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ORIGINAL ARTICLE

Adsorption-guided purification of rose petal anthocyanins

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Abstract
In the current study, a variegated macroporous resins were screened for adsorption of rose anthocyanin rich extract. A series of polyacrylic ester based and polystyrene-divinylbenzene based adsorbent and ion exchange resins (XAD-7, XAD-7HP, DIAION HP 20, DOWEX-50X8, IR 120, OPTIPORE L-493) were investigated to find out the better adsorption properties of anthocyanins predominantly present in rose petals (*Rosa* sp) extract. Profiling of different anthocyanins present in above said extract was done by UPLC-HRMS (ultra-high performance liquid chromatography-high-resolution mass spectroscopy), which projected a wide range of acylated and non-acylated anthocyanins. Anthocyanin adsorption efficiency of selected resins ranges between 0.188 and 4.020 mg C_3G eq. g^{-1}. The least adsorption and highest desorption took place on IR-120 resin. Data on isotherm were fitted well to the Freundlich isotherm with least χ^2 and AICc values. Mean sorption energy (E) value from Dubinin-Radushkevich adsorption isotherm projected that particle diffusion adsorption mechanism is more predominant at macroporous resin surface for adsorption of anthocyanin-rich extract. The spectroscopic and microscopic-based characterization of macroporous resin helped in better understanding the adsorption site of resin and its interaction with anthocyanin. Continuous column adsorption-based purification technique provided purity improvement of anthocyanin to the tune of 44.14%. OPTIPORE L-493 ion exchange resin showed best performance in purification of rose anthocyanin.

Keywords Adsorbent resin · Purification · Adsorption isotherm · Non-acylated anthocyanin · Macroporous resin

1 Introduction

Anthocyanins, a group of natural pigments, reportedly have anticarcinogenic properties and inhibit stress-related lifestyle diseases due to their powerful antioxidant activities [1]. The global food market has seen a significant rise in demand for anthocyanins, driven by their use as both nutraceuticals and natural food colorants. Increasing consumer awareness of the potential health risks associated with synthetic food colorants has led to a greater preference for natural alternatives, boosting the popularity and application of nutraceutical pigments such as anthocyanins in the food industry. The recent COVID-19 pandemic situation further emphasized their importance in our daily life.

This group of flavonoid pigments, commonly available as glycosides through α- or β-glycosidic linkages of anthocyanidins with sugar moieties, frequently co-exists in nature with other groups of phenolic compounds. The commonly employed anthocyanin extraction processes therefore always co-extract other unintended phenolic compounds in large amounts from plant sources. Hence, to maximize the concentration of anthocyanins in crude extracts, purification is one of the important steps to follow [2]. Though techniques such as liquid–liquid partition or preparative HPLC have been reported in the literature for anthocyanin purification from crude extracts, these techniques are not suitable for large-scale production at the industrial level. Silica gel-based simple column chromatographic purification techniques also have their own limitations in terms of the large volume of solvent usage, time requirement, and moreover susceptibility to degradation of anthocyanins. Therefore, adsorbent-based purification techniques have been explored for anthocyanins as robust and recyclable alternatives. In this context,

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