Effects of high-pressure carbon dioxide processing on the physical-chemical properties of inulin-enriched apple juice

Matheus A. Bargas, Eric Keven Silva, M. Angela A. Meireles

Abstract

In this work the effects of supercritical carbon dioxide (SC-CO₂) were evaluated on the physical properties of apple juice added with inulin, a prebiotic carbohydrate. The functional beverage was characterized with respect to pH, soluble solids content (SSC), zeta potential (ZP), particle size distribution (PSD) and rheological behavior.

Key words: *Emerging technology, high-pressure carbon dioxide, inulin.*

Introduction

The study of new non-thermal processes of pasteurization of food products is a subject that has gained prominence in recent years, mainly due to the increase in the demand for the consumer market for functional products. In this sense, the enrichment of apple juice with inulin, followed by the pasteurization of the beverage with SC-CO₂, represents the development of an innovative new product that meets fully the new demands of the consumer market.

The conventional thermal-pasteurization promotes the degradation of the thermosensitive compounds responsible for nutritional quality in fruit juices used as a basis in the formulation of functional beverages. In addition, the use of thermal pasteurizing processes is associated with the modification of the sensorial characteristics of the products due to the cooking process during the application of the heat treatment, thus reducing the added-value of the product.

Furthermore, the use of supercritical fluid technology, in particular SC-CO₂, viable a non-thermal solution for food pasteurization. The use of SC-CO₂ at high-pressure has been evaluated as an efficient method to inactivate bacteria, viruses and yeast, besides enzyme inactivation¹. However, the effects of high-pressure carbon dioxide on the physico-chemical properties of the beverages is not yet fully elucidated by the researches carried out to date.

In this context, the aim of this work was to evaluate the effects of supercritical technology using SC-CO₂ (10, 15 and 20 MPa/35°C/10 min) as a non-thermal process for the inulin-enriched apple juice focusing the physical-chemical characteristics.

Results and Discussion

The results presented in the Table 1 for pH, SSC, ZP and viscosity show that CO₂ pressure did not have effect on the physical-chemical properties of the functional apple juice (p-value < 0.01).

Table 1. Physical-chemical characterization.

Process	SSC (°Brix)	pH (-)	D ₄₃ (µm)	ZP (mV)	Viscosity (mPa.s)
Control	15.3 ± 0.2 a	3.43 ± 0.05 a	28 ± 1 a	- 6.3 ± 0.5 a	1.45 ± 0.04 a
10 MPa	15.2 ± 0.1 a	3.3 ± 0.1 a	9.5 ± 0.2 b	- 5 ± 1 a	1.433 ± 0.002 a
15 MPa	15.2 ± 0.1 a	3.3 ± 0.1 a	7.6 ± 0.1 c	- 8 ± 2 a	1.45 ± 0.02 a
20 MPa	15.3 ± 0.1 a	3.3 ± 0.1 a	5.6 ± 0.8 d	- 8 ± 2 a	1.42 ± 0.01 a

The results are presented as the mean ± standard deviation. The letters a-d represent a significant difference at level of 1%.

However, it was possible to realize that the increase of CO₂ pressure led to a decrease in the mean particle diameter values (Figure 1). The changes observed on PSD of the SC-CO₂-treated beverages is due to the homogenization effect promoted by high-pressure carbon dioxide. The microstructure of the apple juice, mainly related to the cellular material, when submitted to high pressures, undergoes a process of rupture due to the tension applied to the product.

Figure 1. Particle size distribution in volume (%)

Conclusions

The treatment of inulin-enriched apple juice with high-pressure carbon dioxide did not change the physicochemical properties of the beverages such as pH, SSC, ZP and viscosity. The processing of the beverage with SC-CO₂ resulted in a juice with a lower particle diameter. Overall, our findings demonstrate the potential of using SC-CO₂ along the fruit juices processing.

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¹Amaral, G. V.; Silva, E. K.; Cavalcanti, R. N.; Cappato, L. P.; Guimaraes, J. T.; Alvarenga, V. O.; Esmerino, E. A.; Portela, J. B.; Sant' Ana, A. S.; Freitas, M. Q.; Silva, M. C.; Raices, R. S. L.; Meireles, M. A. A.; Cruz, A. G., Dairy processing using supercritical carbon dioxide technology: Theoretical fundamentals, quality and safety aspects. *Trends in Food Science & Technology* **2017**, 64, 94-101.

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