DOI: 10.20396/revpibic.

Effects of high-intensity ultrasound processing on the physicochemical properties and microbial inactivation of apple juice enriched with gallic acid

Arthur F. Dias*, Maria Isabel L. Neves, Renata Vardanega, M. Angela A. Meireles, Eric Keven Silva

Abstract

The aim of this study was to evaluate the influence of high-intensity ultrasound (HIUS) specific energy on the microbial inactivation and physicochemical properties of gallic acid enriched-apple juice. The beverage was enriched with 0.1 g gallic acid per100 g apple juice. The treatments were performed using two HIUS processes, low power and long time (LPLT) and high power and short time (HPST); both operating at the same specific energy levels (1, 3, 5, and 7 kJ/g). The most effective aerobic mesophilic heterotrophic bacteria (AMHB) inactivation was obtained by using the HPST process at the specific energies of 5 and 7 kJ/g, which of them resulted in the same log reduction of 3.14. Physicochemical properties, such as pH, soluble solids content, zeta potential, and color difference (ΔE) were not influenced by the HIUS processes or specific energy levels. The gallic acid content also was preserved in all HIUS treatments.

Key words:

Emerging technology, phenolic compound, functional beverage.

Introduction

The development of functional beverages is a new trend in the food product market. Modern consumers are interested in food products with functional properties able to promote health and well-being. In this sense, the enrichment of fruit juices with phenolic compounds such as gallic acid is an interesting alternative in this market sector. Gallic acid is a strong antioxidant and an efficient apoptosis-inducing agent (anticancer property). In addition, the use of emerging technologies such as high-intensity ultrasound (HIUS) can be a promising alternative to conventional thermal treatment. Several studies have reported many drawbacks associated with thermal processing. Thermally treated food products have present nutritional properties and sensory acceptability lower than non-processed products. Therefore, the processing using HIUS technology can be a non-thermal feasible alternative for these products. Thus, the aim of this study was to evaluate the influence of HIUS specific energy on the microbial inactivation and physicochemical properties of apple juice enriched with gallic acid (0.1 g gallic acid/ 100 g apple juice). The treatments were performed using two HIUS processes, low power and long time (LPLT) and high power and short time (HPST); both operating at the same specific energy levels (1, 3, 5, and 7 kJ/g).

Results and Discussion

For the LPLT process using a nominal power of 100 W, the processing times were 5, 15, 25 and 35 min; and for the HPST process using 475 W, were 1.05, 3.15, 5.25, and 7.37 min. The higher AMHB inactivation was obtained with the HPST process employing specific energies of 5 and 7 kJ/g. These processes conditions had the same log reduction of 3.14. LPLT process was not able to promote the AMHB inactivation. The HIUS microbial inactivation effects are associated with acoustic cavitation. In the HPST process, the input energy rate is higher than in the LPLT process, therefore, the acoustic cavitation is more intense, which results in a higher inactivation efficiency. Table 1 presents the results of the physicochemical characterization of the samples after HIUS treatment. Physicochemical properties such as pH, soluble solids content, zeta potential, and color difference (ΔE) were not influenced by the HIUS processes or specific energy levels (p-value > 0.05). The parameter ΔE indicate the overall difference of each treatment in comparison to unprocessed sample. The low values observed for color difference based on ΔE (<1.65) indicate that the changes in primary color in this case were indiscernible to the human eye. In addition, the gallic acid content also was preserved in all samples. HIUS processing did not promote the chemical degradation of this bioactive compound.

Table 1. Physicochemical properties of gallic acid-enriched apple juice.

HIUS Process	Specific Energy (kJ/g)	pH	SSC (Brix°)	Zeta potential (mV)	Color (ΔE)
LPLT	1	3,75±0,04	21,00±0,28	-9,71±3,64	1,64
	3	3,73±0,01	21,2±0,14	-10,73±3,49	0,33
	5	3,72±0,01	21,3±0,14	-11,79±3,27	1,27
	7	3,76±0,04	21,2±0,14	-11,76±3,12	1,49
HPST	1	3,73±0,01	21,10±0,14	-15,98±3,79	0,95
	3	3,75±0,02	21,25±0,07	-15,05±2,76	0,98
	5	3,73±0,01	21,30±0,28	-10,68±1,25	0,86
	7	3,73±0,01	20,95±0,21	-13,63±4,77	0,54

Conclusions

This study has demonstrated that HIUS technology, from the technological point of view, is a promising alternative for the stabilization of functional beverages and also for the preservation of added gallic acid. The HPST process at higher energy density levels was able to inactivate the aerobic mesophilic heterotrophic bacteria without to promote physicochemical changes in the gallic acid-enriched apple juice.

Acknowledgement

Arthur F. Dias thanks CNPq. Maria Isabel L. Neves and Renata Vardanega thank CAPES (Financial Code - 001). M. Angela A. Meireles thanks CNPq (302423/2015-0). Eric Keven Silva thanks FAPESP (2015/22226-6).