JAM PROCESSING EFFECTS ON ASCORBIC ACID, PHENOLIC COMPOUNDS AND ENZYMATIC ACTIVITIES IN SOUR CHERRY FRUITS

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Abstract: Sour cherries are rich in bioactive compounds. The present study aims to research the stability of ascorbic acid and the dynamics of total phenolic and flavonoid contents, as well as some enzymatic activities (ascorbate oxidase, superoxide dismutase, catalase, polyphenol oxidase and peroxidase) during different operations of the technological process of jam fabrication. Their evolution during jam storage was also studied. Ascorbic acid was comparatively analyzed using 3 different methods (HPLC, Reflectoquant and 2, 6-dichlorophenolindophenol method). The jam manufacturing processes determine strong ascorbic acid degradation, which emphasizes during storage, especially at room temperature (25 °C). But, total phenolic content is very high in the finished product, registering only a slight decrease compared to the raw material. The enzymes are inactivated during the jam fabrication.

Key words: sour cherry jam, vitamin C, polyphenols, flavonoids, technological process

Introduction

Sour cherries are rich in antioxidants like phenolic compounds and vitamin C, but their content is affected by the technological processes of jam fabrication and by preservation time and conditions [2, 7]. The purpose of the present research is to study the variations of the vitamin C, total flavonoids, total phenolic content and some antioxidant enzymes during different steps of the technological process of jam fabrication. Also, the behavior during jam storage was analyzed.

Materials and methods

The material subjected to the research was provided by S.C. Contec Foods S.R.L. Tecuci, Romania. The samples were collected during 2 years, in 2011 and 2012, from June to July. Main steps of technological process of jam fabrication are: fruit washing, blanching, chopping, boiling with sugar (concentration), jar filling, sealing and pasteurization of the finished product. Other ingredients added during the fabrication are citric acid and pectin. The sour cherry jam has been analyzed immediately after preparation and after a period of storage at temperatures of 10 °C and 25 °C in the dark. The samples transportation and storage was performed in a refrigerator at 2 ÷ 4 °C.

The analyses were performed using 3 different methods for the vitamin C determination: 2, 6-dichlorophenolindophenol method according to ISO 6557-1:1986 and ISO 6557-2:1984 [9], a rapid reflectometric test (Reflectoquant ascorbic acid test) [3] and HPLC for ascorbic and dehydroascorbic acids [4]. The total phenolic content (TPC) was analyzed by Folin-Ciocalteu method and the total flavonoid content (TFC) by precipitation with formaldehyde [8].The catalase activity was measured by the gas meter Lobeckand, the activities of ascorbate oxidase, polyphenol oxidase, peroxidase and superoxyde dismutase - spectrophotometrically [1]. All the presented values are mean of 3 determinations.

Results and discussions

Ascorbic acid content

The content of ascorbic acid analyzed by 2, 6-diclorophenolindophenol and Reflectoquant methods show very similar results (fig. 1). After the washing operation, a slight decrease in vitamin C content was registered (13%). The blanching and chopping cause an important decrease of the ascorbic acid content of about 68 % compared to washed product. The final steps induced a decrease of about 87 % of ascorbic acid, mainly due to the boiling, so the finished product contains only about 3.5 % ascorbic acid, compared to the raw material. During 3 months of storage, a significant decrease was observed in the samples kept at 25 °C, the concentration of ascorbic acid being diminished by approximately 50 % compared to the final product obtained at the end of the technological process.

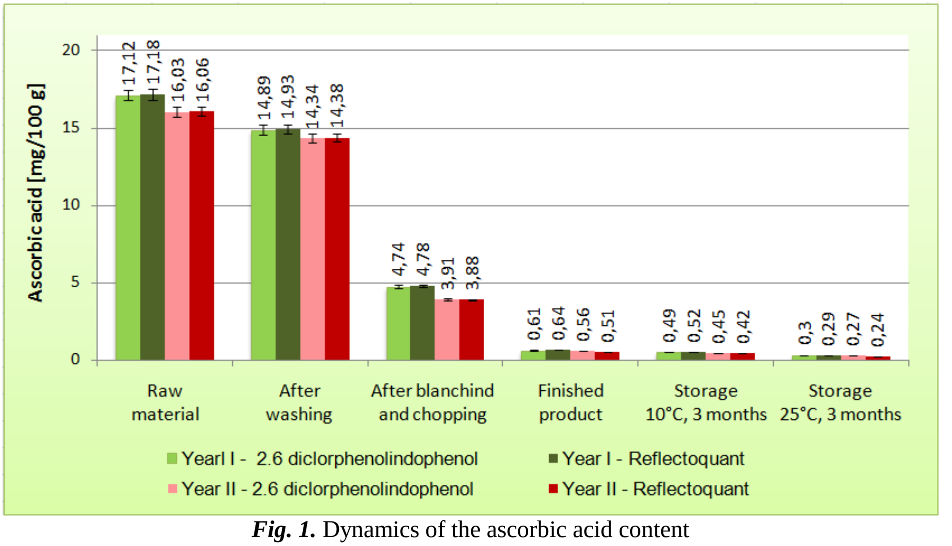


Fig. 1. Dynamics of the ascorbic acid content

The HPLC results showed a similar trend of ascorbic acid variation (fig. 2). Compared to the samples taken after chopping, the jam kept at 10 °C register losses of 90.92 % for the first year and 91.37 % for the samples collected during the following year. The 25 °C storage determines increased losses in ascorbic acid content: 94.46 % for the first year and 95.32 % for the second year.

The dehydroascorbic acid content is continuously increasing during fruit processing, the highest value being recorded after chopping. This increase is due to the contact with the air and the metal of the cutting machine. The next operations (boiling - concentration, filling, sealing and pasteurization of the jars) determine a decrease of the dehydroascorbic acid content. The storage at 25 °C induces an increase of dehydroascorbic acid content together with the decrease of ascorbic acid, compared to the storage at 10 °C.

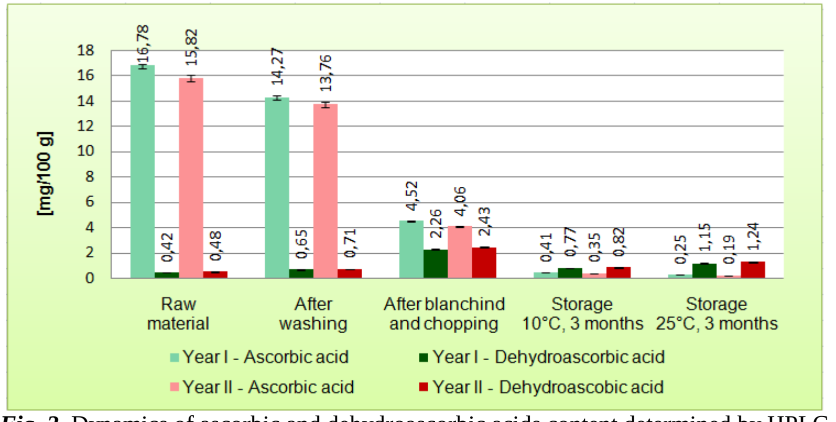


Fig. 2. Dynamics of ascorbic and dehydroascorbic acids content determined by HPLC

Total phenolic and total flavonoid contents

The total phenolic content (TPC) shows a slight decrease during processing (fig. 3). In the raw material, it is 421.62 mg GAE /100 g FW (year 2011) and 419.88 mg GAE / 100 g FW (2012). Other authors obtained similar values in their researches [5, 6]. Kim (2004) obtained for sour cherry cv. Kroeker 398.5 ± 7.9 mg GAE/100 g FW [6]. After blanching and chopping, we noticed that the TPC decreased at 296.71 and 303.17 mg GAE/100g. The sugar addition and boiling, because of the massive water evaporation and product concentration, induced the appearance of increased TPC values in the final product: 360.92 mg GAE / 100g (2011) and 351.92 mg GAE / 100 g jam (2012). This content is much higher than Kim founded in sour cherry jam, which was inferior to 200 mg GAE/100g jam for the 4 tested sour cherry cultivars [6].

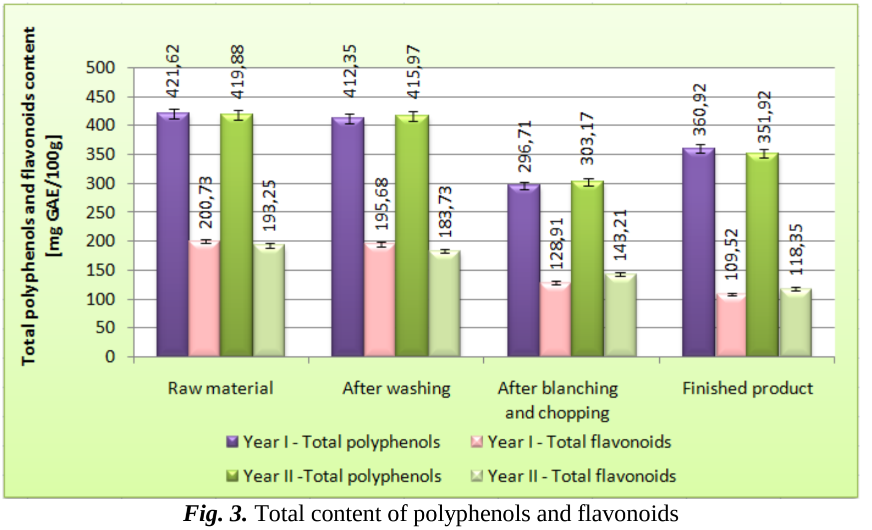
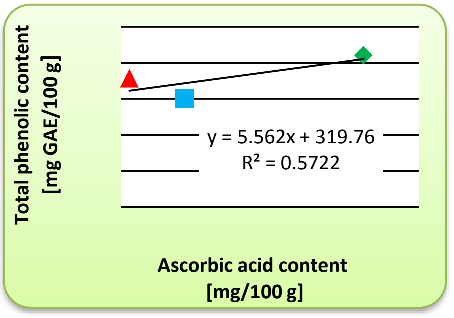


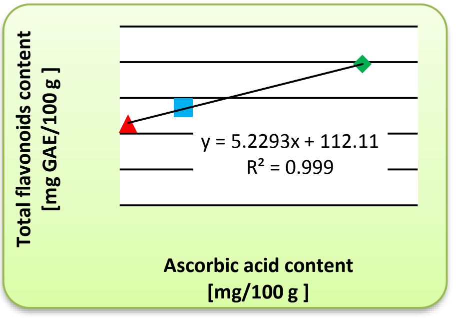
Fig. 3. Total content of polyphenols and flavonoids

The total flavonoid content (TFC) of the raw material is 200.73 mg GAE/100g

FW for the first year, respectively 193.25 mg GAE/100g FW for the second year (fig. 3). Same as for TPC, the washing did not significantly influence the flavonoid content, but blanching and chopping produced a significant decrease. After the concentration through boiling, the TFC did not increase compared to previous content, but still, the finished product is characterized by a high concentration of flavonoids: 109.52 mg GAE / 100 g jam (2011) and 118.35 mg GAE / 100 g jam (2012). There is a positive correlation between ascorbic acid content and TPC, respectively TFC, during the technological process (fig. 4). The correlation is stronger between TFC, because thermal degradations of flavonoids and ascorbic acid are similar and more important than the degradation of other phenols. Some polyphenols are more resistant to the high temperature and concentrate when the water is evaporating.



a. phenols – ascorbic acid



b. flavonoids – ascorbic acid

Fig. 4. Correlations between the TPC (a), respectively TFC (b) and ascorbic acid content (green - the raw material, blue - blanched samples, red - the finished product)

The enzymatic activity

Regarding the enzymatic activities, we analyzed the raw material, the samples taken after the blanching operation and the finished product. As we expected, the highest activities were obtained in the raw material for all enzymes (table 1). After blanching and chopping, the enzymes were partially inactivated and all enzymes registered important loss of activity: ascorbate oxidase – 70 %, superoxide dismutase – 77 %, catalase –66 %, polyphenoloxidase – 72 % and peroxidase – 98 %.

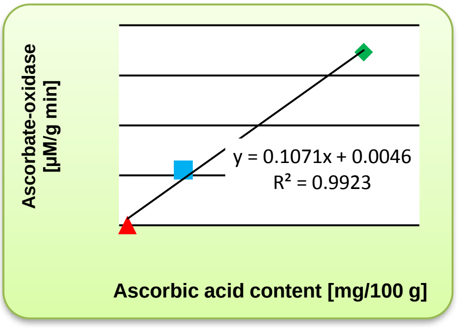
Table 1. Enzymatic activities of some samples collected during the technological process

Enzymes	Year2011			Year 2012		
	Raw material	Blanching	Finished product	Raw material	Blanching	Finished product
Ascorbate oxidase [μM/g·min]	1.7	0.55	0	1.76	0.49	0
Superoxide dismutase[E.U./g·min]	16.22	3.77	0	17.32	3.85	0
Catalase[$cm^3 O_2/g$]	1,2	0.39	0	1.35	0.48	0
Polyphenol oxidase [E.U./g·min]	1.83	0.5	0	1.99	0.56	0
Peroxidase[E.U./g·min]	0.018	0.0031	0	0.02	0.0036	0

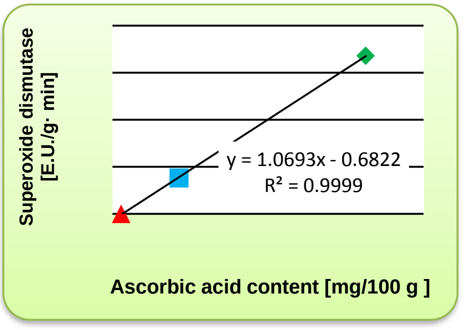
In the finished product, all enzymes are completely inactivated, especially due to the thermic treatments, but also to the process duration and other factors.

Raw material samples analyzed in the second year (2012) have led to slightly superior enzyme activities, and also the samples taken after blanching operation, excepting the ascorbate oxidase.

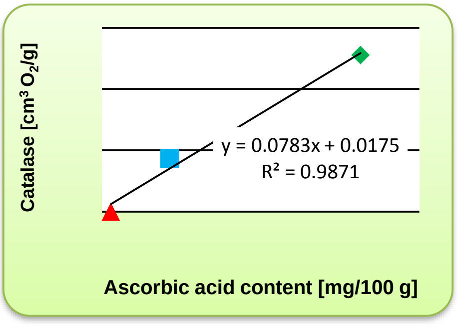
Concerning the correlation between the enzymatic activity and the ascorbic acid content throughout the manufacturing process (fig. 5), the correlation coefficient (R^2) is close to the value 1. All enzymes and the ascorbic acid are strongly affected by thermal procedures, so it is normally to exist a very good correlation between them.



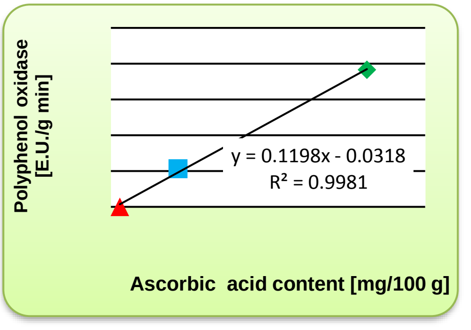
a. ascorbate-oxidase –ascorbic acid



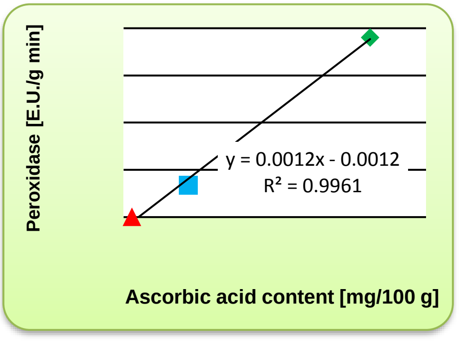
b. superoxide dismutase –ascorbic acid



c. catalase – ascorbic acid



d. polyphenol oxidase – ascorbic acid



e. peroxidase – ascorbic acid

Fig. 5. The correlations between enzymatic activities and ascorbic acid content (green - the raw material, blue - blanched samples, red - the finished product)

Conclusions

The jam manufacturing processes determine strong ascorbic acid degradation, which emphasizes during storage, especially at room temperature (25 °C).

The total phenolic content is very high in the finished product, registering only a slight decrease compared to the raw material. This aspect is different from other reported technologies of jam preparation. Also, total flavonoid content of the jam is important.

The studied enzymes are totally inactivated in the finished product.

Even if the ascorbic acid is weak represented in the finished product, the studied technological process of sour cherry jam fabrication leads to a product rich in other bioactive compounds, from the class of phenolics.

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