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# Vitamin C in Barbados cherry *Malpighia glabra L.* pulp submitted to processing and to different forms of storage

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**SUMMARY.** Ripe fruits of Barbados cherry *Malpighia glabra* L. proceeding from the fruit-growing section of Iguatemi Experimental Farm of Universidade Estadual de Maringa (PR), were triturated in a liquefier and hulled in a stainless steel sieve with 25 mesh. The bagasse (seeds and hull) was discarded and the vitamin C content was immediately determined, which was 1,79 g by 100 g of pulp. After that, the integral pulp was packed in glass flasks and submitted to the exhaustion and pasteurization processes and then hermetically closed. After the heat treatment the vitamin C content was 1,54 g by 100 g of pulp. The sealed flasks of Barbados cherry pulp, with and without the aluminum foil protection, were stored for 40 days. The first portion was kept at room temperature, the second in a refrigerator (1°C), and the third in a freezer (-18°C). The vitamin C content analysis were realized on the 5th, 10th, 15th, 20th, 30th and 40th day. For the flasks stored without the aluminum foil protection, there was a loss of 22,08%, 7,79% and 1,30% and with aluminum foil the loss was of 10,40%, 3,90% and 1,30% for the storage at room, refrigeration and freezing temperatures, respectively. The results show that freezing method is the best form of vitamin C preservation.
**Key words:** Barbados cherry, vitamin C, storage.

**RESUMEN. Vitamina C de pulpa de acerola *Malpighia glabra L.* procesada y sometida a diferentes formas de almacenamiento.** Frutas de acerola *Malpighia glabra L.* provenientes del sector de fruticultura de la Hacienda Experimental de Iguatemi de la Universidad Estatal de Maringá (PR), fueron trituradas en liquadora y separada la pulpa com tamiz de acero inoxidable de malla 25 mesh. El bagazo (cáscara y semillas) fue descartado y el contenido de vitamina C fue determinado inmediatamente, que fue de 1,79 g por 100 g de pulpa. En seguida la pulpa integral fue colocada en frascos de vidrio y estos sometidos a los procesos de vacío y pasteurización, luego cerrados herméticamente. Después del tratamiento térmico el contenido de vitamina C encontrado fue de 1,54 g por 100 g de pulpa. Los frascos cerrados, con y sin protección de hoja de alumínio, fueron almacenados por 40 días a 3 temperaturas: temperatura ambiente (22-27°C), en refrigerador a 1°C y en congelador a -18°C. Los análisis de vitamina C fueron realizados para tiempos de almacenamiento de 5; 10; 15; 20; 30 y 40 días. Para los frascos sin la protección de hoja de aluminio fue determinada una pérdida de vitamina C de 22,08%; 7,90% y 1,30%, con la protección de aluminio de 10,40%; 3,90% y 1,30% para las condiciones de temperatura ambiente, en refrigerador y en congelador, respectivamente, después de 40 días. Los resultados muestran que la vitamina C es preservada cuando los frascos son almacenados en congelador.
**Palabras clave:** Acerola, vitamina C, almacenamiento.

## INTRODUCTION

The Barbados cherry *Malpighia glabra* L. was introduced in Florida, through Cuba, as an ornamental plant. It was after 1946, that researches done in Puerto Rico and in other countries, including Brazil, confirmed its economical importance, Barbados cherry stands out for its high vitamin C content (1).

The Barbados cherry was introduced in Brazil by Universidade Federal Rural de Pernambuco in the fifties, and until today, campaigns are made in order to disseminate it throughout the country (2). Today many states like Para, Bahia, Amazonas, Sao Paulo, Parana and others are producing the Barbados cherry. Between these producing states, Parana is the one that shows the largest planted area, about 400 acre in absolute production, being followed by Sao Paulo, with 140 acre and also by the Northeastern states, with a planting area that varies from 120 to 240 acre. The Barbados cherry plantations have been receiving stimulus from executives interested in implanting unities to hull fruit. Due to that, the Barbados cherry has been offered as an alternative to the small and medium productors who might want to raise their income, taking the place of the typical products of the states (3).

The main characteristic of the Barbados cherry, which gets the attention of researchers and the economical interest of some countries, is the fact that it has a high vitamin C content, as well as other nutrients like vitamin A, calcium, sugars and other vitamins that are part of the B complex (4). The Barbados cherry juice has been used in industries in order to enrich other fruit juices, as well as for keeping canned, dried or refrigerated fruits preserved, keeping them from getting darkened. In Japan, United States and in England, the Barbados cherry is used in jams, sweets, ice-creams, ketchup and others (1).

The fruits produced in Brazil that stand out for their vitamin C content are the strawberry guava (0,33%), kiwi

(0,24%), cashew and guava (0,22%), strawberry (0,07%), pineapple and orange (0,06%), and 0,05% for lemon (5). The camu-camu, a wild berry from the Amazon region, shows approximately 5% of vitamin C in the pulp (6).

Data from the literature show significant differences in the Barbados cherry vitamin C content. The values vary from a minimum of 0,76% (7), to a maximum of 5,0% of vitamin C (1); from 2,0 to 2,3% of vitamin C in Barbados cherries produced in Ceara (8); from 0,76 to 1,4% of vitamin C for barbados cherries in different stages of maturation produced in Sao Paulo (7). Fitting and Miller (9) show that Barbados cherries produced in Mexico show 2,0% and the ones from Colombia and Venezuela show 1,1% of vitamin C. The Barbados cherries produced in Parana, in different stages of maturation called green, not fully ripe and ripe, have shown 4,9%, 3,9%, and 1,8% of vitamin C in the in natura pulp, respectively (10).

Many factors can contribute to the different vitamin C contents obtained, such as: procedence of the culture, type of plantation, period of sun exposure, stage of maturation and analytical methods used in the determinations (11). Other factors that may possibly have influenced in the differences found are: type of packing, time and kind of storage; type of soil of the culture; climate factors; and expressions used to obtain the results of the vitamin C contents, considering only the pulp or the integral fruit. Studies of the effects of trimming in the productivity of Barbados cherry *Malpighia glabra* have been made by Andrade et al. (12) in the fruit-growing section of Iguatemi Experimental Farm of Universidade Estadual de Maringa (PR).

Even though it's not big, the Barbados cherry plantation has been receiving stimulus from executives, universities, research institutes (13). As a result of this effort, nurseries appeared in the region and have been sending plants for cultivation and therefore small and medium industries have been implanted, these are processing the Barbados cherry as an integral pulp, which has been used for the production of juice, jam, sweets, ice-creams and others.

The goal of this work was to obtain data on the losses of the vitamin C content in the Barbados cherry pulp processed and stored in different conditions in a 40-day period.

## MATERIALS AND METHODS

The Barbados cherry used in this experiment proceeded from the fruit-growing section of Iguatemi Experimental Farm of Universidade Estadual de Maringa. The fruits in different stages of maturation were triturated in a liquefier and hulled in a stainless steel sieve with 25 mesh, the bagasse (seeds and hull) was discarded and the vitamin C content was immediately determined. After that, the integral pulp was packed in glass flasks with a 10mL capacity, which had been washed and sterilized previously in oven for 3 hours at 105°C.

The open flasks, containing the integral pulp were submitted to the exhaustion and pasteurization processes in water bath at 80°C, for 20 minutes. The flasks were hermetically closed and sealed after that.

The flasks that were sealed containing the integral pulp were divided in two groups: a) individual flasks with aluminum foil protection; and b) individual flasks without the aluminum foil protection. The two groups were submitted to these storage conditions: i) room temperature (22-27°C); ii) refrigeration at 1°C; and iii) freezing at -18°C. The pulps from these different storage conditions had the vitamin C content analyzed, immediately after the thermal treatment, with a 5-day break during 20 days and then every 10 days until the end of 40 days.

The weights were measured on the analytical balance, Mettler model H35AR, with 0,1mg precision and the determinations of the vitamin C contents were done weighing approximately 100 mg of pulp of Barbados cherry and adding 10 mL of sulfuric acid 20% (v/v). After homogenization, the mixture was filtered. To the filtered was added 1,00 mL of potassium iodide 0.1 $mol \cdot L^{-1}$ and 1,00 mL of 1% (p/v) starch solution. Then the solution was titrated with potassium iodate 0.01 $mol \cdot L^{-1}$ according to the method described on Normas Analiticas do Instituto Adolfo Lutz (14). The analysis were made in triplicates for three samples and the results expressed on a wet basis.

Statistical analysis of data was by analysis of variance and significant differences among treatment means were tested using Tuckey's multiple range test at the 5% probability level (15).

## RESULTS AND DISCUSSION

The vitamin C content was determined immediately after the hulling and after the thermal processing, obtaining 1,79% and 1,54% of vitamin C in the pulp, respectively, observing a 14% loss of the vitamin C content during the processing.

The heat effect on the reduction of the vitamin C levels in processed food is known. There are losses of 20% of vitamin C when the fruits are submitted to heating for 5 to 10 minutes (9). There is a reduction of 16% in the vitamin C content for the pulp of Barbados cherry submitted to a 30 minute cooking, mentioned by Visnardi et al. (16). According to Sawnke & Desai (17), losses of 2% in the vitamin C content were observed for the Barbados cherry fruits submitted to the quick pasteurization process (88°C for 45 seconds).

Table 1 shows the vitamin C content in grams for every 100 g of pulp right after processing (where the analysis result was considered as time zero in number of days) and in determinations with breaks of 5 and 10 days until completing 40 days.

TABLE 1
Vitamin C contents in the Barbados cherry pulp (g/100 g of pulp), stored in different time and storage conditions

| Storage time (Number of days) | Room temperature | | Refrigerator (1°C) | | Freezer (-18°C) | |
|---|---|---|---|---|---|---|
| | N | P | N | P | N | P |
| 0 | $1.54^{a}\pm0.02$ | $1.54^{a}\pm0.02$ | $1.54^{a}\pm0.02$ | $1.54^{a}\pm0.02$ | $1.54^{a}\pm0.02$ | $1.54^{a}\pm0.02$ |
| 5 | $1.52^{abc}\pm0.01$ | $1.53^{ab}\pm0.01$ | $1.52^{abc}\pm0.01$ | $1.53^{ab}\pm0.03$ | $1.53^{ab}\pm0.03$ | $1.54^{a}\pm0.01$ |
| 10 | $1.45^{de}\pm0.03$ | $1.53^{ab}\pm0.02$ | $1.49^{dabcd}\pm0.02$ | $1.53^{ab}\pm0.06$ | $1.53^{ab}\pm0.02$ | $1.53^{ab}\pm0.03$ |
| 15 | $1.44^{def}\pm0.04$ | $1.46^{de}\pm0.01$ | $1.48^{bcd}\pm0.03$ | $1.52^{abc}\pm0.04$ | $1.53^{ab}\pm0.02$ | $1.53^{ab}\pm0.02$ |
| 20 | $1.39^{fg}\pm0.03$ | $1.42^{efg}\pm0.01$ | $1.47c^{de}\pm0.02$ | $1.52^{abc}\pm0.03$ | $1.53^{ab}\pm0.02$ | $1.53^{ab}\pm0.02$ |
| 30 | $1.29^{h}\pm0.04$ | $1.39^{fg}\pm0.02$ | $1.46^{de}\pm0.01$ | $1.49^{abcd}\pm0.02$ | $1.53^{ab}\pm0.02$ | $1.52^{abc}\pm0.01$ |
| 40 | $1.20^{i}\pm0.03$ | $1.38^{g}\pm0.02$ | $1.42^{efg}\pm0.04$ | $1.48^{bcd}\pm0.01$ | $1.52^{abc}\pm0.01$ | $1.52^{abc}\pm0.01$ |

N = samples stored without the aluminum foil protection; P = samples stored with the aluminum foil protection; results of triplicate analysis in three samples, expressed in wet basis. Means containning a common superscript are not significantly different (P > .05).

The losses of vitamin C levels in the samples were made in percentages, considering 100% of vitamin C for time (number of days) equal to zero and subtracting the vitamin C percentage left after the 40-day period.

After 40 days, the losses of vitamin C were of 22,08% and 10,40%; 7,79% and 3,90%; 1,30% and 1,30% for the room, refrigeration and freezing temperatures, respectively, with and without the aluminum foil protection, showing that freezing is the best way to preserve the vitamin C, followed by refrigeration.

Researchers have shown that vitamin C degradation depends on the combination of time and storage temperature. According to Visnardi et al. (15), significant losses of the vitamin C content were not observed in the Barbados cherry pulp without the thermal treatment, when stored in polyethylene bags for a 30-day period in a freezer, and a decrease of 50% for those stored in a refrigerator. According to Shawnke & Desai (16), losses of vitamin C in Barbados cherry juice submitted to the quick pasteurization (88°C for 45 seconds) vary from 53,3% to 81,5% when stored at room temperature for a 1-year period and more then 20% when stored at 7°C for the same period of time.

At the end of 40 days, significant differences in the vitamin C content were observed for the samples stored without and with the aluminum foil protection, for the room and refrigerated temperatures. For the frozen samples this difference was not observed. The samples stored at room temperature at the end of 40 days showed losses of 22.08% (without protection) and 10,40% (with protection), showing a bigger retention of the vitamin C levels for those protected with aluminum foil.

The samples stored in refrigeration showed losses of 7,79% and 3,90% of vitamin C levels, for the samples that were not protected, and for the protected ones, respectively; showing a bigger conservation of vitamin C, for those protected by aluminum foil. Cruz et al. (7), working with the integral green Barbados cherry stored in freezer, observed losses of 15,90% of vitamin C in integral fruits in aluminum foil and 89% in glass flasks after 10 days. Even though the experiments are different, considering the processing and temperature of storage, in both it is proved that packets protected from light show bigger preservation of vitamin C, and the exhaustion and pasteurization processes used in this experiment, probably contributed for the denaturation of oxydases enzymes, in the reduction of the oxygen levels in the samples, so that there was a smaller loss of vitamin C content.

For the samples submitted to freezing, there were vitamin C losses of 1,30% at the end of 40 days, significant differences between the storage conditions did not occur (with and without aluminum foil protection). These losses were always lower then the ones submitted to room and refrigerating temperatures.

Researches developed by Cruz et al. (7), with integral Barbados cherry submitted to freezing, packed in aluminum foil and glass flasks, showed a significant decrease in the vitamin C content until the 10th day of storage. After this period, the amount of vitamin C in the fruits kept in aluminum foil was stable, while the amount of those in glass, showed a progressive degradation process of the vitamin C. A less accentuate decrease was observed in our experiments.

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