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STABILITY OF ASCORBIC ACID DURING THE TECHNOLOGICAL PROCESSES OF APRICOT COMPOTE FABRICATION

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Abstract. Apricots are fruits with a short period of fresh-consumption and the compote fabrication is a usual method for their preservation. The present research is studying the changes in total vitamin C content, as well as the transformations between ascorbic acid and dehydroascorbic acid in four different phases of the technological flow of apricot compote fabrication. The ascorbate oxidase activity was also evaluated. The studied samples are represented by different stages of apricots during the technological flow of compote fabrication: raw material, washed fruits, after blanching (at 70 °C for 3 min), and finished product (after pasteurisation by maintaining at 95 °C the inside temperature of filled and closed jar for 15 min). Also, the ascorbic acid content after 3 months of compote preservation in the dark at 10 °C and respectively, 25 °C was measured. Three analytical methods were used: HPLC, reflectometry (using the Reflectoquant), and titrimetry (using 2, 6-dichlorophenol indophenol). The results proved that thermal processes seriously decreased the ascorbic acid content and increased the dehydroascorbic acid. The 3 months preservation at both temperatures has slight influence on the content of ascorbic acid, but at 25 °C the diminution of ascorbic acid and the increase of dehydroascorbic acid were more significant than at 10 °C.

Keywords: *ascorbate oxidase, blanching, dehydroascorbic acid, pasteurisation, preservation, technological flow, temperature, vitamin C.*

I. Introduction

Apricots are seasonal fruits preferred by consumers, being considered very tasty, with a specific and pleasant flavour [1]. Except the sensorial qualities, they are nutritious fruits, with an important content of carbohydrates, proteins, organic acids, minerals, but also antioxidants, such as ascorbic acid, carotene, phenolic compounds. According to previous studies, the apricots' content in vitamin C ranges between 7-10 mg/100 g [2].

During the storage period, in the vegetables and fruits harvested at maturity, there is a continuous decrease in the amount of ascorbic acid, the intensity of the decrease in the content of ascorbic acid being dependent on the species, variety, temperature [3]. By keeping vegetables and fruits for a few days at ambient temperature, a significant decrease of vitamin C content takes place [4]. Temperature has a great influence on the stability of

ascorbic acid in vegetables and fruits. For example, in green peas the decrease is 50% after 4 days of storage at ambient temperature and 10% at 0 °C; for green beans vitamin C decreases by 72% after 6 days at ambient temperature and by 12% by storage at 0 °C the same time period. According to Agar et al. [5], slices of kiwi stored 6 days at 0, 5 and 10 °C showed a decrease in ascorbic acid content and an increase in dehydroascorbic acid content compared to fresh slices, and with the increase of the temperature these modifications are more important. The structural features of each horticultural product influence the decrease of the ascorbic acid content. If the products have a relatively thick skin, this prevents the diffusion of oxygen inwards and the oxidation of ascorbic acid occurs slower [4]. Potatoes can contribute to human nutrition with a significant supply of vitamin C, but lose up to 50% of the ascorbic acid content after peeling and boiling in water; the loss is half by baking them in the oven, without peeling [6]. Ascorbic acid is thermally unstable, so it is important to know its content in products after thermic processing. During blanching, the level of ascorbic acid decrease depends on the type and duration of the treatment, and losses can be limited by the inactivation of oxidizing enzymes, as ascorbate oxidase. Smaller vitamin C diminutions are recorded in steam blanching (10-30 %) than in hot water blanching (10-50%) [7].

Ascorbic acid, AA, (vitamin C) is a water-soluble vitamin and a powerful antioxidant essential for a proper activity of the human body. It is involved in the immunity; intestinal iron absorption; biosynthesis of some neurotransmitters, of collagen and carnitine; decrease of lipid peroxidation; inhibition of carcinogenic nitrosamines production; reducing of the inflammatory response (anti-allergic action due to its anti-histaminic properties); diminution of the susceptibility to influenza virus, etc. The vitamin C does not accumulate as deposits in the body, so it needs to be constantly introduced from food. As previously stated, ascorbic acid is a reducing agent. It is oxidized to dehydroascorbic acid (DHA), with the loss of hydrogen (Figure 1). DHA is a soft oxidizing agent which can accept hydrogen to reform AA. In most biological systems, AA is present in much higher quantities than DHA, and is considered the active form of the vitamin C [8]. AA has a predominant role in ensuring immunity and participates in intestinal iron absorption processes [9, 10].

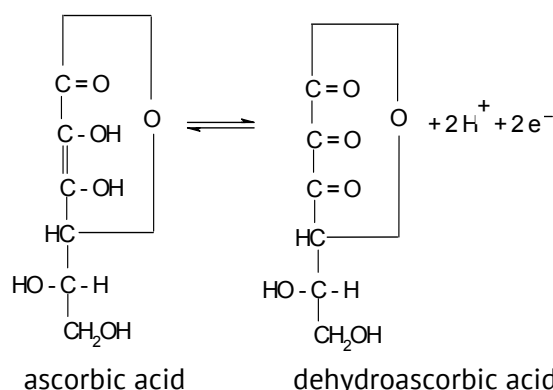


Figure 1. The interconversion ascorbic acid – dehydroascorbic acid.

II. Materials and methods

The studied material was represented by 4 stages of the technological flow of apricot compote fabrication: apricot raw material (A), washed fruits (W), after blanching with hot water at 70 °C for 3 min (B) and finished product after pasteurisation by maintaining at 95 °C the inside temperature of filled and closed jar for 15 min – apricot compote. From the compote were analysed the apricots (AC) and the syrup enveloping the fruits (SC). The finished product was also analysed, after a storage period of 3 months at 10 °C and 25 °C in order to research the stability of ascorbic acid. The samples were supplied by the company S.C. Contec Foods S.R.L. Tecuci in two consecutive years.

The extraction of ascorbic and dehydroascorbic acids for high-performance liquid chromatography (HPLC) used a solution of metaphosphoric acid stabilised with Na_3PO_3 (5%). The reduction of dehydroascorbic acid was performed by the reaction with dithiothreitol. The chromatographic conditions were: solution of sulphuric acid 0.0035 N as mobile phase, 0.60 mL/min flow rate, 30 °C temperature, UV detection. Two other methods were also used for the analysis of the total ascorbic acid content: the titrimetric method using 2, 6 dichlorophenol indophenol (2,6 DCFIF) [11, 12] and the reflectometric method using the Reflectoquant RQFlex, Merck [13]. The activity of ascorbat oxidase was assessed spectrophotometrically at 265 nm [14].

III. Results and discussions

The mean values obtained for the ascorbic acid content by the use of 2, 6 dichlorophenol indophenol and Reflectoquant were similar and during the second year were inferior compared to the first year (Figure 2). This difference can be explained by the initial parameters of the raw material (depending on the transportation/preservation conditions of apricots prior to industrialisation, but also to the geo-pedo-climatic conditions, variety, maturity stage and harvest period of the two studied years). But this research focused on the changes of the AA and DHA contents of the raw material due to the technological processes of compote fabrication, and to post-fabrication preservation conditions, unconcerned of the initial quality of the fruits.

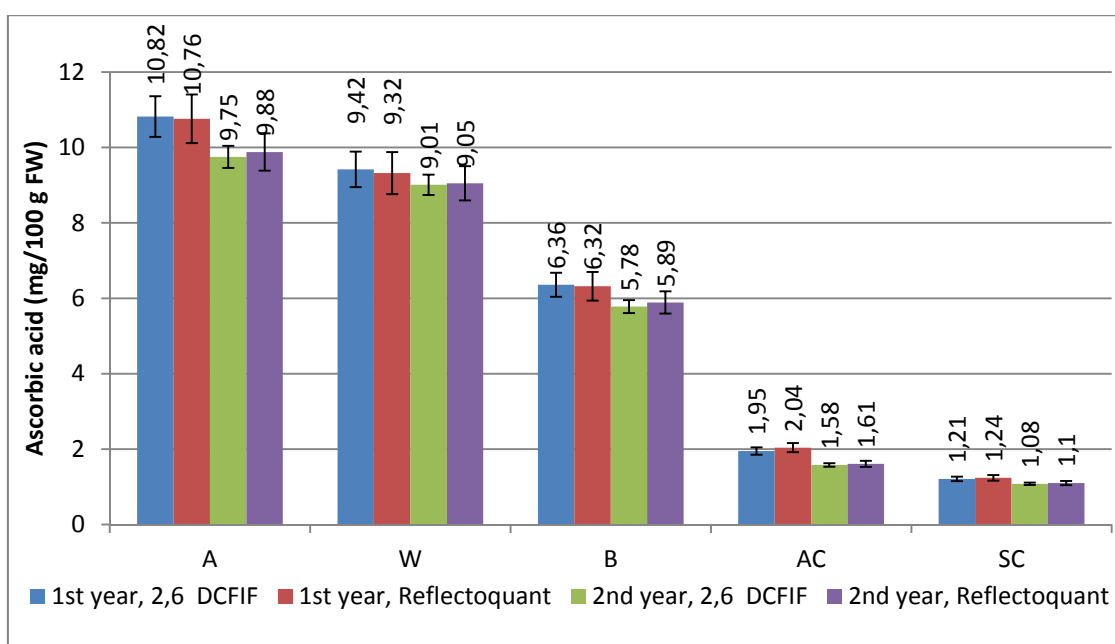


Figure 2. Dynamics of ascorbic acid content during the technological flow of apricot compote fabrication: apricot raw material (A), washed fruits (W), after blanching (B), apricots from compote (AC), and syrup from compote (SC), during two different years and employing 2,6 dichlorophenol indophenol and Reflectoquant methods.

Results are means of 3 determinations \pm standard deviation.

The washing process decreased the AA content by about 13%, while the blanching with hot water at 70 °C for 3 min, diminished it by about 41% compared to raw material. The last procedure, pasteurisation by maintaining at 95 °C the inside temperature of filled and closed jar for 15 min, strongly decreased the AA content of both apricots from compote (by 82%) and enveloping syrup (by 89%) compared to initial fruits. The difference between

the content of ascorbic acid in fruits and syrup of the final compote is light, proving the diffusion of AA outside from the fruits, which could also justify the strong decrease compared to raw material (Figure 2).

Concerning the preservation conditions (Figure 3), the studied period decreased the AA in fruits by 15% at 10 °C and by 46% at 25°C, and in the syrup by 8% at 10 °C and 21% at 25°C, respectively. The apricots in compote have more ascorbic acid than the enveloping syrup.

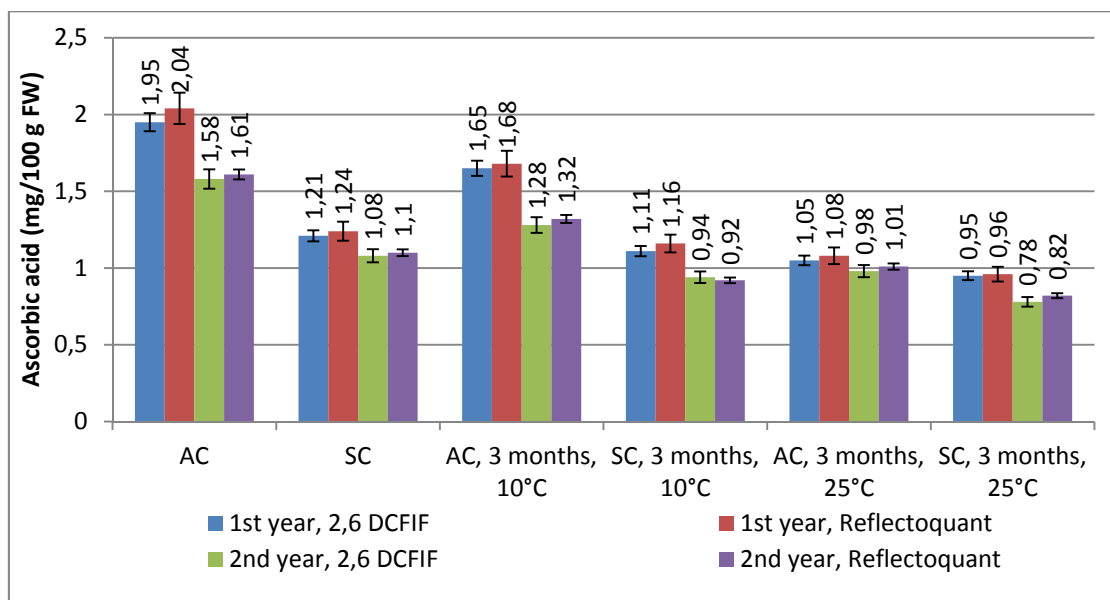


Figure 3. Ascorbic acid content after 3 months of preservation at 10 °C and 25 °C: apricots from compote (AC), syrup from compote (SC), during two different years and employing 2,6 dichlorophenol indophenol and Reflectoquant methods. Results are means of 3 determinations±standard deviation.

The HPLC analysis enables the determination of both AA and DHA and the results are shown in Figures 4 and 5. During the technological flow and preservation period, the decrease of ascorbic acid content is accompanied by the increase of the dehydroascorbic acid, which proves the oxidation of AA to DHA, according to the transformation presented in Figure 1. The general trend of the evolution of AA is similar to the one revealed by the other two employed methods (titrimetric and reflectometric). The HPLC determination brings a new result: the studied processes, most probably, determine the degradation of AA to other compounds, except the DHA. This is proved by the fact that the diminution of ascorbic acid is more important than the increase of dehydroascorbic acid. This fact is obvious for the pasteurisation (which is an aggressive thermal treatment): the diminution of ascorbic acid in AC and SC (with a mean of 8.6 mg/100 g FW and respectively, 9.2 mg/100 g FW) is accompanied by a lighter increase of dehydroascorbic acid (0.55 mg/100 g FW and respectively, 0.67 mg/100 g FW), compared to the raw material. The other thermal treatment, the blanching, determined a decrease of AA with a mean value of 2.8 mg/100 g FW and an increase of DHA with 0.37 mg/100 g FW. During the preservation, the degradation of ascorbic acid and the formation of dehydroascorbic acid are more equilibrated (Figures 4 and 5). As expected, at 10 °C, the degradation of ascorbic acid and the formation of dehydroascorbic acid are less important than at 25 °C. In the fruits from compote, the content of AA is bigger and the DHA is smaller than in the syrup, but differences are very light.

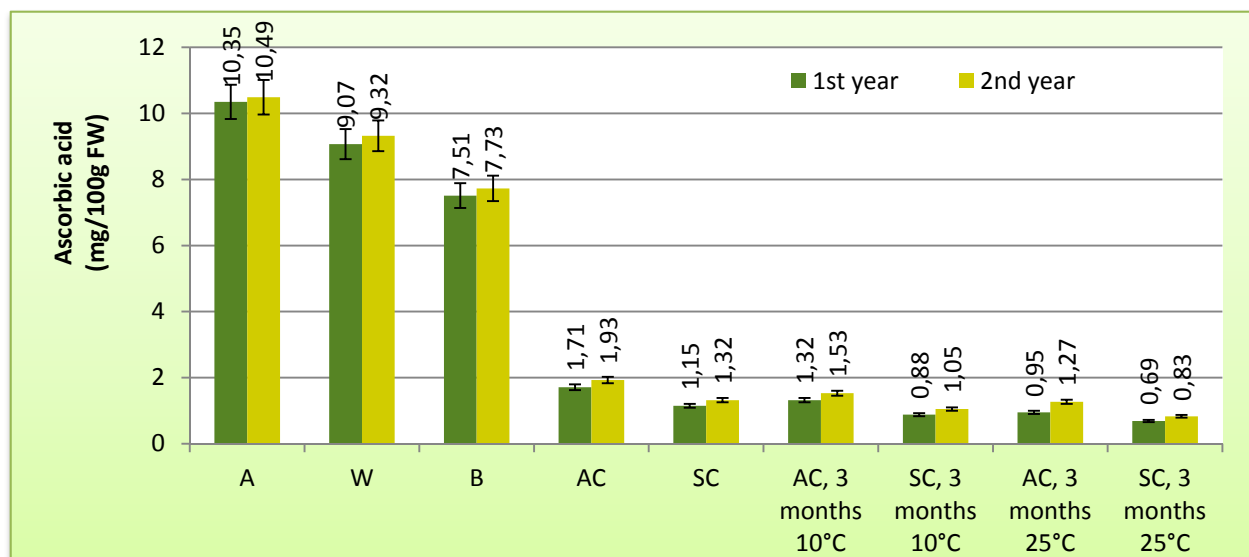


Figure 4. HPLC content of ascorbic acid during the technological flow of apricot compote fabrication and the 3 months preservation at 10 °C and 25 °C: apricot raw material (A), washed fruits (W), after blanching (B), apricots from compote (AC), and syrup from compote (SC), during two different years.

Results are means of 3 determinations \pm standard deviation.

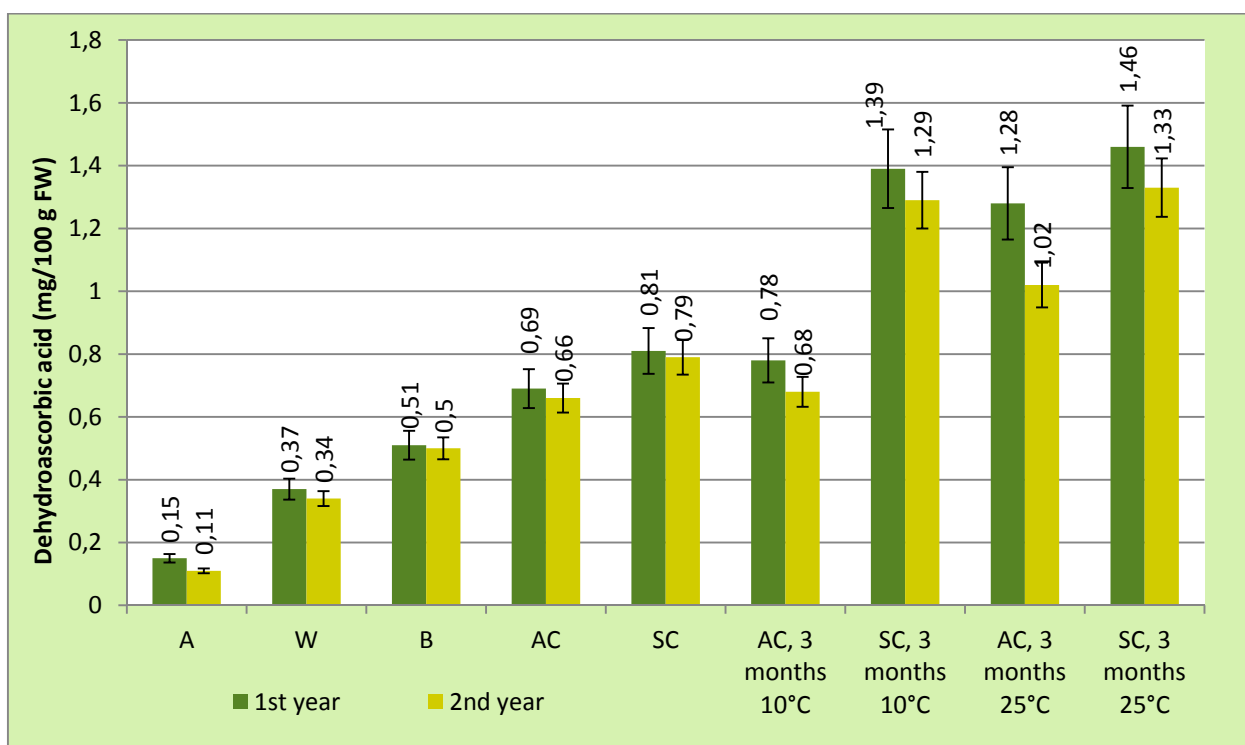


Figure 5. HPLC content of dehydroascorbic acid during the technological flow of apricot compote fabrication and the 3 months preservation at 10 °C and 25 °C: apricot raw material (A), washed fruits (W), after blanching (B), apricots from compote (AC), and syrup from compote (SC), during two different years.

Results are means of 3 determinations \pm standard deviation.

The ascorbate oxidase is the enzyme which catalyses the direct oxidation of ascorbic acid to dehydroascorbic acid. Its activity is strongly inhibited by blanching, being reduced by more than 3 times in both years, and is completely inactivated by pasteurisation

(Table 1). In fact, the enzymes inactivation, as well as the microbial destruction are the main goals of the technologies used for fruits industrialisation. This inactivation of enzymes justifies the good preservation and the stability of AA in the compote, which is proved by light decrease of ascorbic acid and also, light increase of dehydroascorbic acid during the 3 months of conservation at both studied temperatures.

Table 1

Ascorbat oxidase activity ($\mu\text{M/g}\cdot\text{min}$) during 3 phases of the technological flow of apricot compote fabrication, during two different years*

	1 st year		2 nd year			
	after blanching (B)	apricots from compote (AC)	apricot raw material (A)	after blanching (B)	apricots from compote (AC)	
	6.59±0.90	2.15±0.35	0.00±0.00	7.56±1.30	2.25±0.36	0.00±0.00

* Results are means of 3 determinations±standard deviation.

Conclusions

During the technological flow of compote fabrication, only the thermal processes seriously decreased the ascorbic acid content and increased the dehydroascorbic acid and these transformations are more important when the temperature and the duration of the process are more important. The 3 months preservation at both temperatures has slight influence on the content of ascorbic acid, but at 25 °C the diminution of ascorbic acid and the increase of dehydroascorbic acid were more significant than at 10 °C. These results confirmed the previous knowledges and brought new information about the exact values of the contents in ascorbic and dehydroascorbic acids after specific technological processes and after preservation in certain conditions.

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