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Effect of Thermal Pasteurization on Phytochemical Characteristics and Antioxidant Capacity of Orange Juice

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Abstract

The aim of the study was to evaluate the effects of thermal pasteurization at (90°C, 1mn) on physicochemical characteristics and antioxidant capacity (DPPH method) of orange juice (*Citrus sinensis L, Thompson* variety). Results showed (TS, pH, total acidity, total reducing sugar and enzymatic browning index) did not change after thermal processing, whereas vitamin C and antioxidant activity (0.41± 0.01g/l and 61.53%) decreased no significantly ($P \leq 0.05$) in comparison with the treated juice (0.34± 0.06 g/l and 58.9%) respectively, Such information would be helpful for establishing appropriate processing to minimize the degradation of vitamin C and antioxidant compounds

Keywords: Orange juice; Heat treatment; Antioxidant activity; physicochemical parameters

1. Introduction

Orange juice is the most consumed juice in the world, corresponding to 47% worldwide juice consumption [1]. It is an important source of bioactive compounds in diet, like flavonoids and carotenoids, as well as ascorbic acid. Ascorbic acid is the major antioxidant compound in orange juice, contributing with more than 90% of the antioxidant activity [2]. Orange juice flavanones, mainly hesperidin and narirutin, also present antioxidant activity [3], while carotenoids [4], mostly carotenes and cryptoxanthin, have provitamin A activity, and lutein and zeaxanthin, prevent macular degeneration [5]. Orange juice flavanones have been associated with reduced risk of coronary heart disease [6,7]. Several studies show a reduced risk of cardiovascular diseases is associated with a higher intake of vitamin C from either diet or supplements [8]. In cancer patients' intravenous pharmacological doses of vitamin C are normally well tolerated. In addition, vitamin C is also known to be vital for many biological processes such as in absorption of inorganic iron, inhibition of nitrosamine formation, collagen synthesis, reduction of plasma cholesterol level, enhancement of the immune system [9].

The antioxidant capacity of orange juice makes it beneficial for health [10]. Same studies show that the antioxidant capacity of citric fruit is due to ascorbic acid and phenolic compounds, but there is disagreement over which compounds contribute most [11].

During heat treatment, in addition to inactivation of microorganisms, varying percentages of desirable constituent, such as color, pH, viscosity, total acidity and nutritional value of food products [12].

Pasteurization is a mild heat treatment which produces minimal losses of organoleptic characteristics and nutritional value. There are two main groups of pasteurization technologies, those that use low temperatures (60 to 65°C) for fairly long times and those that use higher temperatures (75 to 99°C) for short times. Fruit and vegetable juices are currently subjected to temperatures in the range (90 to 99°C) for 15 to 60 seconds and heat filled aseptically [13].

Heating at high temperature has been reported to cause flavonoid glycosides to change into other forms subsequently reducing antioxidant activity [14].

The consumption of foods rich in antioxidant compounds may contribute to the prevention of oxidative stress situations. Knowledge about the concentrations of these compounds in foods or their total antioxidant power may contribute to a better diet and a decrease in chronic diseases. In recent year, there has been considerable advances in the study of the properties of free radical acceptors and the estimation of the antioxidant power of various substances, such as vitamin C. The aim of our study was to investigate effects of pasteurization on physic-chemical and bioactive properties of orange juice.

2. Materials and Methods

2.1. Extraction of orange juice

Fresh orange (*Citrus sinensis*, *Thompson* variety) procured from local market of Mascara city of Algeria in March 2018. The spice was authenticated by Dr Boualem Sid Ahmed[1]. Orange was identified as Thomson variety, were washed under running water. After removal of skin, seeds are separated and juice extracted using juice extractor (Samsung model). The juice was then filtered through cheese cloth.

2.2. Thermal pasteurization treatment

Orange juice was heat-pasteurized at (90°C, 1 min) using thermostatic water bath, after treatment, the juice was stored (4 ± 2°C) until analysis, which is realized in the same day.

2.3. Analytical parameters

TS was measured by Abbe refractometer; pH was determined by pH meter. Total acidity of the sample was measured by titration method of juice against 0.1 N sodium hydroxide using phenolphthalein as indicator. reducing sugar was estimated by DNS method [15]. Vitamin C was determined by titrimetric method using 2,6-dichorophenol indophenol and the value expressed as gm of ascorbic acid / ml juice [16]. Non-enzymatic browning (NEB) was determined by measuring optical density (OD) values of methanol extracted juice samples at 440 nm in UV-VIS Spectrophotometer [17].

2.4. Antioxidant capacity

The antioxidant activity of orange juice was studied through the evaluation of the free radical scavenging effect on 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical. From the methodological point of view, the widespread use of the stable DPPH radical-scavenging model is recommended as easy and accurate, with regard to measuring the antioxidant activity of fruit and vegetable juices or extracts.

The determination was based on the method proposed by De Ancos *et al.* [18].

This analysis was carried out employing a reaction mixture of aliquots (0.010 ml) of the supernatant of samples of orange centrifuged at 6000 g for 15 min at 4°C, 3.9 ml of methanolic DPPH (0.025 g/l) and 0.090 ml of distilled water. The samples were shaken vigorously and kept in darkness for 30 mn. The absorption of the samples was measured on a Spectro photometer at 515 nm against a blank of methanol without DPPH.

2.5. Statistical analysis

Experiments were performed in triplicate. Data reported are the mean and standard deviation values calculated from the replicates. The results were analyzed using the variance (ANOVA). Differences ($P \leq 0.05$) were considered to be significant.

3. Results and discussion

3.1. Parameters

Physicochemical characteristics of the orange juice were evaluated in normal juice and those heated at (90°C, 1 mn) and the results are presented in table 1. For both juice types, the parameters of physicochemical

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characteristics (TS, pH, vitamin C, reducing sugar and enzymatic browning index) of the treated juice were not significantly different from those of fresh, untreated juice, except the enzymatic browning and vitamin C concentration. Similar results were found by Kim and Tadini [19], who showed that temperature had no effect on TS, pH, total acidity, reducing sugar of pasteurized juice.

The vitamin C concentration in the heated juice (0.41 ± 2.1 g/l) decreased no significantly ($P \leq 0.05$) in comparison with the fresh juice (0.34 ± 1.6 g/l), whereas the non-enzymatic browning index (0.022 ± 0.3), which was found to be increased (0.037 ± 0.3). The results showed that the degradation of vitamin C after thermal processing was less than 18%. These results indicate that after heat treatment, the retention of vitamin C was 83%. In contrast, Bull *et al.* [20] did not find significant differences in vitamin C content between pasteurized juice (65°C, 1 min), and fresh juice.

Vitamin C was used as reference in different industrial processes since its presence ensures a high nutritional quality of the final product due to its easy degradation [21].

These quality parameters are important as they are closely related with the stability of the bioactive compounds in fruit products [22].

One of the most important problems in citrus juice quality is the vitamin C reduction during heat treatment [23].

In addition, Gregory [24] reported that the degradation of vitamin C seems to be influenced by many compounds which are involved in the oxidation reaction of vitamin C.

3.2. Antioxidant capacity

Antioxidant activity of orange juice were measured as free radical-scavenging capacity in a DPPH model. Fresh untreated orange juice exhibited 61.53% inhibition of DPPH (Table 1). Whereas Antioxidant activity of thermal-treated orange juice (90°C, 1mn) was 58.9% inhibition of DPPH.

Antioxidant capacity decreased no significantly ($p \leq 0.05$) after processing (decrease of 4.27% after treatment).

S´anchez-moreno [25] found that the total antioxidant activity (DPPH) of orange juice treated by mild pasteurization (70°C, 30 s) did not undergo significant changes, whereas pasteurization (90°C, 1 min) produced a decrease. Similarly, Polydera *et al.* [26] observed a greater decrease in total antioxidant activity in heated orange juice (80°C, 60 s).

Table 1
Analytical characteristics of fresh orange juice and treated juice

Physico-Chemical Parameters	Untreated Orange Juice	Treated Orange Juice
Soluble solids (Brix)	11.20 ± 0.40	10.98 ± 0.30
Total acidity (meq/100 ml)	14.80 ± 0.08	13.85 ± 0.05
pH	3.78 ± 0.06	3.64 ± 0.04
Reducing sugar (g/100ml)	11.52 ± 0.12	11.12 ± 0.15
Vitamin C (g/1000 ml)	0.41 ± 0.01	0.34 ± 0.06
Enzymatic browning index	0.022 ± 0.30	0.037± 0.20
Antioxidant activity (% inhibition DPPH)	61.53 ± 1.50	58.90 ± 1.40

Results are the means ± SD of three measurements

In general, the obtained results are comparable to those observed for citrus juices by other authors [21,27].

In this case, the total antioxidant activity seems to be more related to vitamin concentration. Similarly, S´anchez-moreno et *al* [25], and Polydera et *al.* [26] reported that vitamin C was the compound with the highest antioxidant activity in various orange juices. However, Elez-Martinez and Martin-Belloso [28] did not find a relationship with vitamin c content in orange juice treated. They indicated that this might be due to the stability of other antioxidant compounds.

4. Conclusion

The study revealed that the total vitamin C decrease after heat treatment at 90°C for 1 mn. The antioxidant activity of juice orange also decreases of heat processing. Such information would be helpful for establishing appropriate processing to minimize the degradation of vitamin C and antioxidant compounds.

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