A REVIEW ON THE ANTHOCYANIN AND ANTIOXIDANT CAPACITIES OF *Clitoria ternatea* FLOWER

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Abstract: Butterfly pea flower has been used as food colourant for decades by Malaysians, purposely to add an aesthetical value to the food. Besides, the flower has been scientifically displaying several bioactivities properties. A multitude of works on the antioxidant capacity of butterfly pea has been presented in literature and the antioxidant capacities are correlated with the presence of polyphenolic compounds. Hence, this review aims to understand the correlation between anthocyanin, phenolic compounds and antioxidant activity of butterfly pea flowers. The finding from this review unveils that antioxidant capacity of butterfly pea are depending on the number of hydroxyl groups attached on the carbon 3' and 4' of ring B, the availability of main reactive sites for nucleophilic and electrophilic attacks, as well as the presence of electron donor on the chemical structure of the bioactive compounds. Furthermore, high antioxidants are obtained in the solvent extraction that has been added with acid. The protonation-deprotonation process of the anthocyanin at various pH is the main factor that contributed to the antioxidant activity. Thus, a comprehensive study on the antioxidant properties of butterfly pea flower as a natural antioxidant towards foods is recommended to widen the application of butterfly pea in the food industry.

Keywords: Antioxidant, anthocyanin, butterfly pea, natural colourants

1. Introduction

Butterfly pea (*Clitoria ternatea*) flower has been used as colouring in bakery products such as sourdough and cake. Anthocyanin pigment is found in butterfly pea and is responsible for the deep blue to purple colour of the flower (Campbell et al., 2019). The stable polyacylated anthocyanin at high temperature due to the complex structure that enables the use of this pigment in the food. Beside of imparting colour, butterfly pea also has antioxidant properties which help to decrease the lipid oxidation and prolong the shelf life of food product with safer ingredient. The antioxidant capacity of butterfly pea flower varied according to the type of solvent used, which is attributable by the different in polarity, solubility and structure of phytochemical (Jaafar et al., 2020). Furthermore, the total phenolic acids, flavonoids content and anthocyanin content present in butterfly pea flowers contributes to the antioxidant capacity. Therefore, high anthocyanin does not always provide high antioxidant power because the high antioxidant activity is primarily derived from other phytochemicals such as flavonoids (quercetin and rutin).

2. Discussion

2.1. Chemical structure of anthocyanin in butterfly pea

A vivid deep blue colour of butterfly pea flower which is known as "Double Blue" (*Clitoria ternatea* var. *pleniflora* Fantz) which has multiple petals and a wild-type butterfly pea (*Clitoria ternatea* var. *ternatea* L.) with single dark blue bilateral petals consists of anthocyanin. Anthocyanin present in the butterfly pea flower has the ability to change colour in different pH that ranges from deep blue to magenta (Muzi Marpaung et al., 2017; Adisakwattana et al., 2020). The basic structure of anthocyanin is glycosylated polyhydroxy and polymethoxy derivatives of 2-phenylbenzopyrylium cation or namely as flavylium cation which was mentioned by Cavalcanti et al. (2011). Delphinidin is the anthocyanidin found in butterfly pea alongside with other polyacylated and polyglycosylated delphinin, known as ternatin. The hydroxyl group attached to the B ring of the delphinidin structure is the main reason for the instability of delphinidin compared to malvidin with the methoxyl unit attached to the B-ring. However, the polyacylated and glucosylated form of delphinidin hinders the nucleophilic and electrophilic attacks on the delphidin structure, then stabilizes the colour (Alappat & Alappat, 2020). Figure 1 shows the chemical structure of dephinidin and ternatin.

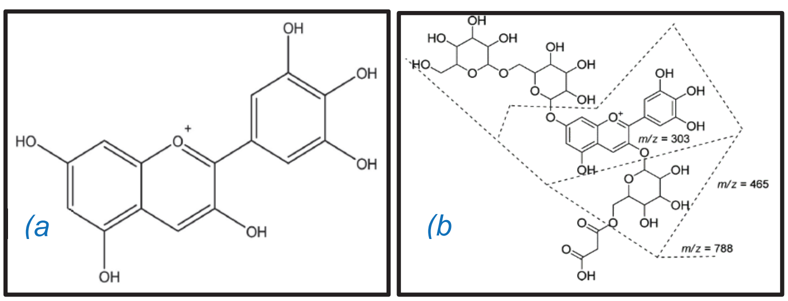

Figure 1. (a) Chemical structure of delphinidin and (b) Chemical structure of ternatin.
Source: Alappat and Alappat (2020); Nair et al. (2015).

2.2. Bioactive compound in butterfly pea in different extraction solvent

Phenolic acids, flavonoids and anthocyanin are detected in butterfly pea flowers and have a significant role in the colour stability and antioxidant activity of the butterfly pea flower extraction (Escher et al., 2020). Although, there are different amounts and types of phenolic compounds are yielded at the end of extraction procedure due to the different types of solvent used, time and temperature of extraction. The solvent used for extracting bioactive compounds has different effectiveness in different species of plant (Jaafar et al., 2020).

2.3. Antioxidant activity of butterfly pea

The antioxidant activity of anthocyanin is mostly determined by their chemical structure, which includes the number and position of hydroxyl groups, conjugated double bonds, as well as the presence of electron donors in the structural ring (Martín et al., 2017). Delphinidin from butterfly pea, which contributes to the main colourant molecules of anthocyanins, has a high antioxidant capacity. Aside from that, phenolic chemicals play a bigger role in antioxidant activity than the anthocyanin found in butterfly pea flowers (Havananda & Luengwilai, 2019). The ethanol and

aqueous extraction can be improved by the addition of acid (Pengkumsri et al., 2019). In order to produce high antioxidant activity, the optimum pH 3 and high concentration of anthocyanin added must be followed (Kungsuwan et al., 2014).

3. Conclusion

In conclusion, phenolic compounds which consist of phenolic acids, flavonoids and anthocyanin contribute to high antioxidant capacities of butterfly pea flowers. Furthermore, the antioxidant capacities are correlated to the phenolic compounds present in the extraction. Thus, it's important to extract the butterfly pea flower at favourable condition (i.e. type solvent and temperature) with suitable solvent which will extract the desired compounds. Solvents may have different affinity towards the phytochemical which is highly dependent on their structure and polarity. Hence, acidified solvent can be used to yield more phenolic acids, flavonoids and anthocyanin which then produce stable colour and antioxidant capacities.

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