



Optimising anthocyanin extraction from strawberry fruits using response surface methodology and application in yoghurt as natural colorants and antioxidants

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Abstract The aim of the present study was to optimise the extraction conditions of anthocyanins from strawberry fruits and incorporate them in yoghurt to achieve a natural coloration as well as enrich the product with antioxidants. The response surface methodology (RSM) based on Box–Behnken design was studied to assess the influence of the three factors being agitation speed (400–800 rpm), sample to solvent ratio (0.5–2 g/40 mL), and extraction time (1–15 min) on total anthocyanin content and antioxidant activity of strawberries. According to the results, the linear, quadratic and interaction effects of the studied factors on total anthocyanin content and antioxidant activity were determined by the response surface methodology, and the optimal conditions for anthocyanin extraction were 586 rpm for agitation speed, 1.26 g/40 mL for sample to solvent ratio, and 9.36 min for extraction time. Under these extraction conditions, the total anthocyanin content and antioxidant activity recorded by the two validated models were 38.04 mg C3GE/100 g FW and 21.38 mg AAE/100 g FW, respectively. The enriched natural yoghurt contains anthocyanins with a content of 36.50 µg C3GE/100 g and

an antioxidant activity of 21.22 µg AAE/100 g. The anthocyanin enriched yoghurt developed in this study may be considered as a functional food with an interesting source of natural antioxidants, and these anthocyanins can substitute synthetic (industrial) colorants.

Keywords *Fragaria ananassa* Duch. · Modelling optimisation extraction · Response surface methodology · Enriched yoghurt · Natural colorants · Antioxidants

Introduction

Fragaria ananassa known as strawberry is widely grown hybrid species of the genus *Fragaria*. It is cultivated worldwide for their fruits that are widely appreciated for their characteristic aroma, bright red colour, juicy texture, and sweetness (Manganaris et al. 2014). They are consumed in large quantities, either fresh or in such prepared foods as jam, juice, ice cream, and chocolates. Strawberries are also consumed for their antioxidant quality due to their functional compounds, considered as bioactive healthier molecules, many of which have demonstrated biological activities; among these compounds we can cite vitamins, minerals, polyphenol-proteins, phenolic acids and flavonoids (Karaaslan and Yaman 2017; Hoskin et al. 2019; Kalt et al. 2020). These latter represent the highest amount of bioactive molecules, and anthocyanins are the compounds responsible for the visual appearance of strawberries. Indeed, they provide the red colour for the strawberry fruits and protect them from UV radiations by their antioxidant property (Kalt and Dufour 1997; Nicoué et al. 2007; Zhang et al. 2019; Kalt et al. 2020).

Anthocyanins are the anthocyanidins glycosides, they are frequently found in the nature as glycosylated form that

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