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Characteristics of pH, Total Acid, Total Soluble Solid on Tomato Juice by Ohmic Heating Technology

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Abstract

Tomatoes (*Solanum lycopersicum* L.) are important vegetables all over the world and are consumed in both fresh and processed form. Tomatoes as food can be processed into tomato juice by using Ohmic heating technology. The ohmic heating technology in food processing is essentially a process in which liquid food, solids, or mixtures between the mare simultaneously heated by passing an electric current through it. Foods passed by an electric current give a response in the form of heat generation internally on foodstuffs due to the electrical resistance. This study aims to determine changes in pH, total acid, total soluble solids in tomato juice which heated at 70°C, 90°C and 110°C and duration time of heating; 15minutes, 30minutes and 45 minutes. The results showed that the temperature and duration of ohmic heating significantly affect the change of pH value and total tomato juice. The total acid value decreases as well as the lower the pH by the longer the heating. While total soluble solids are increasing by the higher temperature and heating time.

Keywords: pH; Total Acid; Soluble Solids; Tomato Juice; Ohmic Heating.

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I. Introduction

Tomato *(Solanum lycopersicum L.)* is an important vegetable worldwide and consumed in both fresh and processed forms [1,2]. Tomatoes belong to a seasonal crop of shrubs and belong to the family of *Solanacea*. World tomato production in 2012 reached 161.8 million tons. China leads world tomato production with about 50 million tons followed by India with17.5 million tons[3]. Indonesia's tomato production in 2013 reached 992,780 tons[4]. Tomatoes are rich in nutrients and functional compounds. The compounds in tomatoes include solanine (0.007%), saponins, folic acid, malic acid, citric acid, bioflavonoids (including lycopene, α and β-carotene, protein, fats, vitamins, mineral and histamine[5]. Lycopene is one of the most chemicals in tomatoes, in100 grams of average tomato containing lycopene as much as 3-5 mg[6]. One of the ways of tomato processing is to make it in to juice. Tomato juice can be made from the crushed tomato fruit taken their juice and then heated. Tomatoes are processed by preheating before consumed increase lycopene bioavailability in tomatoes. The ohmic heating technology in food processing is essentially a process in which food (liquid, solid, or mixtures between the two) is heated simultaneously by passing an electric current through it [7]. Foods passed by an electric current give a response in the form of heat generation internally due to the electrical resistance in the food[8]. The ohmic heating is considered very suitable for thermal processing of liquid food (particulates). The amount of heat produced is directly related to the current caused by the voltage gradient, electric field and electrical conductivity[9].

The ohmic heating differs from conventional heating, where conventional heating of heat transfer occurs from the surface of the material heated to the interior of the product by means of convection and conduction that takes long time, especially when through the conduction and convection paths that may be present in the heating process[10]. Conventional heating processes consist essentially of conduction, convection, and radiation heat transfer mechanisms, whose operations are either stable or unstable[11]. The heating process in foodstuffs involving too high heat and overheating time such as conventional heating can lead to high levels of nutrients and vitamins contained in vegetables and fruits[10].

The ohmic heating is considered to be particularly suitable for particulate thermal processing in liquid food because particles are heated simultaneously or faster than liquids.The amount of heat produced is directly related to the current caused by the voltage gradient, electric field and electrical conductivity[9]. The ohmic heating takes place

volumetrically so as to potentially reduce excessive warming[12], this is incontrast to conventional heat transfer patterns that take place by conduction, convection, and external radiation into the material[11]. The ohmic heating method is widely used in various food processing applications such as preheating, blanching, pasteurization, sterilization, and food product extraction [13]. The main advantages of ohmic treatment are rapid and relatively uniform heating [14, 15], easy to to control the process, high energy efficiency [16], low vitamin C degradation[17], and lower capital costs compared to other electro-heating methods such as microwave and radio frequency heating[18, 19]. Tomatoes contain essential nutrients that need to maintain the nutrients that are beneficial to health so that the alternative to process them into juice is away to facilitate the consumption of tomato processed products.

2. Materials and Method

2.1. Materialand Tools

The materials used were tomatoes obtained from Batulapisi-Malino, Gowa Regency of South Sulawesi. Chemicals for analysis are: hexane p.a (Merck), acetone (Merck), ethanol p.a (Merck), phenolpthalein (pp), and 0.1 N NaOH indicators.

Tool to analysis this research are ohmic reactor of Teflon material, electrode, thermocouple, data acquisition system (data logger), cold box, juicer, jars, vial, hand refractometer, reflux device with double neck flask and rotary evaporator, Spectrophotometer UV-Vis, quartz, scales, magnetic stirrer, and standard laboratory glassware.

2.2. Sample Preparation

Data collection is done in three stages, as follows: setting up an ohmic heating device consisting of asset of heating appliances consisting of a Teflon tube/reactor, the central portion of which is a thermocouple mounted a temperature sensor used to measure temperature through two different types of metal conductors on the left side end and the right end of the tube. This tool is also equipped with complementary features to insert and remove samples. Prepare samples of tomato juice. Tomatoes are selected which are full red, washed, sliced, blended, filtered, and taken liquids. Tomato juice ready, put in a heating tube, ohmic reactor ignited, set the reactor temperature, connect laptop with data logger. After the temperature is reached, observed the duration of heating according to the treatment. If the warm-up has been reached, stop the heating. The sample is removed from the appliance through the faucet.

2.3. Analytical method

PH measurement [20]. PH measurement using pH meter tool, the pH meter to be used is standardized with buffer 4.0 and pH 7.0 at 25°C. The pH value of tomato juice was measured using a calibrated electrode.

Total Acid [20]. A total of 10 ml of tomato juice is put in to a 100 ml measuring flask, diluted to a tera mark with aquades. Filtered sample, take 20 ml of obtained filtrate and inserted in to Erlenmeyer. The sample was added 2 drops of Phenolphtalein and titrated with 0.1 N NaOH until pink. The calculation of the total acid is done by the formula: Total acid = b/a, where; a= amount of NaOH 0.1 N for titration (ml), and b = 10 ml of material. Total Soluble Solids[21]. Total Soluble solids of tomato juice were determined using a digital refractometer (ATAGO, Tokyo, Japan) at 20°C and results were reported as °Brix.

2.4. Experimental Design

Parameters of the ohmic tool that become variable are the heating temperature consisting of 3 levels: 70°C, 90°C, and110°C and duration of heating: 15minutes, 30 minutes, and 45 minutes. Data analysis was done by Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test at 5% level.

3. Results and Discussion.

3.1. Total Acid

Fruits have the characteristics and levels of maturity vary so that the content of substances contained therein also varies. Types of acids are found in many types of plants, especially fruits. These acids are present in small amounts which are the intermediate results in metabolic processes in the Krebs cycle of the tri carboxylic acid, the glycoxylic acid, and the shikimic acid cycle. Citric acid is the most dominant organic acid in tomatoes. In addition to citric acid, malic acid is the most organic acid that contributes to the taste of tomatoes. Other acids that have been detected are acetic acid, formiate, trans-aconitate, lactate and galactatonic acid. The total acid of tomato ohmic juice decreases with increasing time and warming temperature because citric acid participates in the chemical reaction of chocolate pigment formation [22]. The higher the heating temperature, causing a reaction involving the organic acid to take place more quickly. This causes the total acid in the heating process to decrease more rapidly as the temperature of the financing increases.

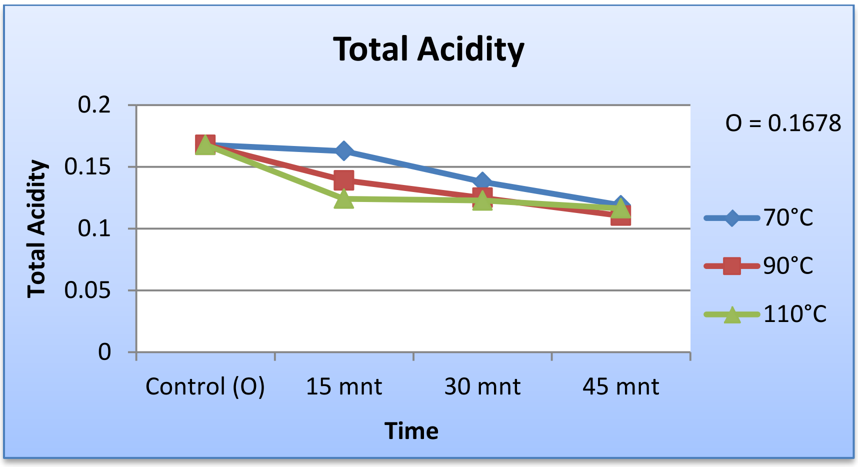

Figure 1: Effect of Temperature (°C) and Heating Time (minutes) on Total Acid

The heating temperature and the duration of the heating period were not significantly different from the total tomato juice. Figure 1 shows that higher heating temperatures and longer heating time periods show a slight decrease in total tomato juice. The average total value of tomato juice acid ranged from 0.1043% to 0.1499%. The results research explain that the percent age of total acid in heated "Ambarella" fruit juice at 90°C tends to decrease as the length of heating increases[23]. Organic acids are classified as weak acids that have partial ionization in a dilute dough [24]. The longer of heating processed, the organic acids found in tomato juice such as ascorbic acid is damaged, so the acidity of the product becomes decreased. Acid damage can be accelerated by the presence of long heat contacts, rays, alkalis, enzymes, oxidizers, and copper and iron catalysts[25].

3.2. Acidity (pH)

The pH value indicates the hydrogen ion concentration which depict the acidity level. Based on the result of the analysis of variance, the heating temperature significantly influences the pH of tomato juice. Duncan's advanced test, showing significantly different heating temperatures between treatment temperature of 70°C and 90°C, 70°C and 110°C treatment, and 90°C and 110°C treatment of tomato juice pH. The results showed that high heating temperature yielded higher pH value. The increased heating duration tends to give a lower pH value of tomato juice (Figure2). The mean value of pH of tomato juice ranged from 4.05 to 4.64. As the control (O) is a sample that does not receive a heating treatment.

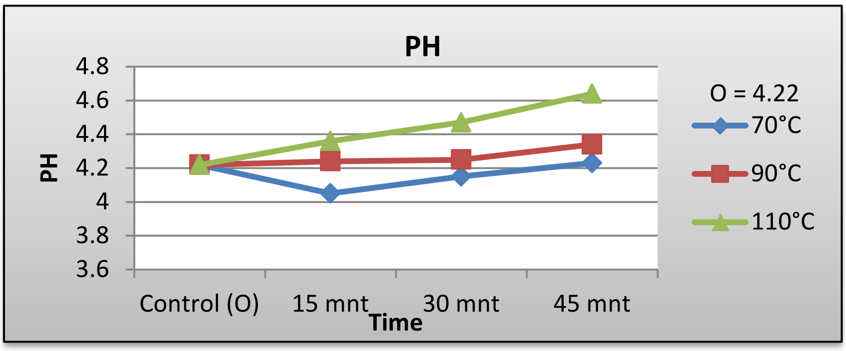

Figure 2: Effect of Temperature (°C) and Heating Time (minutes) on pH.

Most tomato-based products are processed products such as; tomato juice, tomato sauce, sauce, pasta and salsa. In this study made tomato juice is heated with ohmic technology. Tomato juice analyzed its acidity characteristics (pH) and observed the relationship between temperature and heating time to the pH of tomato juice. The tendency to increase the pH of ohmic tomato juice product with increasing length of heating due to the effect of heat given can lead to degradation of some nutrients, especially heat- labile substances such as organic acids, one of citric acid, ascorbic acid and other acids. Acid damage can be accelerated by the presence of long heat contacts, rays, alkalis, enzymes, oxidizers, and copper and iron catalysts[25].

3.3. Total Soluble Solids

The components in the fruit consist of water-soluble components, such as glucose, sucrose fructose, and water-soluble proteins (pectin). In this research, total analysis of soluble solids of tomato juice treated with ohmic heating has been done.

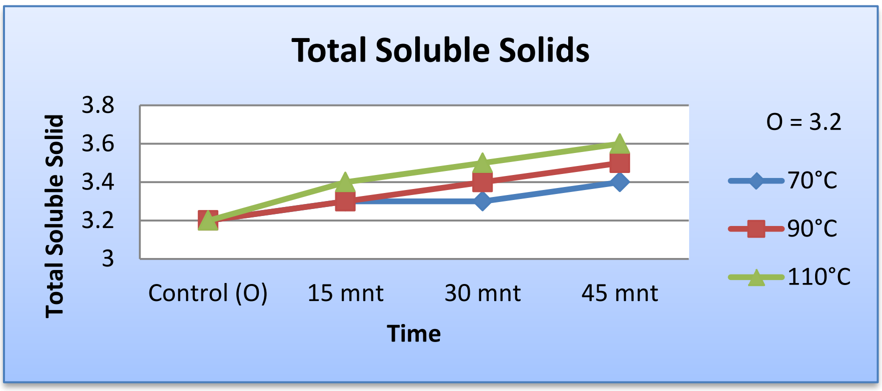

Figure 3: Effect of Temperature (°C) and Heating Time (minutes) on Total Soluble Solid Content.

The result of the analysis of variance was concluded that there was no real difference in the treatment of heating temperature and the heating time of total soluble solids of tomato juice. In Figure 3 the higher the temperature of the heating process, and the longer the heating period, yields the higher total dissolved solids. Total soluble solids average about 3.2-3.6 °Brix.

The increase in total soluble solids can be caused by the breaking of long chain carbohydrate compounds into soluble sugar compounds [26]. This is in line with the increase in temperature and heating time, the higher the temperature causes the breaking of long chains of carbohydrate compounds into the dissolved sugar compound becomes faster, so that the sugar content contained in the solution (juice) increases. In this study, the liquid from the tomato juice has gone through a process of destruction and then filtered, so the diffusion of nutrients dissolved during ohmic heating is not much, because there is not too much cell damage by a combination of electrical and thermal effects.

The results of Meikapasa and Seventilova (2016) experiments on conventionally heated tomato sauce, at 70°C, 80°C, 90°C, and100°C, respectively, obtained the highest total soluble solids at 100°C, and total soluble solids continue to increase as the heating time increases [30].

Ohmic heating generally does not cause any differences in acidity and Brix values of fluid foods[27,29]. Ohmic treatment results in the effective damage of cells by a combination of electrical and thermal effects, resulting in the important diffusion of soluble nutrients during ohmic heating.

4. Conclusion

Temperature and duration of ohmic heating significantly affect the change of pH value and total tomato juice. The total acid value decreases as well as the lower the pH by the longer the heating. While total soluble solids are increasing by the higher temperature and heating time.

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