CHANGES IN THE QUALITY IN TOMATO FRUIT DUE TO HOME-SCALE FREEZING

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Abstract
The aim of the study was to evaluate the effect of home-scale freezing in the quality of tomato fruit cultivated in field conditions, in Romanian west area.Freezing is one of the oldest and most widely used methods of vegetables preservation.Tomatoes were analyzed fresh and stored frozen in domestic freezer at -18^{0}C for 2-6 months until analysis. Tomatoes were analyzed regarding moisture, sugar, lycopene content,ascorbic acid, phenolic compounds and total antioxidant capacity. Most important losses due to 6 months home-scale freezing were recorded for lycopene content (47%) followed by vitamin C content (20%), total antioxidant capacity (16%) and phenolic compounds content (13%). The freezing process has no to much effect on the nutritional compounds but for the best quality, use the tomato fruit within short time.

Introduction
Tomato (*Lycopersicum esculentum*) is the most popular and widely cultivated seasonal fruit vegetable crop; it is grown in the backyard of most people's home [12].
Tomatoes produced in climatic conditions of Romanian country is highlighted by high sugar content, acidity, ascorbic acid and carotenoids, especially the tomatoes produced in the field the months from July to September, due to high temperature and solar radiation [8]. Tomatoes are especially important for the human diet because of their content of vitamin C, carotenes, lycopene and phenolic compounds. Ascorbic acid, lycopene and phenolic compounds are a major source of antioxidants [14].
Freezing is one of the oldest and most widely used methods of food preservation, which allows preservation of taste, texture, and nutritional value in foods better than any other method [5].Freezing has been successfully employed for the long-term preservation of many foods. The process involves lowering the product temperature generally to -18°C or below [6]. Frozen tomatoes are best when used within 4-6 months, depending on quality of fruit at time of processing and how they are processed for the freezer, but have a freezer life of 8-12 months [18]. Tomatoes must be select firm, ripe tomatoes with a deep red color. Frozen tomatoes have a mushy texture when thawed and are suitable only for cooking, such as in soups, stews and spaghetti sauces [16].

Experimental
Tomatoes samples were collected on June-July at thoroughly fruit maturity. After harvesting tomato fruit were used for the analysis on fresh products and frozen immediately. Were used whole tomatoes, closed in the freezer bags, excess air removed, without blanching and kept in the Zanussi domestic freezer at -18^{0}C for 2-6 months. Before analysis, the tomato samples were thawed in refrigerator at 3-5^{0}C for 6 hours; tomatoes defrosted completely were using.

Tomatoes samples were homogenized and centrifuged for 10 min.
Moisture content was determined using the AOAC method (1990) [2]: tomato fruit were dried in the oven at 105 ± 1^0C; readings were taken hourly until constant weight was achieved. The results were reported as %fresh weight (FW).
Determination of sugar content:Tomatoes samples were homogenized and centrifuged for 10 min. The supernatant was used to measure the sugar content using a refractometer method by hand refractometer Carl Zeiss Jena. The results were reported as ^{0}Brix at 20^{0}C.
Determination of lycopene:Lycopene content in the tomatoes samples was extracted by hexane:ethanol:acetone (2:1:1, v:v:v) mixture following the method of Sharmaand Le Maguer (1996) [13]. The lycopene concentration were measured spectrophotometrically at 472 nm using its specific extinction coefficient (E1% 1cm) of 3450 in hexane at 472 nm by Spectrophotometer UV-VIS SPECORD 205 by Analytik Jena. The results were expressed as mg/100g FW.
The ascorbic acid content of samples was carried out based on AOAC method (1990) [2] by 2,6-Dichlorphenolindophenol Natrium. The results were expressed as mg ascorbic acid/100g FW.
Determination of phenolic compounds: The content of total polyphenolic compounds in tomatoes ethanol extracts diluted 1/10 was determined by Folin-Ciocalteu method (1927). The absorbance of blue-colored complex solution was then read at 725 nm using Spectrophotometer UV-VIS SPECORD 205 by Analytik Jena. Gallic acid was used as a standard, and results were calculated in gallic acid equivalents (GAE) per 100 g FW [11]. Correlation coefficient (r^2) for calibration curve was 0.9807.
Determination of total antioxidant capacity (TAC) by FRAP method: For determination phenolic compounds and total antioxidant capacitysample it was made the alcoholic extraction. FRAP method depend upon the reduction of ferric tripyridyltriazine complex to the ferrous tripyridyltriazine by a reductant at low pH. This ferrous tripyridyltriazine complex has an intensive blue color and can be monitored at 593 nm. TAC in tomatoes in Fe (II) equivalents was calculated [11]. Correlation coefficient (r^2) for calibration curve was 0.9891.
All determinations were repeated for three times.

Results and discussions

The consumers define quality. For tomatoes, the most important quality factors for consumers acceptance are that they look and taste good, are firm and have a good nutrient value. High sugar and high acid contents generally have a favorable effect on taste [9].
Cooking and freezing are generally regarded as destructive to antioxidants, so supporting the consumers' assumption that only fresh vegetables are healthy [10].
One of the main differences between home freezing and industrial deep-freezing is the blanching procedure, which is generally not used in home practice [4]. Tomatoes do not need to be blanched before freezing [17]. During freezing most of the liquid water changes into ice, which greatly reduces microbial and enzymatic activities? Oxidation and respiration are also weakened effectively by low temperature. However, freezing itself slightly decreases food quality [7]. Tomatoes were analyzed regarding moisture, sugar, lycopene content,ascorbic acid, phenolic compounds and total antioxidant capacity (Table 1).

Table 1. The nutritional compounds content in tomato fruit(fresh and freezing)

Freezing time	Compounds content					
	Moisture [%]	Sugar [^{0}Brix]	Lycopene [mg/100g]	Ascorbic acid [mg vit.C/100g]	Phenolic compounds [µM/100g]	TAC [µMFe/100g]
fresh	92.25	7.10	16.26	24.16	156.70	446.22
after 2 months	92.80	6.80	12.95	22.58	150.24	408.45
after 6 months	94.00	6.50	8.65	19.22	136.24	375.76

Water makes up over 90 percent of the weight of most fruits and vegetables. This water and other chemical substances are held within the fairly rigid cell walls which give support structure, and texture to the fruit or vegetable [15]. The freezing tomatoes were found to have the highest moisture content (94%) whilst fresh fruit has the lowest (92.25%) (Table1). When the water freezes, it expands and the ice crystals cause the cell walls to rupture. Consequently, the texture of the produce, when thawed, will be much softer than it was when raw. This textural difference is especially noticeable in products which are usually consumed raw: when a frozen tomato is thawed, it becomes mushy and watery [15].

The freezing process did not affect too much the level of sugars. However, differences between the fresh and freezing tomato fruit content are very small (8%)(Table1).

The freezing process had a significant decreasing effect on lycopene content. During the 2 months there were reduced to 21% up to 47% after 6 months freezing reported of fresh tomato fruit(Table1). Generally, the field grown tomatoes have been reported to contain higher levels of lycopene, ranging from 5.2 to 23.6 mg/100 g [1]. The main causes of tomato lycopene degradation during processing are isomerization and oxidation. Isomerization converts all-trans isomers to cis-isomers due to additional energy input and results in an unstable, energy-rich station. Determination of the degree of lycopene isomerization during processing would provide a measure of the potential health benefits of tomato-based foods. Thermal processing (bleaching, retorting, and freezing processes) generally cause some loss of lycopene in tomato-based foods [14].

The level of vitamin C was significantly higher in fresh tomato fruits (24.16 mg vit.C/100g FW) it decreased considerably after freezing(Table1). It is documented that vitamin C is lost during processing, but ascorbic acid represents only a minor part of the antioxidant activity, polyphenols being very important antioxidant compounds [10].

The content of phenolic compounds was slightly lower in the freezing months to fresh tomato fruit, the losses were between 4 - 13%.

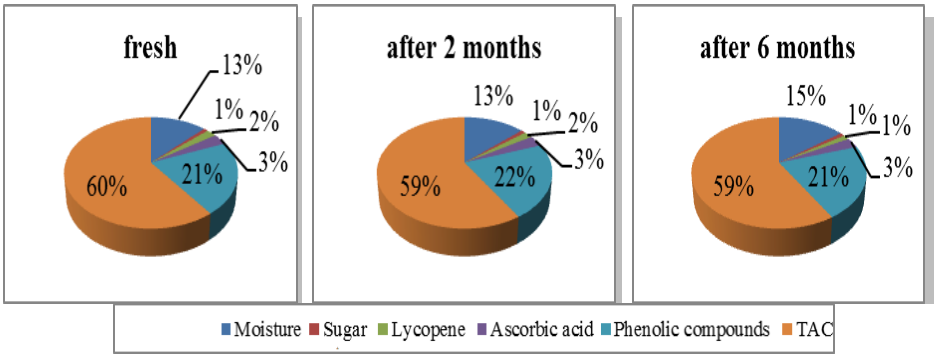

Figure 1. Changes in the nutritional compounds content in tomato fruit due to home-scale freezing

Also a decrease of the total antioxidant capacitylevel in fruits after freezing was not significant. This loss was higher in frozen tomatoes, possibly due to the alteration of the peel barrier. This decrease in total antioxidant capacityis in agreement with the recent study of Capanoglu and others [3], who showed that processing significantly affects the levels of antioxidants.From statistical terms, the sugar content and the ascorbic acid content it does not change during freezing. So, 1% respectively 3% of nutritional compounds in tomato fruit is insured by them. Other compounds were having a minor variation (Figure 1).

Conclusion

The home-scale freezing has no important changes of the level of sugars, ascorbic acid, phenolic compounds and total antioxidant capacity. Instead, were observed differences in the lycopene content and moisture level.

The decrease in the nutritional compounds content in tomato fruit occurring after home processing is relatively small.

For best quality, use the whole tomatoes without blanching, closed in the freezer bags, within six months.

References

[1] A.A. Abushita, H.G. Daood, P.A. Biacs, J Agric Food Chem. 48 (2000) 2075–2081.
[2] Association of Official Analytical Chemists (AOAC) Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists Inc.; Arlington, VA, USA: 1990.
[3] E. Capanoglu, J. Beekwilder, D. Boyacioglu, R. Hall, R. de Vos, J Agric Food Chem. 56(3) (2008) 964–73.
[4] F. Danesi, A. Bordoni, J. Food Science. 73(6) (2008) 109-112.
[5] A.E. Delgado, D.W. Sun, J. Food Engineering. 47 (2000) 157-174.
[6]O.R. Fennema, W.D. Powrie, E.H. Marth, Eds, Plenum, New York, Ch.3, 1973.
[7]W. Haiying Z. Shaozhi, Ch. Guangming, LWT. 40 (2007) 1112-1116.
[8] E.M. Ionica, Review of Science and Scientometric Policy, Bucuresti, 2005.
[9] R.L. Mikkelsen, Better Crops. 89 (2) (2005)
[10]N.J. Miller, A.T. Diplock, C.A.Rice-Evans, J Agric Food Chem. 3(7) (1995)1794–1801.
[11] M.A. Poiana, M.F. Munteanu, D.M. Bordean, R. Gligor, E. Alexa, Chem Cent J. 7(1) (2013) 1-13.
[12] M.U. Sainju, D. Ramdane, S. Bharat, J. Food Agric. Environ. 1(2) (2003) 176-183.
[13] S.K Sharma, M. Le Maguer, Italian Journal of Food Science. 2 (1996) 107- 113.
[14] J. Shi, M. Le Maguer, Crit. Rev.Biotechnol. 20(4) (2000) 293-334.
[15]http://www.extension.umn.edu/food/food-safety/preserving/freezing/the-science-of-freezing-foods/
[16] http://extension.missouri.edu/p/GH1503
[17] http://food.unl.edu/freezing-raw-tomatoes-or-without-their-skins
[18] http://www.tomatodirt.com/freezing-tomatoes.html