

## Rheological and Crystallization Properties of Dark Chocolate Formulated with Essential Oil of Orange and Carotene Extracted from Pineapple Peels

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**Abstract :** The consumption of dark chocolate is beneficial due to its high content of flavonoids, catechins, and procyanidins. To improve its properties, fortification of chocolate with polyphenols, anthocyanins, soy milk powder and other compounds has been evaluated in several studies. However, to our best knowledge, the addition of carotenes to chocolate has not been tested. Carotenoids, especially  $\beta$ -carotene and lutein, are widely distributed in fruits and vegetables so that they could be extracted from agro-industrial waste, such as fruit processing. On the other hand, limonene produces crystalline changes of cocoa butter and improves its consistency and viscosity. This study aimed to evaluate the production of dark chocolate with the addition of carotenes extracted from an agro industrial waste and to improve its rheological properties and crystallization, with orange essential oil. The dried and fermented cocoa beans were purchased in Puerto Quito, Ecuador, and had a fat content of 51%. Six types of chocolates were formulated, and two formulations were chosen, one at 65% cocoa and other at 70% cocoa, both with a solid: fat ratio of 1.4:1. With the formulations selected, the influence of the addition of 0.75% and 1.5% orange essential oil was evaluated, and analysis to measure the viscosity, crystallization and sensory analysis were done. It was found that essential oil does not generate significant changes in the properties of chocolate, but has an important effect on aroma and coloration, which changed from auburn to brown. The best scores on sensory analysis were obtained for the samples formulated with 0.75% essential oil. Prior to the formulation with carotenes, the extraction of these compounds from pineapple peels were performed. The process was done with and without a previous enzymatic treatment, with three solid-solvent ratios. The best treatment was using enzymes in a solids-solvent ratio of 1:12.5; the extract obtained under these conditions had  $4.503 \pm 0.214$   $\mu\text{g}$  Eq.  $\beta$ -carotene/mL. This extract was encapsulated with gum arabic and maltodextrin, and the solution was dried using a freeze dryer. The encapsulated carotenes were added to the chocolate in an amount of 1.7% however 60,8 % of them were lost in the final product.

**Keywords :** cocoa, fat crystallization, limonene, carotenoids, pineapple peels

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