

# Anthocyanin Implementation Using Biopolymers as a Reinforced Colouring Agent for Food Applications

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## Abstract

Anthocyanins are natural colourants that are gaining popularity in the food industry due to their wide range of colours and health benefits. However, anthocyanins' susceptibility to environmental stress may limit their applications, which could be improved by encapsulation systems composed of various biopolymers such as proteins, polysaccharides, and composite formulations. The main biopolymers used as encapsulate materials for anthocyanin protection and delivery has been introduced in this review; the geometry of these encapsulation systems, their properties, and the fabrication technologies has also been discussed. The information in this review can be used to guide anthocyanin encapsulation for food applications.

**Keywords:** Anthocyanins; Biopolymers; Natural colorant

## Introduction

In recent years, the food industry has shown increasing interest in using natural colourants to replace synthetic colourants, despite the fact that the latter have higher stability, better colouring effect, and, most importantly, lower cost. Except for a few vegetables and berries, there are very few blue foods in nature. Artificial blue colourants such as bright blue and indigo carmine are currently used in food applications, whereas natural blue pigments such as anthocyanins and anthocyanins can be obtained from fruits, flowers, and vegetables. [1, 2, 3, 4].

## Natural anthocyanins are being preserved and delivered using biopolymer-based encapsulation systems

Several methods, including acylation, metal complexation, co-pigmentation, self-association, and encapsulation, have been used to improve the stability and bioavailability of anthocyanins/anthocyanins. Both chemical and enzymatic acylation could be used to produce acrylate anthocyanins, which protects anthocyanins by reducing attack from hydrophilic groups and increasing steric hindrance. In this regard, acrylate anthocyanins outperformed uncollated anthocyanins in terms of resistance to high temperature, pH, oxygen, and light. Enzymatic acylation has milder reaction conditions, higher catalytic efficiency and selectivity, and a higher cost than chemical acylation. Another method for preserving anthocyanin colour is complexation with metal ions. For example, after complexing with Fe<sup>2+</sup> and Fe<sup>3+</sup>, anthocyanins' thermal and storage stability were greatly improved, and a colour enhancement effect was observed.

Intermolecular and intramolecular co-pigmentations could improve anthocyanin stability. Anthocyanin is noncovalent bound to an aromatic accessory pigment for intermolecular co-pigmentation, primarily via  $\pi$ - $\pi$  interactions. The interaction between the anthocyanin skeleton and the co-pigment must be part of the anthocyanin itself for intramolecular co-pigmentation to occur. Both co-pigmentations provide steric hindrance, reducing water molecules' nucleophilic attack on anthocyanins. However, the combination of free anthocyanins by co-pigmentation may result in a colour enhancement effect, which is unfavourable for keeping the colour blue. Self-association is also known as intermolecular co-pigmentation, and it is observed at relatively high anthocyanin concentrations. [5,6, 7, 8].

## Conclusion

Various biopolymer-based encapsulation systems to improve the stability and bioavailability of anthocyanins were discussed in this review, as were the main techniques involved in the formation of these encapsulation systems. Composite formulations outperformed single biopolymer encapsulates in terms of encapsulation performance. [9, 10].

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## Conflict of Interest

The authors affirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

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