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A comprehensive review on anthocyanin-rich foods: Insights into extraction, medicinal potential, and sustainable applications

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ABSTRACT

Anthocyanins (ACNs) are natural pigments commonly found in plants which contribute to the vibrant colors of fruits, vegetables, and flowers. The present review aims to cover the ACNs field in terms of sources, extraction/purification techniques, as well as characterization methods that are crucial for assessing their medicinal potential and sustainable applications. Characterization methods e.g. HPLC, UPLC-QTOF-MS, MS, and NMR are discussed as analytical tools for the identification and quantification of ACNs in various vegetable matrices. Their antioxidant, anti-inflammatory, antidiabetic, anti-cancer and cardiovascular properties are, also, highlighted. Besides, the use of ACNs as natural colorants, preservatives, and functional ingredients is discussed considering their impact on the food industry. Likewise, due to their anti-aging and skin-protective properties, their employment in the cosmetic field is reported making them appealing for skincare formulations. This review provides a comprehensive overview, emphasizing the ACNs versatility in medicine, food industry, and cosmetic field, fostering future research and innovation.

1. Introduction

In contemporary times, food is acknowledged as a crucial supplier of dietary substances and biologically active compounds, contributing to the enhancement of human health and overall well-being. The growing awareness among consumers regarding the profound impact of diet on health is evident in their preference for natural products rich in vitamins, minerals, and various bioactive compounds e.g. carotenoids, peptides or anthocyanins (ACNs) [1]. ACNs are a group of bioactive pigments naturally found in common plants. From a chemical view-point, ACNs belong to the flavonoids group, a subclass of the polyphenol family, contributing to the attractive orange, red, purple, violet, and blue colors of fruits, vegetables, and flowers [2]. Berries, currants, grapes, and some tropical fruits are reported to possess a high ACNs content [3]. There are many different ACNs in nature and the six most common are represented by cyanidin, delphinidin, malvidin, peonidin, petunidin and pelargonidin [4]. ACNs occurring in berries, blackcurrants, and other types of red to blue-colored fruits, vegetables and flowers have been reported to be strong antioxidants. Moreover, anthocyanin-rich foods e.g. black carrots, red cabbages, and purple potatoes are potential functional foods [3].

ACNs are known for their sensitivity to pH, light, and temperature [5], thus facing challenges in traditional extraction methods, mainly due to time consumption which negatively affect the antioxidant activity. Modern extraction technologies, such as ultrasonic-assisted extraction (UAE), offer efficient alternatives. UAE is cost-effective, time-efficient,

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