CAROTENOID AND ANTIOXIDANT RETENTION OF THE DEHYDRATED TOMATO PRODUCTS AFFECTED BY THEIR DIFFERENT TECHNOLOGICAL TREATMENTS

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ABSTRACT

Tomatoes are the most commonly preserved vegetables in the world. Traditional tomato products are tomato juice, puree or ketchup but demand for dried tomatoes is increasing at the market. Drying is one of the oldest methods of preservation and often accompanies the degradation of nutritionally important ingredients. In order to protect nutrients from excessive oxidation during drying, the right choice of the drying temperature and the treatment of the raw material prior to drying are important elements of the manufacturing process. In our work we investigated the impact of various ways of antioxidant treatment of the raw material before drying on the stability of total carotenoids, polyphenols and antioxidant activity of the product. We used Uno Rosso F1 cultivar of tomatoes, dried by air at 70 °C, and the fruits were cut into slices of 3 mm thickness. To increase the stability of phytonutrients, we used the slice treatment with 1% potassium bisulphite, ascorbic acid, citric and acetic acid and 5% sucrose and sodium chloride solutions. We found that the 1% solution of ascorbic acid was the most effective in protecting of total carotenoids and polyphenols. In the protection of total polyphenols, acetic acid and potassium bisulphite solutions were equally effective. The most significant increase in antioxidant activity was found to be ascorbic acid solution.

Keywords: drying, tomato, treatment

INTRODUCTION

At the food product market, there has been an increasing demand for dried tomatoes, which are used as flavoring or decorative ingredient in food (Marfil et al., 2008). Dried tomatoes, tomato powder, as well as other processed products are subject to scientific studies due to the high antioxidant activity and high carotenoid content especially lycopene (Chung et al., 2006; Monteiro et al., 2008; Kobori et al., 2010 ).

The basic preservative principle of drying is to reduce water activity, limiting microbiological activity, enzymatic processes, and minimizing physical and chemical changes during storage of finished products (Maskan, 2000; Krokilda et al., 2001).

Karam et al. (2016) report that drying is a widespread and widely used process of fruit and vegetables preserving in which the removal of water from the product minimizes the various product degradations caused either by microorganisms or by enzymes that require sufficient water content in the environment. The drying conditions as well as the method of product processing significantly affect the nutritional quality of the product, but also physical, textural and sensory properties. Traditionally, warm air drying techniques are the most widely used, which may have an adverse effect on the quality of the product, especially due to the ongoing physico-chemical changes that occur during drying in the tissues. During drying in tomatoes, changes associated with degradation of nutritionally important components, e.g. vitamin C and lycopene occur. Incorrect choice of drying conditions, especially low or too high temperature or too long drying time, can cause serious damage to the product, especially its taste, color and nutritional content (Doyzmaz, 2007; Heredia et al., 2007; Cruz et al., 2012). Color change is most often caused by degradation of carotenoids and lycopene and also by processes of non-enzymatic browning in the reaction of sugars and amino acids in the Maillard reaction process (Marfil et al., 2008). Several authors studied the optimal drying conditions (Sacilik et al., 2006; Doyzmaz, 2007; Sanjinez-Arangoa et al., 2011; Doyzmaz a Özdemir, 2014).

Optimizing the tomato drying process can be achieved by providing maximum drying speed and minimizing oxidative and thermal damage. The prerequisite for achieving the desired quality and stability of the colors is the acceleration of the drying process due to the reduction of the cut thickness of the dried tomatoes. It is recommended the fruit to be cut into smaller pieces before drying, eg. slices, quarters. This operation will provide the larger contact area of the dried product with flowing air and will require less time to achieve the same level of moisture removal (Giovanelli et al., 2002; Sanjinez-Arangoa et al., 2011). In order to improve the quality of dried tomatoes, it is recommended that tomatoes should be treated with calcium chloride solutions before the drying process (Lewicki et al., 2002; Lewicki and Michaluk, 2004), sodium chloride (Sacilik et al., 2006) or sodium metabisulphite (Akanbi et al., 2002; Santos-Sanchez et al., 2012).

Latapi and Baret (2006) report that the most widely used food additive in the drying industry is sulfur dioxide used in the gaseous state or as the sulfur dioxide salt used as a solution. Santos-Sanches et al. (2012) used the solution of 1% sodium metabisulphite in their work. The authors report that sulfur dioxide and sulphites are used as antioxidants to prevent degradation of ascorbic acid and lycopene during drying, but also during storage. Muratore et al. (2008) recommend tomatoes to be treated with a 1% citric acid solution before drying. Abreu et al. (2011) used osmotic solutions of sugar and sodium chloride at concentrations of 5 and 10% in order to increase the proportion of soluble substances in the final product and to speed up the drying process. The aim of this study was to evaluate the efficacy of tomato slice treatment before drying with acetic acid, citric, acetic, potassium disulphite, sucrose and sodium chloride solutions for the stability of total carotenoids, total polyphenols and antioxidant activity.

MATERIAL AND METHODS

The experiment was performed using Uno Rosso F1 cultivar of tomatoes. It is medium early determinate variety, suitable for mechanized harvesting. It has...
By evaluating the total polyphenol content we found, similarly to the total carotenoid content, statistically significant (P<0.05) the highest total polyphenol content after treatment with 1% ascorbic acid (250.25 mg GAE/100 g DM). Compared to the control sample with no treatment (204.44 mg GAE/100 g DM), it is the highest difference (45.81 mg GAE/100 g DM). There were statistically significant (P<0.05) different 11 test pairs. Treatment with 1% ascorbic acid was not statistically significant different (P>0.05) compared to the treatment with 1% acetic acid and 1% potassium metabisulfite (Table 1).

Treatments with 1% citric acid solution and 5% sodium chloride solution were evaluated to be the less effective treatments for polyphenol protection. Treatment with 5% sucrose solution (218.90 mg GAE/100 g DM) was not statistically significant (P>0.05) different from the untreated control sample (204.44 mg GAE/100 g DM) in total content polyphenols in dried tomato slices. As the statistically significant (P<0.05) the most effective in antioxidant protection was the solution of 1% ascorbic acid again. Ascorbic acid is considered to be the significant antioxidant, it increased the antioxidant potential of dried tomatoes, that can be seen on the high antioxidant activity (540.98 mg GAE/100 g DM). Based on the one-way ANOVA and post-hoc Tukey HSD tests, it can be concluded that all 5 pre-drying treatments applied showed the statistically significant (P<0.05) positive effect on antioxidant activity of dried tomato slices (Table 1).

Table 1 shows positive effect of the individual treatments on the antioxidant activity of the dried slices. Relatively similar in antioxidant protection of dried tomato slices were solutions of potassium metabisulfite, acetic acid, sodium chloride and citric acid, among which we did not find any statistically significant difference (P> 0.05). Statistically significant (P<0.05) the lowest effect in antioxidant protection showed the sucrose solution (388.05 mg AAE/100 g DM), but even this solution showed no statistically different (P>0.05) results compared to the citric acid solution (411.22 mg AAE/100 g DM) and sodium chloride (419.04 mg AAE/100 g DM).

Muratore et al. (2008) investigated the effect of drying and treatment temperature on changes in lycopene, β-carotene and ascorbic acid, during drying at various temperatures as well as the effect of fruit treatment prior to drying. Cherry tomato fruits were treated with 1% sodium chloride solution and 1% citric acid prior to drying. Drying was performed at 40, 60 and 80 °C. They dried the samples to the relatively high residual moisture up to 40% and named the product as semi-dry cherry tomatoes. They found that the temperature of 80 °C was the most suitable for the stability of lycopene and β-carotene for both untreated and treated samples. The fresh sample contained 99.8 mg/100 g DM of lycopene, and only 58.5 mg/100 g DM of the sample was retained in 40 °C dried sample and in the sample dried at 80 °C, 76.4 mg/100 g DM. In the treated samples, the authors did not find significantly higher contents of lycopene or β-carotene compared to untreated samples. However, the positive effect of the treatment was shown in relation to ascorbic acid. In the fresh sample of tomatoes, they detected 433.5 mg/100 g DM, in the untreated sample dried at 40 °C, the ascorbic acid content was 311.5 mg/100 g DM and in the treated sample 368.1 mg/100 g DM.

Abreu et al. (2011) used 5 and 10% osmotic solutions of sucrose and sodium chloride as well as various combinations prior to tomato drying. They used Bonus variety, the treatment with osmotic solutions was performed for 120 minutes, followed by drying at 65 °C for 12 hours. Treatment with osmotic solution prior to drying resulted in the higher soluble dry matter content, especially in solutions with 10% sucrose content. They found interesting results in the evaluation of lycopene retention in dried samples. Sucrose solution showed the best results. After treatment with this solution, they detected an increase in the lycopene content in the sample by 5.63%. The lycopene content increased from 446.85 μg/g DM to 472.02 μg/g DM. 10% sucrose solution and 5% sodium chloride solution were also found to be suitable solutions for treating of tomatoes.
prior to drying to improve lycopene stability. In the case of 10% sucrose solution, the lycopene content after drying was 43.5% higher than in the control sample and 34.1% in the case of 5% sodium chloride solution. In our work, comparing to 5% solution of sucrose and 5% sodium chloride solution, we found better results with sodium chloride solution in relation to the stability of total carotenoids, even though it is far from being such a high retention percentage as reported by the authors. In case of 5% sodium chloride solution, the total carotenoid content was higher by 13.8% compared to the control sample and 6.8% by the 5% sucrose solution. HASTURK, Sahin et al. (2011) compared the effect of different ways of drying in tomato slices: in the sun, in a hot air dryer at 65, 75 and 85 °C, and the tomatoes were cut in half, quarter and eighth. Spectrophotometric determination of total phenolics and lycopene in plodoch rajčiaka jedlého. Drying characteristics and stability of dried tomatoes. Misk Journal of Agricultural Engineering, 25(3), 957-979. ISSN 1687-384.

CONCLUSION
Based on the results, we can conclude that all pre-drying treatments used, showed positive effect on the resulting nutritional quality of the dried tomato slices. In assessing the effect of treatment on carotenoid stability, we found the highest total carotenoid content after treatment with 1% ascorbic acid solution, but based on the results of the Tukey test, this treatment was not statistically significant (P>0.05). The weakest effect on polyphenol stability was in the case of 3% potassium carbonate solution and 1% acetic acid solution. In their conclusions they note the positive effect of the pre-drying temperature on the results of the Tukey test, this treatment was not statistically significant (P>0.05). The decrease in the antioxidant protection effect during drying showed solutions of sodium chloride, citric acid and sucrose, among which we found no statistically significant (P>0.05) difference.

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