MICROWAVE AND ULTRASOUND ASSISTING TO DEVELOPMENT OF CONTINUOUS FLOW BASED ON EXTRACTION PROCESS OF CAROTENOIDS USING GREEN SOLVENTS

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Abstract: The objective of this work is to develop methods for the extraction of bioactive compounds from agroindustry wastes using alternative green solvents in flow chemistry. The development of all method about flow chemistry includes the green solvent synthesis (Ionic liquid), sample homogenization (ultrasound and microwave) and compound extraction (Amberlite resin column). The extraction process is a viable alternative, which follow the Green Chemistry principals, minimizing contaminates and optimizing obtainment of important nature pigments, as the carotenoids.

Keywords: Ionic liquid application. Lycopene. Solanum lycopersicum.

Resumo: O objetivo deste trabalho é desenvolver métodos para a extração de compostos bioativos de resíduos da agroindústria usando solventes verdes alternativos da química de escoamento. O desenvolvimento de todo o método por química de fluxo inclui a síntese de solvente verde (líquido iônico), homogeneização de amostra (ultrassom e micro-ondas) e extração de compostos (coluna de resina Amberlite). O processo de extração é uma alternativa viável, que segue os princípios da química verde, minimizando os contaminantes e otimizando a obtenção de pigmentos importantes da natureza, como os carotenóides.

Palavras–chave: Aplicação do líquido iônico. Licopeno. Solanum lycopersicum.

INTRODUCTION

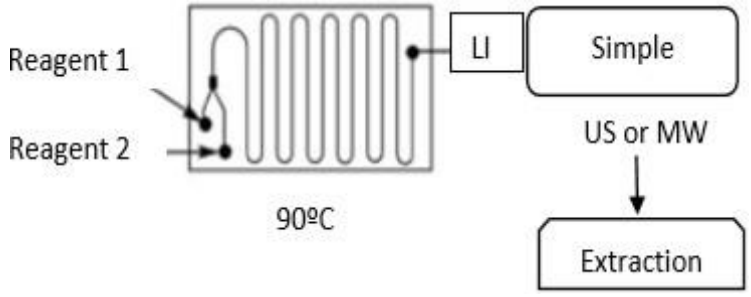
Currently incentives for sustainable development have prospered over the previous two decades, promoting the search for new production methods that minimizes environmental impacts. The quest for lower emissions of volatile organic compounds (VOCs) and their replacement with other less polluting compounds are the motivation of this study. There are numerous substitutes for VOCs. For example, supercritical fluid extraction and synthesis methods that employ metal catalysis, solid supports, acid salts, eutectic solvents, ionic liquids, and even water are available (DA PORTO et al., 2015; HALLET and WELTON, 2011; ANDRADE and ALVES, 2005). Combining the use of these substituents with heating and homogenization techniques to promote a reaction, such as continuous-flow microreactors, ultrasound (US) and microwaves (MW), it is possible to practice green chemistry that is free of volatile solvents. In light of this context, it is fundamental to follow the improvements in industrial practices, and to implement concepts of Continuous Flow in the production process involving chemical reactions which is called “Flow Chemistry” means of production where there is no paralysis throughout the process, in other words, smooth production processes without interruptions and with the best possible use. In this system, the substances flow more easily and agility, significantly reducing production time. In addition, the aim of these studies is to propose the extraction method using new technologies in Flow Chemistry.

DEVELOPMENT

Ionic Liquid synthesis by Flow decreases product losses, due to high viscosity and time reaction (BAUMANN et al., 2011). As shown in Figure 1, IL synthesis will be prepared in a micro-chip (temperature of 90 ° C). This is an addiction reaction, between Reagent 1 (1bromebutane) and Reagent 2 (1-methylimidazole), thus, it does not generate by-products. Subsequently (aim to extract carotenoid compounds), the IL receives ethanol (co-solvent) and is mixed with the water-free tomato sample and ultrasonized for better solvent / solid sample homogenization. Then there is the simple filtration (and repeating this step) and finishing with the separation (solvent / carotenoids). The laboratory scale extraction method is the basis for continuous flow optimization. The initial step was to test the best form of solvent and extract homogenization (US or MW), with yield measured by spectrophotometer (470 nm for

total carotenoids).

Figura 1- Flowchart



RESULTS AND DISCUSS

According to the preliminary results, it was possible to establish the feasibility and efficiency of the extraction of carotenoids with ionic liquid in pilot scale, indicating optimization of methodology for the industrial application. A new approach in Flow Chemistry for extraction is a successful expected. The respective 9–12 μg·g-1 and 11-15 μg·g-1 was the carotenoids extraction results from triplicate experiments comparation between US and MW process for homogenization (not statistically significant by ANOVA - $p < 0.05$). The results will be evaluated at each stage to verify progress, solve problems and plan future steps. According to the previously presented results, it will be possible to design a pilot scale or even a large scale automated industrial application of the extraction method developed. The sustainable production of bioactive compounds attracts interest within the field of natural product development

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