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Effect of Drying Temperature on Physicochemical Characteristics of Tomato Powder

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ABSTRACT
Tomato powder is produced by dehydrating tomatoes. The powder consists of only one ingredient, it represents the specificity of this product, namely dehydrated natural tomatoes. Among other things, drying as a preservation process is considered one of the best methods, because it ensures ease of use, transportation and storage. As part of the canning and processing of fruits and especially vegetables, tomato products have always occupied a very important place due to the organoleptic and culinary properties of these products, and the nutritional value of tomatoes as a raw material. Compared to other types of vegetables, tomatoes have a high yield, with some varieties even over 90%.The most important factor in tomato dehydration is the dehydration temperature as well as the time interval during which the dehydration process is carried out. In the dehydration process, two varieties of fresh tomatoes from the local market were used, which were dehydrated at temperatures of 50 and 75 °C. In parallel, a comparative physicochemical analysis of fresh tomato samples with dehydrated ground samples of tomato powder was performed. All analyzes in this research work were edited three times, and the mean value was used to display the graphical results.

Keywords : Dehydratation, Fresh Tomato, Tomato Powder, Physicochemical Characteristics

I. INTRODUCTION

Tomato (*Lycopersicon esculentum*) belongs to the Genus Lycopersicon under Solanaceae family [1]. Fresh tomatoes and tomato products represent a significant contribution to the diet due to their easy availability, nutritional value and low price [2]. The nutritional value of tomatoes and tomato products is reflected in the rich sources of folate, vitamin C and mineral K and to a lesser extent it also contains other components useful for the health of consumers, such as water-soluble vitamins, bioelements, flavonoids, phytosterols. Of the phytonutrients, the most abundant is lycopene, which actually belongs to the group of carotenoids. Tomato is a rich source of lycopene as well as to a lesser extent beta carotene, gamma carotene, and phytoene, making it a rich source of antioxidant activity [3]. One of the major problems affecting the tomato crop is its short shelf life due to oxygen absorption resulting in physicochemical changes, with post-harvest losses of around 21% in the production chain and 25% to 40% in the horticultural sector [4]. Therefore, tomatoes need to be preserved in one of many ways, methods of preserving tomatoes include making concentrates, canning whole fruits, juice, sauces and dehydrated products. Drying is one of the oldest methods for the preservation of food products [5]. There are many methods of drying and obtaining tomato powder, some of them are: freeze drying, traditional method of drying tomato slices, foam drying and spray drying [6]. Dehydrated tomato products are dried products of tomato fruits or their products. The production process is not so simple, primarily due to the high content of water and sugar, which are very hygroscopic and cause the particles to stick together when water is removed or their sticking to the contact surface of the drying device [7a]. This product is characterized by protection against enzymatic and oxidative spoilage, stability in taste and smell at room temperature for several months [8]. To obtain "tomato powder", intended for the production of dehydrated soups and sauces, tomato concentrates are regularly used as starting raw materials [7b]. Today's consumers, when choosing a food product such as dried tomato powder, pay attention to the functional and quality characteristics that differ from fresh tomatoes [9].

The focus of this research work is determining the physicochemical of tomato powder, as well as finding the optimal dehydration temperature in order to preserve the nutritional properties of tomato powder.

II. METHODS AND MATERIAL

The production of dehydrated tomato powder is another preservation method that offers a product to consumers when weather conditions no longer allow the consumption of fresh tomatoes. This product can be used to enrich other tomato products or used as such in many culinary recipes. Dehydrated tomato powder obtained by different methods, drying temperatures has different properties in the content of nutrients, color and reconstruction, respectively. Therefore, the aim of this research work was to produce tomato powder dehydrated at two different temperatures, 50 and 75 °C, and to do a comparative physicochemical analysis of the obtained powders with the fresh product.

For the purposes of this research, two varieties of tomatoes were used, available on the market where the research was conducted, namely the Pink rock and Big beef varieties, respectively. Dehydration of fresh tomatoes was carried out at two temperatures: 50 °C and 75 °C, and the samples were marked as follows: PR50 and PR75 - Pink rock variety dehydrated at 50 °C and 75 °C and BB50 and BB75 – Big beef variety dehydrated at 50 °C and 75 °C.

Fresh tomato fruits

Two tomato varieties were used in the research: Pink rock and Big beef, easily available on the market.

Pink rock variety

Pink rock or pink tomato is the most sought-after variety of tomato because of its size, juicy and fleshy part of the fruit, pleasant smell and taste on the market of Bosnia and Herzegovina for 2021. This variety is characterized by a high yield, good quality fruits whose fruit size reaches a weight between 250-350 g, so even 10 kg of tomatoes can be harvested from one stem of this tomato.

Big beef variety

Big Beef is an early variety and will reliably produce fruit even in cold, wet weather. It is a large, globe-shaped, red slicer tomato with a tangy-sweet old-fashioned tomato taste. Big Beef is best known as an easy-to-grow classic red tomato with rich flavor well suited to tomato sandwiches, burgers, and other fresh recipes.

Dehydratatiom process at a temperature of 50 and 75 °C

The production of dehydrated tomato powder at two different temperatures is presented in Chart 1. The technological procedure for obtaining dehydrated tomato powder is long-term and needs to be carried out very carefully. After receiving the raw material, fruit selection is carried out, which implies the use of only fruits that are technologically mature, firm and of the appropriate color. After this operation, the tomato fruits were washed, and then the fruits were sorted into appropriate crates. The next technological operation that was performed was cutting the tomato fruits into slices, the thickness of which was approximately the same for all slices and was 1 cm. The tomato slices obtained in this way were carefully transferred to the dehydrator and arranged on the dehydrator grids so that the dry air dries all the slices evenly. As mentioned earlier, the dehydration process was carried out at two different temperatures, namely 50 and 75 °C, and the process itself lasted until dehydrated tomato slices of constant mass were obtained. After dehydration, the tomato slices were cooled to room temperature and grinding and tomato powder was obtained. This kind of powder was stored in a dark place in hermetically sealed jars that were labeled like the samples at room temperature.

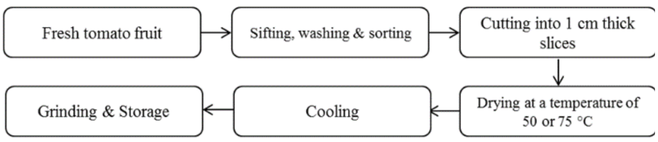

Chart 1. Dehydratatiom process at a temperature of 50 and 75 °C

The food dehydrator with large drying space Adler, Europe, AD 6655 was used in this study. The dehydrator used in this study is shown in **Figure 1.**

Figure 1. Food dehydrator with large drying space

Determination of aw

The container was filled ⅔ with tomato powder and was carefully transferred to the measuring chamber of the instrument for measuring water activity. Before measuring the water activity, the samples were stored at room temperature and in a dark place in hermetically sealed jars. Precise determination of water activity in the samples was carried out with the LabSwift-aw instrument with a resolution of ± 0.001 aw and an activity measurement range of 0.03-1 aw. Three parallel measurements were performed for each sample.

Determination of pH

5 g of ground tomato sample was dissolved in 50 mL of distilled water. The pH value of such a suspension was measured using a combined glass electrode by Yusuf et al. 2017 [10]. The instrument used in this research is the PC 52+ DHS.

Determination of total water content (TWC, %)

0.5 g of ground tomato sample weighed on an analytical balance and then measured on an instrument used for the direct determination of total water content KERNDBS 60-3, UK.

Determination of total soluble solids (TSS, %)

5 g of ground tomato sample was dissolved in 50 mL of distilled water and the sample was then homogenized. TSS, % was measured with a manual refractometer. Before use, the prism of the refractometer was cleaned with distilled water and wiped. A drop of the sample was placed on the prism of the refractometer and the lid closed. Reading results are expressed in Brix. The refractometer used in this research is ATAGO, SMART 1, Germany.

Determination of titratable acidity (TA, %)

1.5 g of ground tomato sample was transferred to a conical vessel with 50 mL of distilled water. The conical vessel is connected to the return cooler and the contents are heated in a water bath for about 30 minutes. After cooling, the content is quantitatively transferred into a 250 mL measuring vessel and topped up to the mark with freshly boiled and cooled distilled water, then filtered. A specific aliquot of the sample is taped and titrated with NaOH (0,1 mol/L) with the indicator phenolphthalein until the appearance of a pink color that does not disappear even after 30 seconds, Rulebook on methods of analysis of fruits and vegetables [11].

Determination of adsorption capacity (g)

Determination of water absorption capacity was carried out according to Lewicki [12]. 2 grams of dried tomato sample powder was weighed (initial weight) into 250 ml beakers and 50 mL of distilled water was added at room temperature and set aside for 2 hours and the water was filtered through filter paper using a vacuum pump (D-7800) all until all the water was squeezed out and the water from the stick was removed using laboratory tissue paper and finally the weight of the water absorbed samples was taken (final weight). Finally, the ability to absorb water was determined according to the following formula [10 b], [13].

III. RESULTS AND DISCUSSION

Results of aw of tomato powder dehydrated at 50 °C and 75 °C

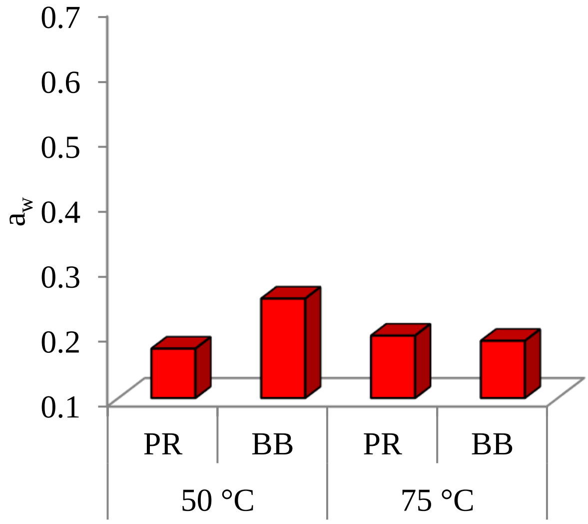

Figure 2. a_w of tomato powder dehydrated at 50 °C and 75 °C

Water activity (a_w) is defined under conditions of static equilibrium, and it measures the vapor pressure produced by the moisture present in the product [14]. Water activity is a suitable parameter with which it is possible to control the growth and development of microorganisms, because most bacteria cannot grow if a_w is below 0.91, while for most molds to live, the a_w value must be above 0.80 [15]. It is a dimensionless number. Water activity is rarely used as the sole preservation factor food due to bad influence on the sensory properties of food. Foods with a water activity value below 0.60 can be said to be sterile [16]. Water activity in a food is not the same as moisture content. Some products may have the same moisture content with different aw values [17]. ***Figure 2.*** shows the result of water activity in tomato powder, and those values were 0.253 for sample BB at a temperature of 50 °C, while the a_w value was 0.188 at a temperature of 75 °C. According to Baloch et al. 2000 values of a_w tomato powder range from 0.11 to 0.88 [18], which is in accordance with the values obtained in this work for both tomato varieties at dehydration temperatures of 50 °C and 75 °C.

Results of pH of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

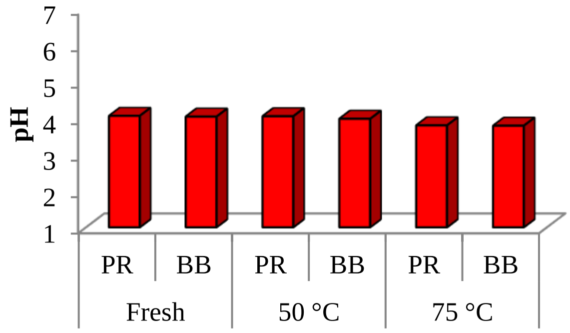

Figure 3. pH of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

Two important quality characteristics of fresh tomatoes for further processing are pH value and titratable acidity [19]. Therefore, in this work, as the first quality characteristic, the pH value of fresh tomatoes was measured and this value was 4.06 for PR sample and 4.04 for BB sample. Aderibigbe et al. 2018 reported that the pH of fresh tomatoes was 3.85±0.15 [20]. Ajayi and Olasehinde, 2009 reported that the pH value of fresh tomato fruit is in the acidic range [21]. Tigist et al. 2013 showed in their research that one of the quality characteristics of tomatoes is the pH value and that value was in the range from 3.37 to 4.44 respectively. This research showed that varieties with a lower pH value were positively correlated with a slower respiration rate and better maintenance [22]. For dried tomato powder, the pH values were slightly lower than those of fresh ones. The lowest change in pH value was actually for sample PR and was 0.26, or pH 3.8. Obadina et al. 2018 reported that the pH of dried tomato powder at 60 and 70 °C is in the interval from 4.19 to 4.29, which is slightly higher than the pH obtained in this work. They also reported that the influence of production conditions, in relation to dehydration, has no significant effect on the pH value of the final product, as was also proven in this work [23]. Saad et al. 2014 reported that the mean pH value of fresh tomato fruits was 3.69 [24 a].

Results of total water content (TWC, %) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

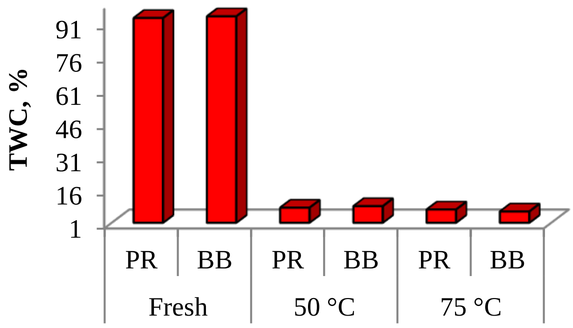

Figure 4. Total water content (TWC, %) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

Although tomatoes as a fleshy vegetable make up over 93% water, little is known about the influence of water on sugar metabolism and its composition. It is assumed that the water content plays a regulatory role in the metabolism of carbon to carbohydrates [25]. The total water content in fresh tomatoes in both samples was above 93%, which means that the rest was dry matter. According to Koh et al. 2011 the moisture content in the fresh tomato sample was the same as in this research and amounted to 94.5% [26]. According to Sohail et al. 2011 moisture content in fresh tomatoes is 94% [27]. Li et al. 2011 reported that the average water content of three-locular and four-locular tomato was 95.13±0.28% and 95.21±0.38%, respectively [28]. With dry tomato powder, the percentage of total water decreased to 8.51% for BB and 7.82% for PR at a dehydration temperature of 50 °C. By further increasing the temperature to 75 °C, the total water content decreased to below 7%. That is, for sample BB 6.09%, and for sample PR 6.99%.

The dry matter of tomatoes consists of dietary fiber and organic acid content, which have both a role in the determination of antioxidant capacity. The average dry matter content is 5,5% [29].

Results of total soluble solids (TSS, %) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

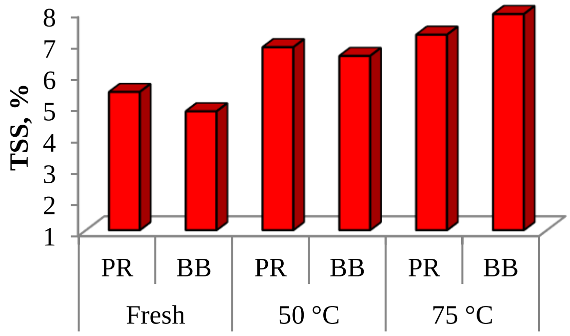

Figure 5. Total soluble solids (TSS, %) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

TSS, % values for fresh tomato samples ranged from 4.8-5.4%. According to Kasim et al. 2015 TSS content, % in ripening stages from green to red color of tomato fruit was 3.88 to 4.3% [30]. Nour et al. 2013 determined TSS in fresh tomatoes of different varieties and these values ranged from 4.98-8.38% [31]. Also, TSS values in this research ranged from 4.8-5.42%. According to Saad et al. 2014, the mean value of TSS, % was 4.61 [24 b]. Castoldi et al. 2014 reported that fresh tomatoes used in the production of tomato powder had a TSS in the range of 4.8 to 5.2 °Brix [32]. However, in the case of dried tomato powder, those values were significantly higher, for example, the highest value was recorded for sample BB, 7.91%, while for sample PR it was 7.25%.

Results of titratable acidity (TA, %) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

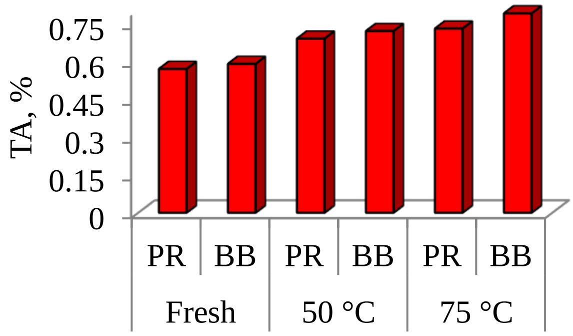

Figure 6. Titratable acidity (TA, %) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

TA was determined by means of an acid-base titration method, using 0.1 mol/L NaOH to pH 8,1 [33]. The lowest TA,% value was recorded in fresh tomato samples for both varieties. Thus, for the PR sample it was 0.57%, while for BB it was 0.59%, respectively. A further increase in the dehydration temperature resulted in an increase in the TA value, so for sample PR at a temperature of 75 °C, this value was 0.73%, while for sample BB at the same temperature, a slightly higher value of 0.79% was recorded. Saad et al. 2014 reported that TA is an important component of tomatoes and varieties with a high content of acids and sugars have a good taste, while on the other hand, the fruits of varieties with lower acidity have a milder taste [24 c].

Results of adsorption capacity (g) of fresh tomato and tomato powder dehydrated at 50 °C and 75 °C

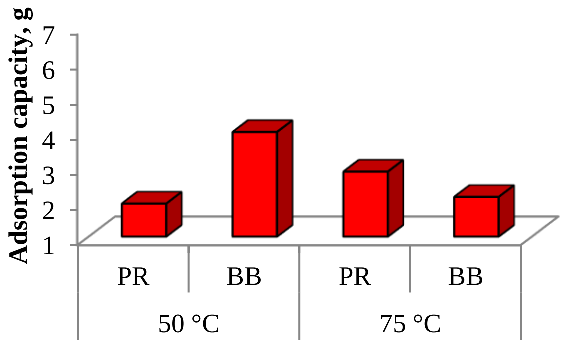

Figure 7. Adsorption capacity (g) of tomato powder dehydrated at 50 °C and 75 °C

Adsorption capacity, g of tomato powder had different values in Pink rock and Big beef cultivars during different dehydration temperatures. Thus, in the case of the Pink rock variety at a lower temperature (50 °C), the adsorption capacity value was 1.94 g, and with a further increase in the dehydration temperature, the adsorption capacity also increased, so this value was 2.85. However, with the Big beef samples, the results were different, that is, at a lower dehydration temperature, the adsorption capacity value was 3.98 g, which is also the highest value obtained. By further increasing the dehydration temperature (75 °C), a value of 2.13 g was recorded. The adsorption capacity of water provides information about phytochemicals, which enables their behavior in food [34].

IV.CONCLUSION

The purpose of this study was to determine the optimal dehydration temperatures for maintaining the physicochemical properties of tomato powder. From the obtained study, it can be concluded that dehydrated tomato powder at a dehydration temperature of 75 °C has higher values of TSS (%), TA (%) of tomato varieties Pink rock and Big beef.

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