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EVOLUTION OF VITAMIN C AND ANTHOCIANS CONTENT IN FRESH AND PROCESSED BLACKCURRANT FRUITS

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ABSTRACT

In a healthy diet, fruits are a valuable component and blackcurrants are excellent sources of biocompounds with beneficial properties. These have seen an expansion of organic and conventionally cultivated areas, being highly appreciated for the nutritional and therapeutic value of their fruits. Their consumption supports the immune system, protecting the body against infections. Considering the fact that their availability is only for short periods of time, processing in various forms becomes necessary and of real interest for consumers who can thus benefit from their nutritional qualities and antioxidant potential. The heat treatment applied to obtain the derived products can influence the quantity and stability of these compounds, therefore this paper presents their evolution. Thus, compounds with antioxidant properties (vitamin C and anthocyanins) were analyzed from the processed products in the form of compote, jam and syrup as well as the fresh fruits from which they were obtained. Within the processed products, compote preserves the highest level of vitamin C value and jam preserves that of anthocyanins. The results indicated considerable levels of compounds with valuable properties: vitamin C with values ranging between 50.66 – 173.45 mg/100g and anthocyanins 153.24 - 236.51 mg/100g, which reinforces the fact that blackcurrant is a valuable fruit and can be used as a functional food ingredient in order to expand the range of processed products.

KEYWORDS: anthocyanins, blackcurrant, processing, vitamin C.

INTRODUCTION

Blackcurrants (*Ribes nigrum* L.) are native to Central, Northern Europe and North Asia. In the last decade in Europe they have seen an expansion of organically or conventionally cultivated areas, being highly appreciated for the nutritional and therapeutic value of their fruits (Gopalan et al., 2012; Djordjević et al., 2013). Their consumption supports the immune system and protects the body against infections. In addition to anti-inflammatory and antioxidant effects, they protect cells against oxidative stress, thus reducing the risk of chronic diseases. In vitro research on blackcurrant preparations has shown that fruit juices and extracts significantly reduce the proliferation of prostate, stomach, intestinal and colon cancer cells, as well as breast cancer (Ejaz et al., 2023). All these benefits are attributed to the high levels of ascorbic acid (vitamin C) along with other antioxidants and acids (Paraschiv and Petrescu, 2024). The ratio of these biocompounds to sugars, the slightly sour taste and the special aroma make them highly appreciated among other fruits, becoming a sought-after ingredient in the food industry (Milivojevi et al., 2009). In addition, blackcurrant fruit residues (such as those from juice production) can be used as natural dyes or as a source of biologically active compounds for the manufacture of various healthy food products (Ejaz et al., 2023). Whether consumed fresh or processed into various products such as juice, jam, dried fruit (Lipińska et al., 2014) or jellies, sauces, desserts, blackcurrants add a distinctive note and a vibrant color, enhancing the taste and visual appeal of various products.

Like many other purple fruits, currants contain anthocyanins, present in significant quantities (Lakshmikanthan et al., 2024; Paraschiv and Petrescu, 2024). These compounds, plant metabolites, are of interest both due to their attractive color and their antioxidant power (De Rosso and Mercadante, 2007; Ejaz et al., 2023). Furthermore, foods rich in anthocyanins are considered potentially functional foods (Khoo et al., 2017).

The color stability and the content of bioactive compounds during fruit processing, in order to obtain products with an extended shelf life, can undergo changes, being influenced by several factors: temperature, processing time, pH, oxygen (Garcia-Viguera et al., 1998). Anthocyanins and vitamin C, from the perspective of the benefits they bring to the body, are analyzed in this paper and their evolution in processed products made in the form of compote, jam and syrup is presented.

MATERIALS AND METHODS

The blackcurrant fruits were provided by the Institute of Research-Development for Fruit Trees Cultivation, Pitesti - Maracineni, Arges County and the processing in the form of compote, jam and syrup (Figure 1.) was carried out at the Institute of Research - Development for Processing and Marketing of Horticultural Products - "*Horting*", Bucharest. The compote was obtained naturally, according to a classic recipe, as a fruit base in sugar syrup, with the addition of lemon juice. The jam was obtained from fresh fruit with the addition of sugar and lemon juice, resulting in a concentrated gelled product. The syrup was obtained by boiling the fruit in water, followed by squeezing and concentrating it with sugar, obtaining a viscous, uniform and clear liquid. Of all the products, the compote had the shortest thermal processing time and the syrup the longest.

All the preserves were packed in hermetically sealed and pasteurized containers.

A) b) c)

Figure 1. Processed products: a) compote b) jam c) syrup.

Vitamin C was determined by spectro-photometric method, using 2,6-dichlorophenol, indophenol after xylene extraction for obtaining the amount of ascorbic acid existing in vegetable and fruit products, according to the STAS SR ISO 6557. Total anthocyanin content (TAC) was determined using the differential pH method (Lee at al., 2009). To the values obtained at the above determinations, the confidence interval (95%) and the standard error were calculated. The analysis of the means within the two groups was performed within the one-way ANOVA analysis.

RESULTS AND DISCUSSIONS

The availability of fresh fruits throughout the year is limited, therefore it is necessary to process them in forms that ensure the preservation of valuable nutrients and the preservation of perishable material in stable products for a longer period of time.

The vitamin C content of the samples taken in the study ranged between 50.66 -173.45 mg/100g, where the minimum was recorded in syrup and the maximum in fresh fruit.

Table 1: The content of vitamin C and anthocyanins.

Samples	Vitamin C (mg/100 g)	Anthocyanins (mg/100 g)
Fruits	173.45	236.51
Compote	62.82	153.24
Jam	55.85	176.22
Syrup	50.66	162.28
Average	85.69	182.06
Std.error	29.37	18.76

Comparing the values obtained for vitamin C and anthocyanins by analyzing the means of the two groups in one-way ANOVA, the value $F = 7.67 > 5.99$ (critical value for $\alpha = 0.05$) was obtained, which results in the difference between the means being statistically significant. For all the samples analyzed, it was found that the content of anthocyanins is higher than that of vitamin C (Table 1). The value of 173.45 mg/100g (Table 1) for fresh blackcurrant fruit is similar to that found in the study conducted by Nour et. al (2011), which obtained values ranging from 161.6 to 284.5 mg/100 g fresh fruit for eight blackcurrant varieties grown in Romania. High values for vitamin C were also indicated by Netcu et al. (2021) who mentioned that blackcurrants have a high vitamin content, being three times higher than in oranges, and Rachtan-Janicka et al. (2021) emphasized that only rose hips exceed blackcurrants in vitamin C content. Differences between the amounts of vitamin C, according to reports by Ňorbová et al., (2023), can occur within the same species depending on the variety, the climatic conditions in which the crops were grown and the stage of maturity at fruit harvest. The values obtained for compote, jam and syrup for vitamin C were: 62.82 mg/100g, 55.85 mg/100g and 50.66 mg/100g, being relatively close to each other but lower compared to fresh fruit. The amount of vitamin C in the three determinations was different and lower than in the case of anthocyanins. This is mainly due to factors that influence the production process and are able to decrease certain components for processed products. Most conventional thermal technologies cause a reduction of bioactive compounds present in berries (Marszałek et al., 2015).

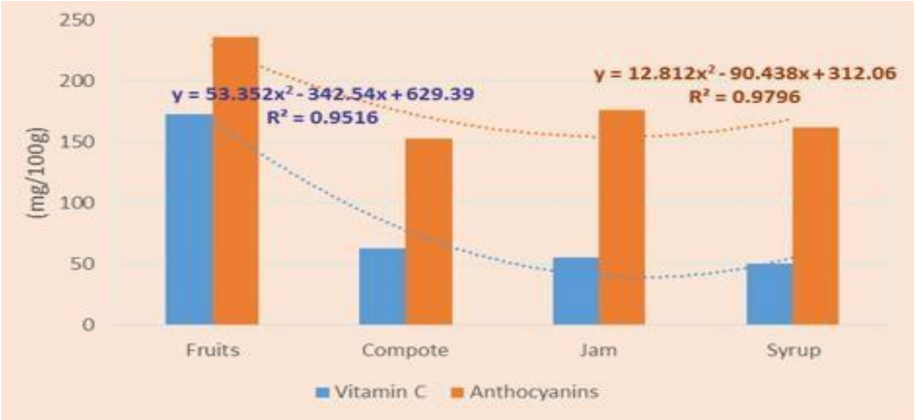

Figure 2. Evolution of vitamin C and anthocyanin content after processing.

Figure 2. indicates for vitamin C a strong correlation between fruit processing and its loss, wich reinforces the fact that it is very sensitive to thermal processing and losses are significant. In blackcurrants, the losses recorded after processing were 68% for jam, 71% for syrup and 64% for compote. These values are lower than in the study conducted by Veliković et al. (2019) which for strawberry jam recorded a loss of 91% and 78% for strawberry syrup. The study conducted by Poiana et al., (2011) where after the manufacturing process of jam with reduced sugar content, a loss of vitamin C of 78% was recorded in the case of strawberries, 70% for sour cherries and 54% for cherries. Also in the case of jam preparation, Aquilera (2024) reported losses of ascorbic acid between 33-57%.

In the case of blackcurrants, maintaining vitamin C values at higher levels would be due to the presence of organic substances from the anthocyanins and polyphenols group, which inhibit oxidation processes, making the vitamin in blackcurrant fruits more stable, both thermally and to oxidation (Netcu et al., 2021; Paraschiv and Petrescu, 2024).

In the study, Frei et al. (2012) mentioned that dietary supplementation with vitamin C reduced arterial hypertension, chronic inflammation and Helicobacter pylori infection. It acts as a natural antioxidant by reducing levels of oxidative stress, thus contributing to the prevention of diseases caused by these imbalances. They also concluded that 200 mg of vitamin C per day is the optimal dietary intake for most adults to achieve a beneficial effect on health.

Anthocyanins represent the most important group of flavonoids contained in blackcurrants, being influenced by the variety and cultivation conditions. They are valuable due to the beneficial effects they exhibit: antioxidant, anti-inflammatory, anticarcinogenic, improving visual acuity, chelating metals and reducing lipid oxidation (Rachtan-Janicka et al., 2021). Although estimating the daily intake of anthocyanins is difficult due to incomplete data on their amounts in foods, Lakshmikanthan et al. (2024) mentioned in their work that China recommends a daily intake of 50 mg and the USA about 12.5 mg/day. For Europe it varies between 19 and 65 mg/day for men and 18-44 mg/day for women and in Finland, it could reach up to 150 mg/day, mainly from the consumption of berries.

The anthocyanin content for fresh fruits found in this work was 236.51 mg/100g. Our results are higher than the data provided by Rachtan-Janicka et al. (2021) who reported a content between 101.24-138.22 mg/100 g, but fall within the values of 166.86-298.22 mg/100g provided by Petrisor et al. (2013) and 160 - 411 mg/100 g mentioned by Ejaz et al. (2023).

In blackcurrants, the losses recorded after processing were 25% jam, 31% syrup and 35% compote, lower compared to those recorded by Marszałek et al. (2015) who in the study on thermal pasteurization at 92 °C, 15 min on strawberry puree decreased the anthocyanin content by approximately 43% compared to the control sample. One explanation would be that, if the acidity is increased, as is the case in blackcurrants, the stability of anthocyanins in processed products is improved. The interaction with metals and the formation of stable complexes with tin, copper and iron would be due to the intermolecular copigmentation phenomenon that occurs (De Rosso and Mercadante, 2007; Horbovicz et al., 2008).

The mechanisms of transformation are not fully understood, but there is evidence of the involvement of sugars, ascorbic acid and metal ions (Poiana et al., 2011). The effect of added sugar on the stability of anthocyanins depends on the structure, concentration and type of sugar. When the sucrose concentration increased by 20%, the stability of anthocyanins in strawberries also increased.

On the other hand, at a low sucrose concentration (86 g/L), the degradation of anthocyanins from red cabbage, blackcurrant and elderberry extracts was higher in soft drinks compared to buffer systems, both at pH 3, while the opposite was observed for grape extract (De Rosso and Mercadante, 2007). The mechanism could be associated with the inhibition of phenoloxidase and peroxidase enzymatic activities (Delgado-Vargas and Paredes-López 2003).

CONCLUSIONS

- Blackcurrant in fresh and processed form has a significant vitamin C and anthocyanin content, therefore it is a rich source of substances with beneficial health properties.
- Jam, compote and syrup contain an important part of anthocyanins.
- Within the processed products, compote preserves the highest level of vitamin C value and jam preserves that of anthocyanins.
- Vitamin C registers a higher percentage loss compared to anthocyanins in processed products, under the conditions of heat treatment applied through technological processes.
- The results obtained qualify blackcurrant as a valuable species from which products with nutraceutical value can be made.

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