the break; these parameters have a major impact on the rheology of the tomato concentrate. The objective of our work is the study of the rheological and physicochemical characteristic of two types of tomato concentrate from Amour group (Blida; Algeria) at two different break temperatures (90ºC and 65ºC); the results show the rheological properties of tomato concentrate depend of the break temperature.

Keywords: Tomato Paste; Break; total Soluble Solids (TSS); Viscosity.

1. Introduction

Tomato (lycopersicon esculentum) is one of the most popular and widely grown vegetables in the world [1;2]; it is the second most consumed vegetable and the largest part is consumed in processed form, such as tomato juice, paste, puree, ketchup, sauce and canned tomatoes [3-5]; its consumption is constantly increasing, reaching more than 15kg per inhabitant per year [6;7]. The plant is grown in greenhouses and in open fields, over an area of approximately 3 million hectares, which represents almost 1/3 of the world's surface area devoted to vegetables. Tomatoes have given rise to the development of a major processing industry, for the production of concentrates, sauces, juices and preserves [8]. Given its economic importance, it is the subject of numerous scientific researches serving as a model plant in genetics [9]. According to certain studies, consumption of tomatoes or its derivatives reduces the risks of cancer, cardiovascular diseases, diabetes and osteoporosis [10-12]. Today, consumers are increasingly demanding in terms of taste, colour, and texture [13]. They are looking for products that are beneficial for health but also foods that have taste, an attractive colour and consistency, and which last a long time. Tomato concentrate is like a fluid continuous non-Newtonian, that is to say a liquid whose viscosity varies depending on the shear forces applied to it. Many studies focus on the texture of products based on tomato. The effects of cooking methods, homogenization and refining at different sieve meshes, homogenization by high pressures have made it possible to highlight a relationship between the size and shape of the particles present in the concentrate and its viscosity [14; 8]

The objective of our work is the study of the physico-chemical and rheological characteristic of tomato concentrate from the Amour group (Mouzaia; Blida), transformed at two different break temperature (90 ºC and 65 ºC) by measurement the viscosity; total soluble solids (TTS), pH, acidity, sodium chloride, ash, colour and consistency. The results show that the rheological properties of tomato concentrate depend of degradation of soluble pectin during the break process.

2. MATERIALIS AND METHODS

2.1- Samples

For the tomato, we used the local appellation tomato variety: Dombello, a variety with a round shape, red in color. The choice of this variety is justified above all by its greater frequency of use observed on the market, and also it is a product belonging to canned fruits.

2.2- Tomato Paste Preparation

Generally, the tomato paste preparing process involves several steps, as described in figure 1. Briefly, the ripe tomatoes are harvested and sorted to remove any damaged or unripe ones; the sorted tomatoes undergo thorough washing to remove dirt and impurities and they are crushed and ground into a rough pulp for 2 min; and then subjected to different break treatments. The thermal treatments at 65 °C and 90 °C water bath for 10 min were named as Break-65 and Break-90, respectively. The pulp was placed in the ultrasound treatment at 22°C for 10 minutes and 65°C. After the respective treatments, the softened tomato pulp undergoes juice extraction. This can involve processes such as pulping or pressing to separate the juice from solids. The extracted tomato juice is strained to remove any remaining seeds, skin, or large particles, resulting in a smooth liquid, it now resembles a paste, it is heated and evaporated to remove water content. This concentrated paste is then pasteurized, ensuring the elimination of bacteria and prolonging shelf life.

2.2- Physicochemical analysis

Physicochemical analysis of double concentrate tomato involves assessing various physical and chemical properties of the product. Here are parameters evaluated:

a- Total Soluble Solids (TSS): This measures the total amount of dissolved solids in the tomato concentrate and is often expressed as degrees Brix. It gives an indication of the sweetness and overall concentration of the product.
b- Acidity: The acidity of the tomato concentrate, often expressed as a percentage of citric acid or tartaric acid, indicates its tartness. It's an important parameter for both flavor and preservation.
c- pH: The pH level of the tomato concentrate is a measure of its acidity or alkalinity. It influences flavor, stability, and microbial growth.
d- Viscosity: Viscosity refers to the resistance of the tomato concentrate to flow. It's a critical parameter for processing and handling, as well as for determining consumer acceptability.
e- Texture Analysis: Texture analysis evaluates parameters such as firmness, cohesiveness, and adhesiveness, which are important for consumer acceptance and product quality.

The percentage of total soluble solids (TSS) was determined by using an digital refractometer. The pH of samples (mixed in distilled water at 1:2 ratio) was determined with a glass electrode pH meter; after standardization. Total titratable acidity(%) as citric acid was determined by direct titration of 2 g. of sample with 0.1N sodium hydroxide using phenolphthalein as an indicator according. Sodium chloride content was determined according to the Moher method as described by Ranganna (1986). Consistency of tomato concentrate samples were diluted to 12 °Brix. Then, their consistencies were measured by Bostwick consistometer at 25°C. The results were reported as the distance traveled (cm) in 30 seconds.

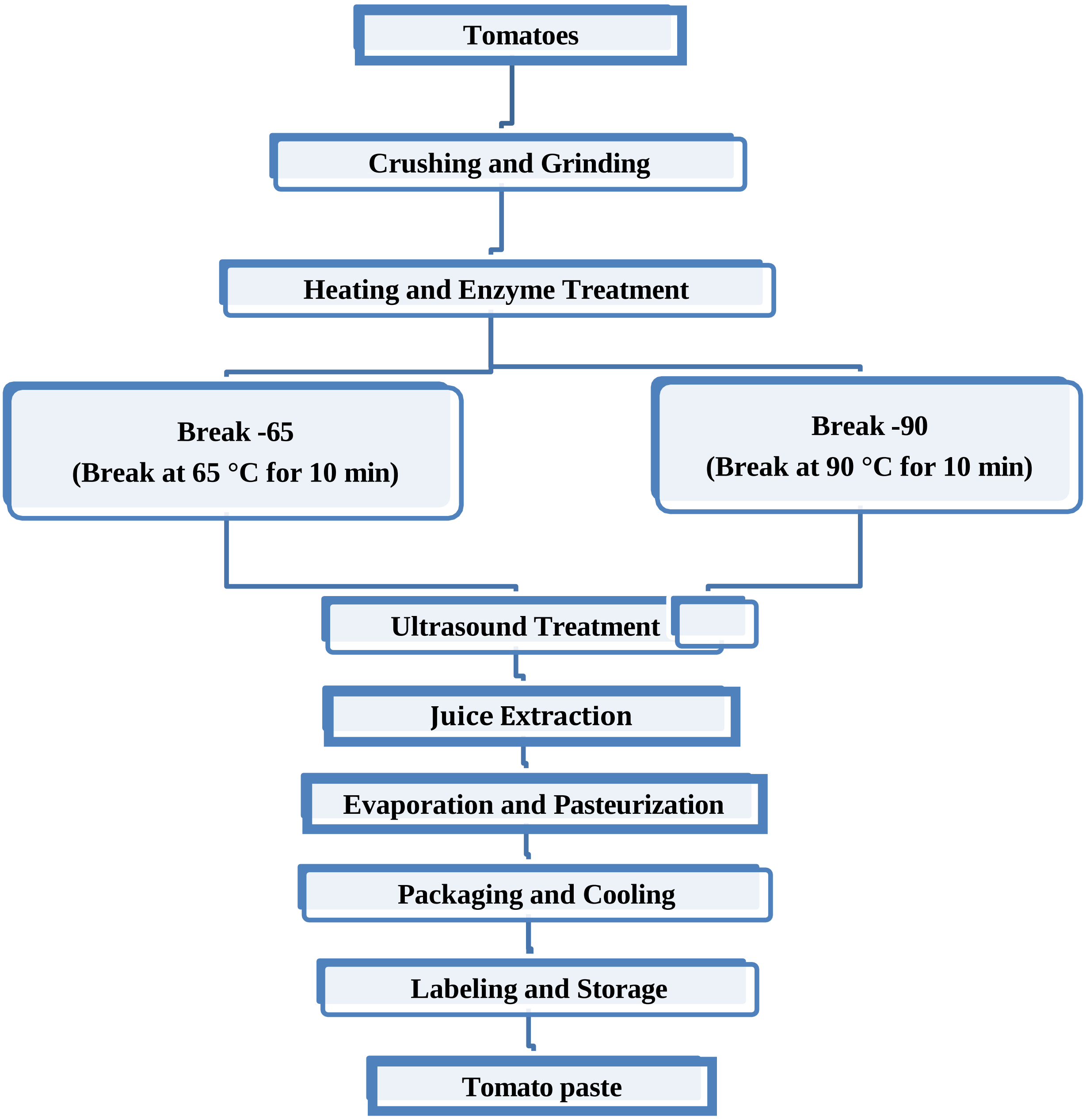

Figure 1. Tomato pastes production scheme

2.3- Viscosity Measurement:

Viscosity is a key parameter in rheological analysis and can be measured using various methods such as rotational viscometry, capillary viscometry, or falling ball viscometry. For tomato paste, rotational viscometry is commonly used. A rotational viscometer measures the torque required to rotate a spindle immersed in the paste at different speeds, allowing the determination of viscosity as a function of shear rate or shear stress.

3 Results and discussion

3.1 Viscosity:

The viscosity of double concentrated tomato (DC) at different break temperatures can vary significantly depending on factors such as the concentration level, the type of tomatoes used, and the processing methods employed. In tomato processing, the "break temperature" refers to the temperature at which the tomato concentrate begins to thin out and lose its consistency. This temperature can vary depending on the concentration level and the specific characteristics of the tomatoes. Viscosity is a measure of a fluid's resistance to flow. Generally, as the temperature increases, the viscosity of most fluids, including tomato concentrates decreases. This means that at higher temperatures, the tomato concentrate becomes less viscous and flows more easily. However, the viscosity of double concentrated tomato (DC) at different break temperatures can also be influenced by other factors, such as the presence of pectin and other soluble solids in the tomatoes, which can affect the consistency of the concentrate.

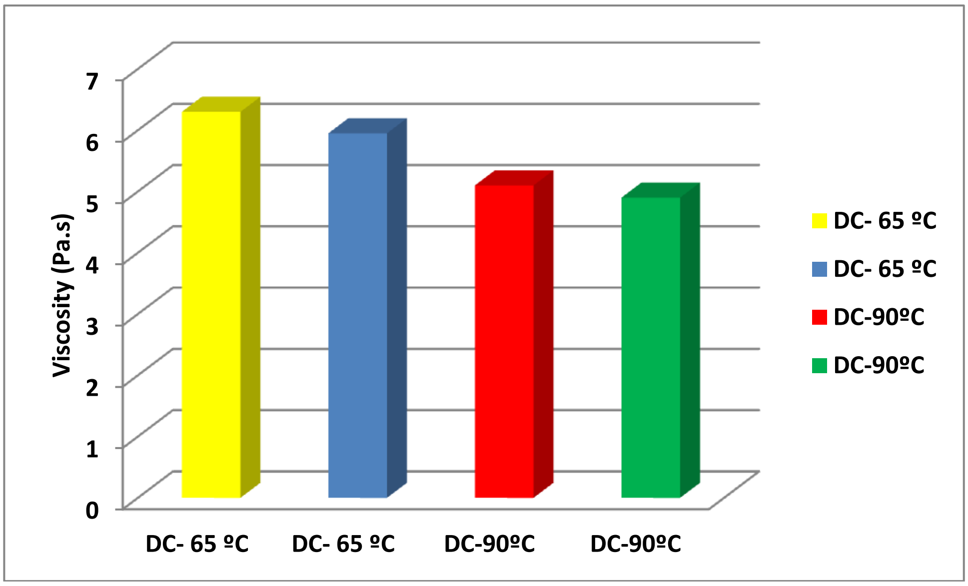

Figure 2: viscosity of double concentrated tomato (DC) at different break temperatures.

3.2 Brix

Figure 2 represents a comparison of the soluble dry matter content (Brix) of tomato paste at different temperature. The Brix level of double concentrated tomato (DC) at different break temperatures can be an essential parameter to monitor during tomato processing. Brix is a measurement of the sugar content in a solution and is often used as an indicator of the overall concentration of soluble solids in a liquid, including sugars and other dissolved compounds. During the processing of double concentrated tomato (DC), the break temperature refers to the point at which the concentrated tomato begins to thin out and lose its consistency. This temperature can influence the concentration of soluble solids, including sugars, in the tomato concentrate. Typically, as the break temperature increases, there may be changes in the Brix level of the double concentrated tomato (DC). Higher break temperatures may result in more evaporation of water from the tomato concentrate, leading to a higher concentration of soluble solids and thus a higher Brix level.

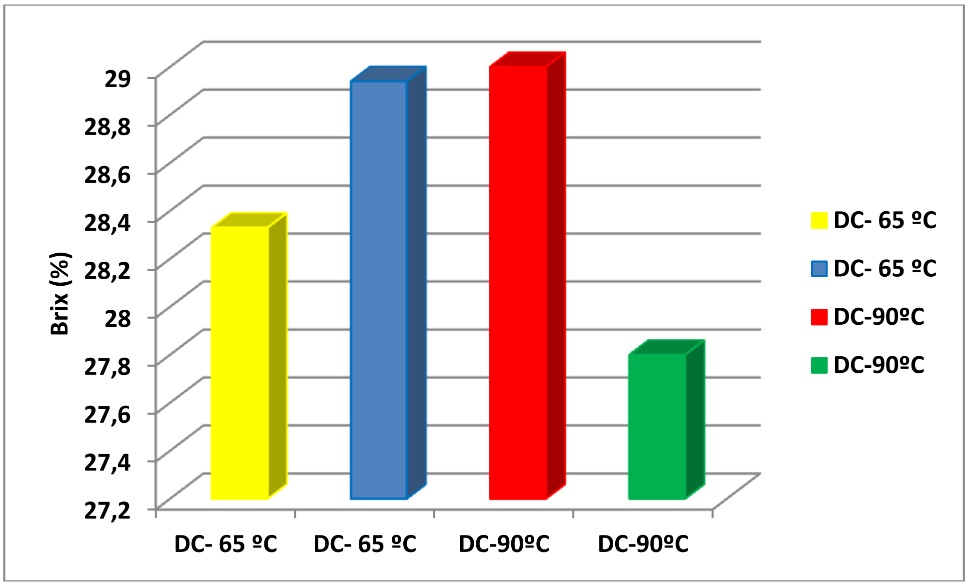

Figure 3: Brix of double concentrated tomato (DC) at different break temperatures.

3.3 pH

The pH of double concentrated tomato (DC) at different break temperatures can indeed vary. pH is a measure of the acidity or alkalinity of a solution, with lower pH values indicating higher acidity and higher pH values indicating higher alkalinity. During the processing of double concentrated tomato (DC), the break temperature is the point at which the concentrated tomato begins to thin out and lose its consistency. This temperature can affect various chemical properties of the tomato concentrate, including its pH. As the break temperature increases, there can be changes in the pH of the double concentrated tomato (DC). Higher temperatures may lead to chemical reactions that alter the acidity of the product. Additionally, the breakdown of certain compounds in the tomatoes may also influence pH.

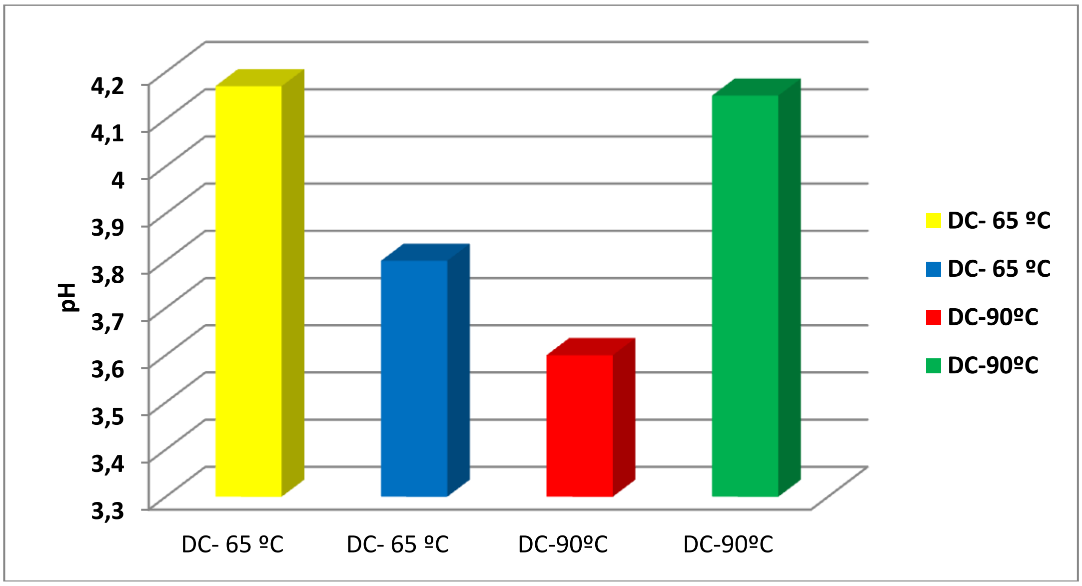

Figure 4: pH of double concentrated tomato (DC) at different break temperatures.

3.4 Bostwick

Bostwick consistency is a measure of the flow properties of a food product, particularly its viscosity. It's commonly used in the food industry to assess the thickness or fluidity of various substances, including tomato products. The break temperature refers to the temperature at which the tomato paste is initially processed or broken down to achieve the desired concentration.

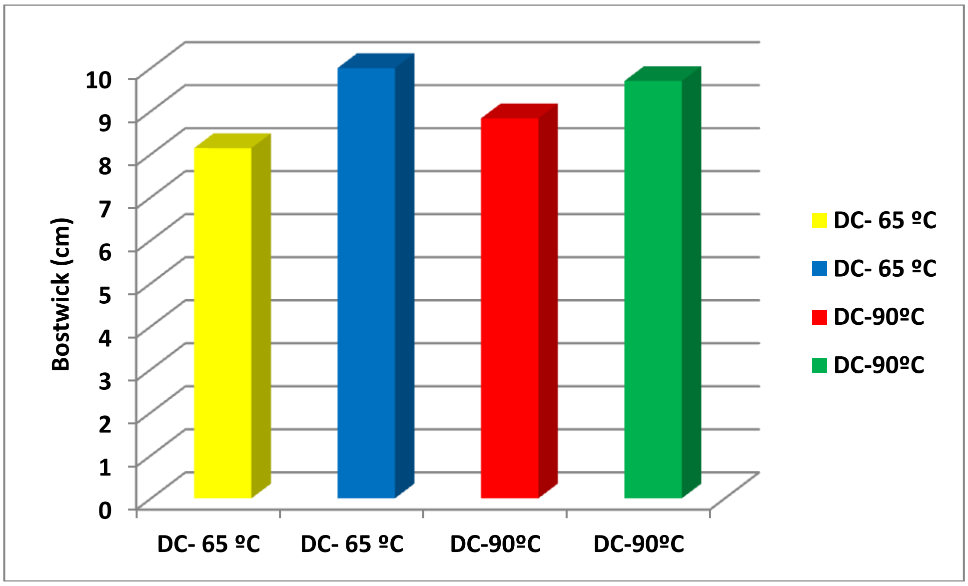

Figure 5: Bostwick of double concentrated tomato (DC) at different break temperatures.

3.5 Acidity

The acidity of double concentrated tomato (DC) at different break temperatures can vary depending on factors such as the type of tomatoes used, the processing methods, and the degree of concentration. In tomato processing, the "break temperature" refers to the temperature at which the tomato concentrate begins to thin out and lose its consistency. This temperature can vary depending on the concentration level and the specific characteristics of the tomatoes. The acidity of tomato products is often measured in terms of pH. Generally, tomato products tend to have a slightly acidic pH, typically ranging from around 4.0 to 4.5. However, the pH can be influenced by various factors including the type of tomatoes used, the processing conditions, and any added ingredients.

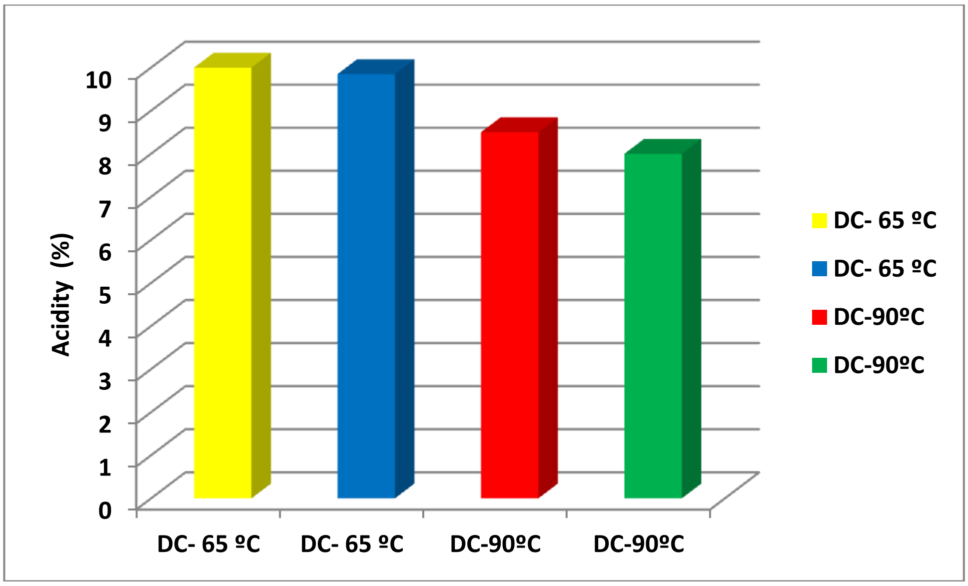

Figure 6: Acidity of double concentrated tomato (DC) at different break temperatures.

4 Conclusions

- The temperature at which the break occurs can impact the viscosity of the concentrate. Higher temperatures during the break can lead to a more significant breakdown of the pectin network, resulting in a thinner consistency and lower viscosity in the final product. Lower temperatures may preserve more of the pectin structure, resulting in a thicker consistency and higher viscosity.
- The temperature during the break can also affect the texture of the concentrate. A higher break temperature may result in a smoother texture, while a lower break temperature might preserve more texture from the tomato solids.

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