

# **Estudio del proceso de obtención de zumo de arándanos y su utilización como ingrediente para la obtención de un alimento funcional por impregnación a vacío**

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*Tesis doctoral*

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## Abstract

The doctoral thesis presented is conceived by the need to find alternatives to industrializing the surplus production of blueberries in the region of Entre Rios (Argentina). Improvements for the depectinization operation are proposed and it is evaluated with inclusion of a high pressure homogenization treatment in the flow chart of blueberry juice production. This also constitutes the framework to carry out technological development of fruit snacks that include blueberry juice as an ingredient in order to benefit from its bioactive compounds.

First, the blueberry beverage market in Concordia (Argentina) and in Valencia (Spain) was analyzed. Eight beverages including blueberry juice and four with cranberry juice were found. The twelve samples were characterized from the market point of view taking into account the type of beverage, manufacturer, ingredients, nutrition claims, package, price and selling point. The beverages elaborated with blueberry juice were also physicochemically and functionally analyzed. The results revealed that commercial blueberry beverages are poorly standardized, of variable composition and in some cases not clearly defined. Regarding the beverage functional quality, HPLC analysis showed that drinks from the Argentine market did not contain anthocyanins. This revealed poor manufacturing processes that use high temperature conditions and promote oxidation phenomena causing significant losses of functional compounds.

Considering the content of monomeric anthocyanins and total phenolics in blueberry juice are primarily responsible for its beneficial effects on health, a study of the process of blueberry juice manufacturing in order to obtain a product with a high content of bioactive compounds was carried out. In this sense, it was established that enzymatic depectinization is a critical operation. Depectinization was studied in terms of enzyme source, temperature and duration of the treatment required to obtain a product with high content of bioactive compounds. First, it was analyzed the depectinization with two commercial enzymatic packs, Viscozyme L® y Rapidase ex color®, at 50 and 60°C during 60 and 150 minutes. The juice obtained in each case was characterized in terms of physicochemical and functional properties. The results indicated that the best conditions of processing were: 50°C, 150 minutes with Viscozyme L® pack.

Additionally, in this process step the possibility to introduce an improvement using as source of pectinolytic enzymes, yeasts with high endopolygalacturonase activity was evaluated. These yeasts were obtained by a novel technique of genetic modification called genomic evolution by molecular design. Firstly, the enzymatic activity of yeast extracts from the parental strain and three of his transformants was determined qualitatively and quantitatively. After that, the most active extract was selected and applied in depectinization of blueberry juice. While the results indicate the need to study the dosage of yeast extract to obtain a product with suitable rheological properties, from the functional point of view it was observed a lower polymerization of anthocyanins and a higher content of total phenolics. Furthermore, from an industrial point of

view, the use of these enzymes represents significant energy savings because the depectinization is performed at room temperature.

Moreover, it was determined the effect of the incorporation of a high pressure homogenization step in the process of manufacturing blueberry juice. Four levels of pressure (25, 50, 100 and 150MPa) were applied. The effect of the pressure treatment on physical characteristics (particle size of suspended pulp and turbidity) and the content of functional components was evaluated. In the range of pressures studied, while a slight decrease in monomeric anthocyanins was found, an increase in the content of phenol and antiradical capacity was detected. The set of results indicates that homogenization operation can be applied with different objectives, either to improve the stability of the cloud juice, to modify the functional properties or as a pretreatment to improve vacuum impregnation of porous structures.

Finally, using blueberry juice as a functional ingredient two healthy snacks, one made from apple and blueberry juice and another made from apple, blueberry juice and *Lactobacillus salivarius* spp. *salivarius* as a probiotic microorganism, were developed by vacuum impregnation technique. In developing the first snack was evaluated the effect of stabilization by air-drying at three different temperatures 30, 40 and 50°C on the physicochemical properties and the functional quality of the final product. Furthermore the drying process was compared with lyophilization. The hot air drying resulted in significant losses of anthocyanins, whereas lyophilization did not affect in any extent the content of the bioactive compound. Among the conditions of drying, the process performed at 40°C allowed to obtain a snack with better functional and physical characteristics. For the probiotic snack, the best pH condition of blueberry juice for the maximum development of microorganism was evaluated. After growing the lactobacillus in blueberry juice was introduced inside the apple matrix by vacuum impregnation, the snack was air-dried at 30°C and a plate count was made of it in the final product. The snack obtained is an alternative to dairy products with probiotics, and may be consumed by lactose intolerant groups. Besides, the inclusion of the product in the diet of children infected with *H. pylori* may reduce the level of infection and relieve symptoms related to inflammation of the gastric membrane.