STABILITY OF ASCORBIC ACID DURING APPLE PROCESSING

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Summary: The present study analyses the influence of different phases of the technological process for the fabrication of the product "grated apples for pie", on the ascorbic acid content. Other related parameters have also been measured: some enzymes activities (ascorbate oxidase, superoxide dismutase, catalase), pH, total acidity, dry weight and soluble dry matter. In order to analyse the content in ascorbic acid, we used three different methods: 2, 6 – dichlorophenolindophenol, reflectometrically (using Reflectoquant) and HPLC and the obtained results were very similar. The researches were conducted in two consecutive years, in same conditions and the experimental material was produced by Contec Foods Tecuci, Romania. Both years, we observed an important instability of the ascorbic acid during the technological steps.The decrease of the ascorbic acid content in the final product was about 96% reported to the raw material.

Keywords: apple, ascorbic acid, technological process

The harmonious combination of taste, texture and flavour,together with the nutritive and health promoting compounds,makes the applesto bepreferred by the consumers all over the world.

Vitamin C is one of the most popular vitamins known since antiquity. It is a water soluble vitamin, very important due to the antioxidant properties. Its content in apples is varying in large limits, depending of thevariety, development phase of the fruit,and obviously, processing technology, storage conditions and duration.Vitamin C is an essential factor for neuronal function and survival, existing in two redox states, ascorbic acid and its oxidized form, dehydroascorbic acid.

Materials and Methods

The analysed material (fig. 1)was provided by S.C. Contec Foods S.R.L. Tecuci, Galaţi County, Romania. We analysed samples from every phase of the technological process: raw material (apples), apples after washing, spine apples removal stage, apples mechanically divided in small pieces, blanched apples with a mixture water – citric acid at 80°C, the final product as commercialized in jar (after autoclaving at 120°C for 10 min). In order to study the influence of the preservation conditions, we analysed the final product after storage 3 months in the dark at 25°C and 10°C.

The measurement of ascorbic acid content was done by three comparative methods: HPLC, 2,6-dichlorophenolindophenol method according to ISO 6557-1: 1986 and ISO 6557-2: 1984and a rapid reflectometric test (Reflectoquant ascorbic acid test) [2]. The activities of ascorbate oxidase and superoxide dismutase were analysed spectrophotometrically(Artenie V. et al, 2008)and the catalase activity by the gas meter Lobeck.

Titratable acidity was determined by titrimetric method according to ISO 750: 1998 and soluble dry matter according to ISO 2173: 2003.

Fig. 1. Analysed samples

Results and Discussions

The organoleptic analysis provided the following information:

- *raw material*: intact apples with red, yellow and green tint, specific to the variety, no spoilage or mold.After washing operation the smell and taste are typical, no foreign influences.
- *the final product*: the packing jar is tightly closed, no bulging, no rust spots or cracks; the apples are divided as noodles, with uniform aspect, nice colour andsweettypical taste, without foreign smell or taste.

Ascorbic acid content differs in the two analysedyears; there are also very slight differences between the two methods performed. Higher values (for the first year) were obtainedusing theReflectoquant,in all stages of the technological flow comparing to the second year where the values fluctuate from one stage to another. During the technological process, the largest decrease was recorded at the blanching stage where the vitamin content decreased by 76%. Due to thermal treatment and processing time, the final product also registered a loss of 84.76% compared to blanching stage.

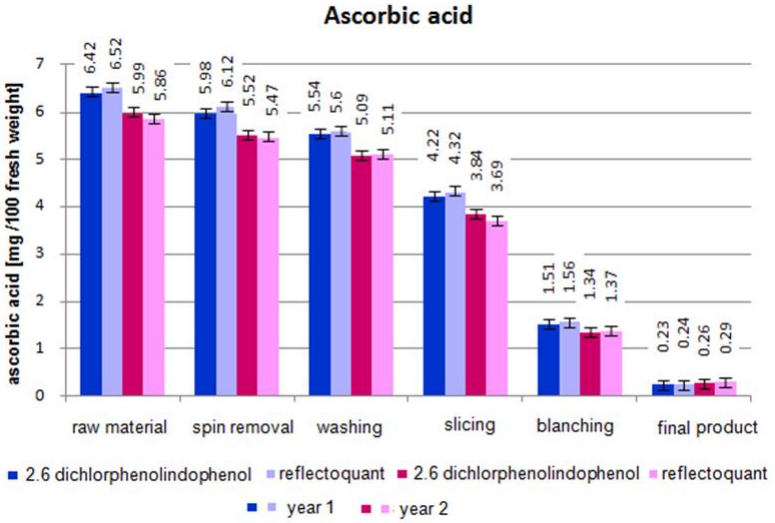


Fig. 2. The content of ascorbic acid during the technological processes

The raw material contained 6.42 respectively 6.52 mg ascorbic acid/ 100 g fresh weight for the first year and for the second year, 5.99 respectively 5.86 mg ascorbic acid/100 g fresh weight. Our results are similar to those obtained by Marian V. Eberhardt, 2000[3]. At the end of the technological process, the final product has 0.23, respectively 0.24 mgascorbic acid /100 g for the first year samples and 0.26, respectively 0.29 mg /100 g for the second year.

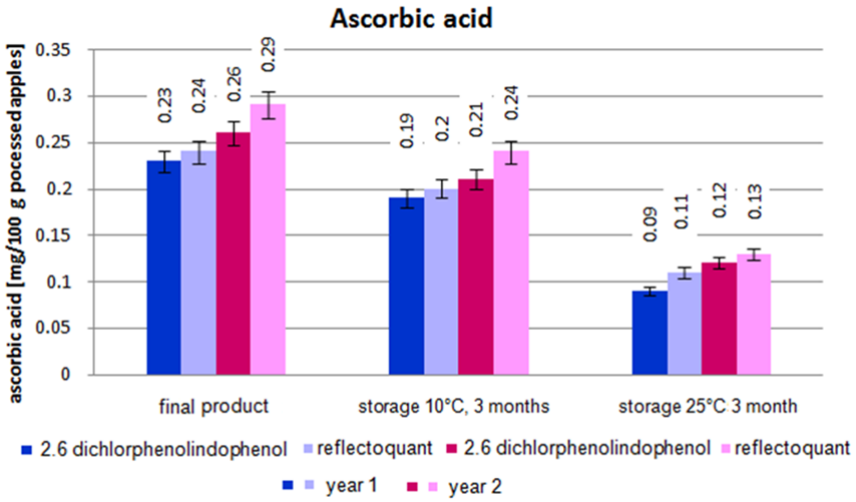


Fig. 3. Ascorbic acid content during storage

During the commercial (final) product storage, the differences in ascorbic acid content are due especially to the storage temperatures. The storage at 10°C induces a 17.03 ÷ 18.24% decrease and the storage at 25°C induces 54.51 ÷ 57.01% decrease compared to the final product. The global loose in ascorbic acid from raw material to commercialised product is 96 ÷ 98%.

Figures 4 and 5 present the results obtained by high performance liquid chromatography (HPLC) analysis.

In the case of dehydroascorbic acid the highest value recorded at the moment of division. This increase is influenced by the contact with oxygen and metal blades of the knives. Inactivation of enzymes in the next processing phasestops the enzymatic degradation of ascorbic acid and leads to a decrease of the dehydroascorbic acidcontent. The sterilization, which additionally ensures the conservability of the final product, is decreasing the amount of air present in containers, avoiding the oxidation of the current ascorbic acid.

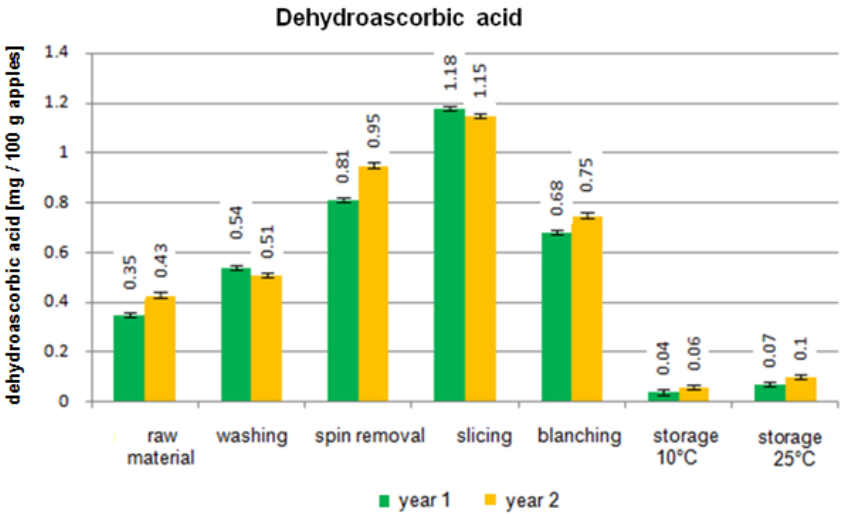


Fig.4. Dehydroascorbic acid content

Ascorbic acid revealed lower values than the previous methods because the samples were additionally stored for 3 months in the deep freezer before the HPLC analysis. However, the results do not differ much from other methods. The rate of ascorbic acid degradation is affected by pH, temperature and presence of oxygen [4].

Figure 5 highlights the downward trend in vitamin C content; important losses are recorded afters pin removal, slicing, blanching and sterilization followed by storage.

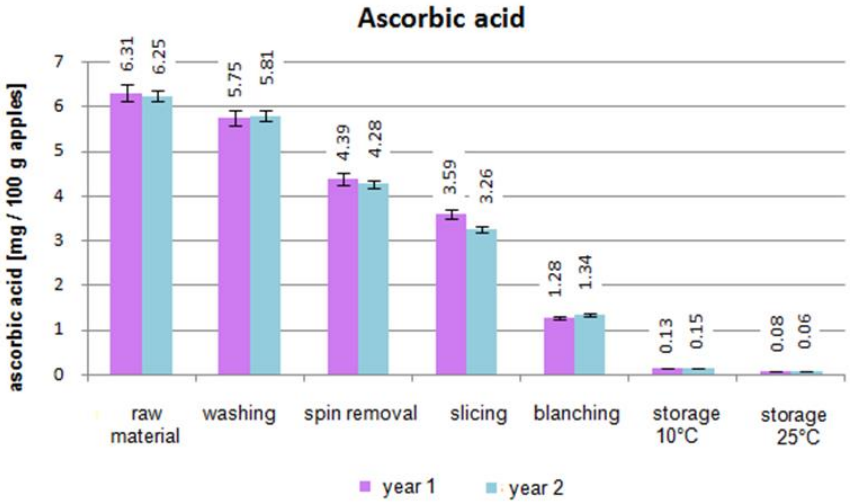


Fig. 5. Ascorbic acid content

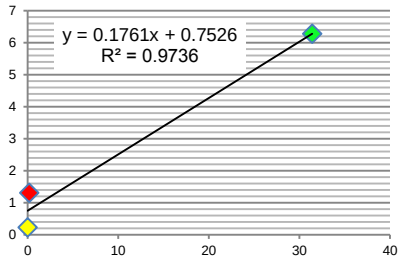
Concerning the enzymes activities, the measurements were done

afterblanching,which inevitable leads atthe inactivationof enzymes and the values were compared with the activities in raw material and final product.

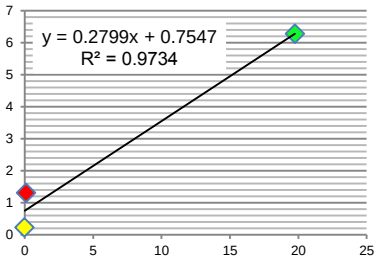
In Table 1 are presented the values of ascorbate oxidase (AOX), superoxide dismutase (SOD) and catalase (CAT) activities.As expected, the highest enzymatic activity occurs in raw material. During the technological process,all enzymes are partially inactivated by blanching and at the end of processing, the enzymes were practically inactive.

Table 1. Enzyme activity

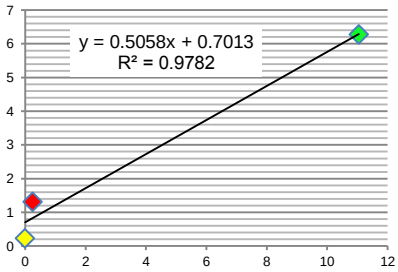
Enzyme	Year I			Year II		
	Raw material	Blanching	Final product	Raw material	Blanching	Final product
AOX [μM/g/min]	32,14	0,16	0	30,68	0,2	0
SOD [U.E./g/min]	19,14	0,11	0	20,37	0,09	0
CAT [cm^3O_2/g]	11,2	0,3	0	10,9	0,21	0



a. ascorbat oxidase – ascorbic acid



b. superoxid dismutase – ascorbic acid



c. catalase – ascorbic acid

Fig. 6.Correlations between enzymatic activities and ascorbic acid content after processing (*green - raw materials; red - blanching; yellow - the final product)*

There were no significant differences between the two years of study, so that the ascorbate oxidase and catalase recorded higher values in the first year studied and at the superoxide dismutase, compared to the second year, the values are lower.

Referring to figure 6, there is a positive correlation between the enzymatic activities and ascorbic acid content throughout the duration of the processing. The correlation coefficient is close to the value 1 (R^2 = 0.9736, R^2 = 0.9734, R^2 = 0.9782),

which means a very good correlation between the parameters analysed.

In Table 2 are presentedthe values of physico-chemical parameters. There are no major differences between the two studiedyears. The increase of acidity during blanching operation is due to the addition of citric acid, in order to prevent excessive oxidation. The soluble dry matter (SDM) is very slightly decreasing due to technological stages. The total dry matter (TDM) and the humidityregistered slight variations during processing.

Table 2. Physico-chemical parameters

Analysed sample	**Acidity** (ml NaOH /100 g apple)		**SDM** (°Bx)		**TDM** (%)		**Humidity** (%)	
	Year I	Year II	Year I	YearII	Year I	Year II	Year I	Year II
raw material	1.4	1.5	11.7	11.9	14.08	14.1	85.92	85.9
washing phase	1.4	1.5	11.5	11.8	13.99	14.11	86.01	85.89
spin removal	1.4	1.5	11.7	11.6	14.07	13.05	85.93	86.95
slicing phase	1.4	1.5	11.5	11.6	13.97	13.85	86.03	86.15
blanching phase	1.5	1.6	10.2	10.4	12.5	12.36	87.5	87.64
final product	1.5	1.6	10.3	10.4	12.29	12.18	87.71	87.82

Conclusions

The processing technology has an important influence on bioactive compounds (like ascorbic acid) and other analysed parameters.

The thermal treatmentswere severe and completely inactivatedall enzymes.

Ascorbic acid content decreased a lot, due to the contact with oxygen and metallic knives, the thermic treatmentsduring blanching and sterilization and also the storage conditions.

The commercial final product issue from this technological process is tasty and safe for consumers; the only inconvenient being the loss of ascorbic acid.

Acknowledgements

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