STATISTICAL APPROACHES TO OPTIMIZING EXTRACTION OF CARROT

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Abstract - Human studies have demonstrated the multiple health benefits of fruits and vegetables. Due to her high fiber, mineral and antioxidant content, carrot (Daucuscarota) is an ideal source for the development ofnutraceuticals or functional ingredients. Natural antioxidant compounds, such as polyphenols and carotenoids, play an important role in the prevention of human diseases and maintaining good health as part of a balanced diet through a synergistic cooperation.Their recovery in adequate amounts is indispensable. Accelerated solvent extraction is automated technique that uses common solvents or solvent mixtures at elevated temperatures and pressure to rapidly extract target compounds.In the process of scaling-up the isolation of bioactive compounds from plant material careful optimization is required, in order to save valuable material, time and effort. When many factors and interactions may affect a desired process, response surface methodology (RSM) is an effective statistical technique to find a combination of factor levels that produce the optimal conditions. The main aim of the application of chemometric methods (hierarchical cluster analysis – HCA, and sum of ranking differences approach – SRD) is to classify the conducted experiments, rank and group similar experiments and gain an overview of the optimum experimental conditions. In this respect, a research has been carried out to assess accelerated solvent extraction traits which affect the antioxidant qualities (properties) of carrot extract. The mixture of pure organic solvents, acetone and ethanol, with or without the addition of 20% water were applied following Simplex-Latice experimental design. Total carotenoid (TCar) and polyphenol contents (TPh) in extracts, as well as their scavenging activity (SA) and reducing power (RP), were used as responses for the optimization of ASE extraction. Multi response optimization, in the case of 20% water involvement, included 49% of acetone and 31% of ethanol (Opt1), while in the case of pure organic solvents pure ethanol was the best choice for overall optimization (Opt2). The results of the HCA clearly pointed out that there is significant statistical difference between the properties of the extracts obtained from the experiments in which water was used in the solvent mixture. This means that the use of water in the solvent mixture should be carefully considered if an extract with certain properties should be obtained. Based on the results of the SRD analysis it can be concluded that the experiment defined as Opt2 in RSM analysis is confirmed to be optimal considering its place in the SRD graph, which is very close to the reference rank. In the experiments with pure ethanol as a solvent the extracts with significant TCar, TPh, SA and RP were obtained. The conducted RSM, HCA and SRD analysis confirmed the same conclusion - water in the solvent mixture can significantly affect the extraction efficacy and that the optimal solvent for extracting antioxidants from carrot by ASE is pure ethanol.

Keywords - Carrot, Extraction, Response Surface Methodology,Chemometric Methods