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ENZYMATIC AND THERMAL SUGAR EXTRACTION METHODS FROM APPLE POMACE – LOWERING SUGAR LEVELS AND MODIFYING SWEETNESS

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Vegetable and fruit by-products constitute 44% of global food waste. Apple byproducts (skin, flesh, seeds, and stems), which are increasing due to consumer demand for apple juice or cider, are largely wasted or underutilized, despite being rich in dietary fiber, phenolic compounds, proteins, and inorganic salts. Recent processes have focused on extracting polysaccharides and oligosaccharides from these by-products, primarily for fermentation and bioethanol production, with limited use as functional ingredients in the food, pharmaceutical, and cosmetic industries. Objective: This work aims to obtain natural ingredients with sweetening power from apple pomace (skin, flesh, seeds and stems). It aims to evaluate the effect of hydrolysis conditions, namely enzyme concentration (XA: 0,5% to 3%), substrate/solvent ratio (XB: 1/2 to 1/10), and duration (XC: 1h to 4h), on sugars obtained from apple pomace through four Box-Behnken Designs and determine the enzyme (Viscozyme® L or Pectinex® Ultra SPL) and substrate state (fresh or 30 days frozen) optimal conditions to maximise the ºBrix.
Enzymatic hydrolysis using citrate buffer followed by thermal hydrolysis in an autoclave was performed to release sugars from apple pomace. The supernatant was separated by centrifugation, and sugar content was measured with an ATAGO® Pocket refractometer. Four experimental designs (I, II, III, and IV) were used, considering three independent factors (XA, XB, XC) at three levels (-1, 0, 1). A total of 15 assays, including three central point repetitions, were conducted. The Box-Behnken design and statistical analysis were carried out using Stat- Ease 360 Software. Results: The results variance of the four experimental designs was well explained by three different models, two-factor interaction (2FI) (Eq (I)), Quadratic (Eq (II)), and Linear (Eq. (III) and (IV)), since it had statistical significance ($p < 0.05$) and a lack of fit that was not significant. Furthermore, the R2 and the predicted R2 indicated that the model explained >98% of the observed data and >97% of the predicted values. The ºBrix was affected by all the factors and their interactions in experimental design (I) and (II), and was only affected by the substrate/solvent ratio (XB) in experimental design (III), and also affected by enzyme concentration in experimental design (IV). Conclusion: Extracting sugars from apple pomace is an effective and affordable method to incorporate fruit by-products into various food products, thereby promoting the development of healthier options. This approach aligns with the circular economy framework, offering significant environmental benefits by reducing pollution and economic benefits through the valorization of by-products. The study's statistical models evaluated the impact of enzyme concentration (XA), substrate/solvent ratio (XB), and hydrolysis duration (XC) on °Brix. Further research is needed to optimize sugar concentration, yield, and sweetness index from apple by-products.

Keywords: Apple By-product, Pomace, Sugar extraction.

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