Spray-dried anthocyanins from butterfly pea flower as color indicator

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Abstract. Butterfly pea flower can be used as natural source to produce anthocyanin pigments. In this study, anthocyanin extract was prepared by using distilled water as a solvent. Then, anthocyanin extract powder was obtained from spray drying process. Maltodextrin and gum arabic were used as carrier agents for powder production. Color variations of spray-dried anthocyanins with different carrier agents in different pH buffers (pH 1-11) were observed under natural light and in the dark. Color stability was also studied under storage at day 0, 3, 5, 7, 10 and 14. In addition, color parameters, absorption maxima ($\lambda_{\text{max}}$, nm) and absorbance were characterized by UV-Vis spectrophotometer. The results showed that spray-dried anthocyanins with maltodextrin and gum arabic can be acted as a color indicator in different pH values. Moreover, natural light, the dark condition and storage times also affected on color variations, color parameters, $\lambda_{\text{max}}$ and absorbance in both of spray-dried anthocyanins with maltodextrin and gum arabic.

1. Introduction
Butterfly pea flower has been used in food products as an antioxidant [1] and a colorant [2]. Anthocyanin extract from butterfly pea flower has been attracting the attention in color indicator. In general, anthocyanin extract is in liquid form, which appears to be sensitive to light and temperature. Therefore, in this work, anthocyanin extract from butterfly pea flower was prepared in powder form by spray drying process. This technique can produce anthocyanins coated with carrier agent. Thus, this could delay the damage of anthocyanins from light and temperature. Maltodextrin and gum arabic were used as carrier agents for powder production due to their common use in spray drying process. Color change and stability of the spray-dried anthocyanins prepared using different carrier agent under natural light and in the dark were investigated.

2. Materials and methods

2.1. Materials
Dried butterfly pea flower was supplied from Sukhothai province, Thailand. Maltodextrin, DE-10 (Roquette, France) and gum arabic, KB-120 (Sieving, Germany) were used as carrier agents for spray drying process. The buffer solutions (pH1-11) were prepared using reagents of analytical grade.
2.2. Preparation of anthocyanin powder by spray drying process
The ratio of dried butterfly pea petals (6% moisture content): distilled water is 1:14 (w:v). Distilled water was used as a solvent for extraction of anthocyanins at temperature 60 °C for 50 min. The anthocyanin extract was left at room temperature for 60 min and filtered using the cheesecloth. The total soluble solid of anthocyanin extract was adjusted to 20 °Brix by adding carrier agents (maltodextrin or gum arabic) for powder production. The carrier agent was dissolved in anthocyanin extract under constant stirring at 1,000 rpm for 45 min at room temperature. The mixture was fed into a spray-dryer (JCM Engineering Concept Co., Ltd, Thailand) at a flow rate 1500 ml/h. The inlet and outlet air temperatures were 180 and 90 ± 1 ºC, respectively. Powder of spray-dried anthocyanins were kept in aluminum foil bag to prevent light exposure and stored in desiccators.

2.3. Characterizations
Color variations and stability; spray-dried anthocyanins were dissolved in pH buffer values of 1 to 11 in a ratio of 1:100 (w:v) and stirred with magnetic stirrer for 10 min. The samples kept in glass test tubes, sealed with parafilm and stored at room temperature. The color changes were visually monitored under natural light at day 0, 3, 5, 7, 10 and 14 and in the dark at day 14.

Color parameters; the CIELab color system was used with L* = 100 (white) to 0 (black), a* = −a (green) and +a (red) and b* = −b (blue) and +b (yellow). The color parameters were measured using UV-Vis spectrophotometer, V370 Jasco, Japan. The measurement was taken at day 0, 3, 5, 7, 10 and 14 for the sample kept under natural light and at day 14 for the sample stored in the dark.

UV-Vis analysis; Absorption maxima (λmax, nm) and absorbance were examined by UV-Vis spectrophotometer, V370 Jasco, Japan. The measurement was taken at day 0, 3, 5, 7, 10 and 14 for the sample kept under natural light and at day 14 for the sample stored in the dark.

3. Results and discussion

3.1. Anthocyanins from spray drying process
The spray-dried anthocyanins with maltodextrin and gum arabic appeared as the blueish purple powders as shown in Figure 1. The blueish purple color corresponds to malonylated delphinidin 3,3’,5’-triglycoside [3].

![Figure 1. Powders of spray-dried anthocyanins with different carrier agents; (a) maltodextrin and (b) gum arabic.](image)

3.2. Color variations and stability
The color changes of spray-dried anthocyanins with maltodextrin and gum arabic in buffer solutions (pH 1-11) under natural light and in the dark at day 0, 3, 5, 7, 10 and 14 are presented in Figure 2 and Figure 3, respectively. At day 0, the spray-dried anthocyanins with maltodextrin and gum arabic exhibited similar color in the pH range of 1-11 under natural light. During storage in 14 days, the visual color fade of spray-dried anthocyanins with maltodextrin was slower than that of spray-dried anthocyanins with gum arabic in the pH range of 7-11. Moreover, in the dark at day 14, the visual color fade of spray-dried anthocyanins with maltodextrin was also slower than that of spray-dried anthocyanins with gum arabic. These can be indicated that the spray-dried anthocyanins with...
maltodextrin was more stable than the spray-dried anthocyanins with gum arabic under storage at day 0 to 14 under natural light and in the dark in the pH range of 7-11.

| Day  | Natural light | pH          |
|------|---------------|-------------|
| 0    |               | 1 2 3 4 5 6 7 8 9 10 11 |
| 3    |               |             |
| 5    |               |             |
| 7    |               |             |
| 10   |               |             |
| 14   |               |             |
| Dark |               |             |
| 14   |               |             |

**Figure 2.** Spray-dried anthocyanins with maltodextrin in buffer solutions.

| Day  | Natural light | pH          |
|------|---------------|-------------|
| 0    |               | 1 2 3 4 5 6 7 8 9 10 11 |
| 3    |               |             |
| 5    |               |             |
| 7    |               |             |
| 10   |               |             |
| 14   |               |             |
| Dark |               |             |
| 14   |               |             |

**Figure 3.** Spray-dried anthocyanins with gum arabic in buffer solutions.

### 3.3. Color parameters

The color parameters of spray-dried anthocyanins with maltodextrin in buffer solutions (pH 1-11) under natural light and in the dark at day 0, 3, 5, 7, 10 and 14 are shown in Figure 4-6. At day 14, all color parameter values are closer to those at day 0 as compared under natural light. Therefore, the spray-dried anthocyanins with maltodextrin storage in the dark exhibited more stable than storage under natural light. The color parameters of spray-dried anthocyanins with gum arabic under natural light and in the dark are present in Figure 7-9. In comparison between day 0 and day 14, all color parameter values
of spray-dried anthocyanins with gum arabic and maltodextrin under natural light and in the dark were different. The variation of color parameter values of spray-dried anthocyanins with gum arabic at the pH range 7-11 were observed.

**Figure 4.** $L^*$ of spray-dried anthocyanins with maltodextrin in buffer solutions.

**Figure 5.** $a^*$ of spray-dried anthocyanins with maltodextrin in buffer solutions.
Figure 6. $b^*$ of spray-dried anthocyanins with maltodextrin in buffer solutions.

Figure 7. $L^*$ of spray-dried anthocyanins with gum arabic in buffer solutions.
3.4. UV-vis analysis

The $\lambda_{\text{max}}$ of spray-dried anthocyanins with maltodextrin and gum arabic in buffer solutions is shown in Table 1. In addition, the absorbance of spray-dried anthocyanins with maltodextrin and gum arabic in buffer solutions are shown in Figure 10 and Figure 11. The color intensity of spray-dried anthocyanins was examined as the absorbance at $\lambda_{\text{max}}$. It can be seen the absence of absorbance at $\lambda_{\text{max}}$ in the pH range of 7-11 at day 14 of spray-dried anthocyanins with maltodextrin and gum arabic under natural light.
This can be implied that spray-dried anthocyanins with maltodextrin and gum arabic are stable in the pH range of 1-6 rather than in the pH range of 7-11. Furthermore, in the dark at day 14, it can be seen the absorbance at $\lambda_{\text{max}}$ in the pH range of 1-10 for spray-dried anthocyanins with maltodextrin and the absorbance at $\lambda_{\text{max}}$ in the pH range of 1-6 for spray-dried anthocyanins with gum arabic. Thus, the spray-dried anthocyanins with maltodextrin is stable than the spray-dried anthocyanins with gum arabic during storage in the dark.

| pH | $\lambda_{\text{max}}$ of spray-dried anthocyanins with maltodextrin | $\lambda_{\text{max}}$ of spray-dried anthocyanins with gum arabic |
|----|-------------------------------------------------|-------------------------------------------------|
|    | Natural light (day)                              | Natural light (day)                              |
| 1  | 547                                             | 543                                             |
| 2  | 547                                             | 544                                             |
| 3  | 569                                             | 569                                             |
| 4  | 572                                             | 572                                             |
| 5  | 574                                             | 573                                             |
| 6  | 619                                             | 573                                             |
| 7  | 628                                             | 619                                             |
| 8  | 629                                             | 621                                             |
| 9  | 627                                             | 625                                             |
| 10 | 601                                             | 601                                             |
| 11 | 593                                             | 593                                             |

**Table 1.** $\lambda_{\text{max}}$ of spray-dried anthocyanins with maltodextrin and gum arabic.

![Figure 10. Absorbance of spray-dried anthocyanins with maltodextrin.](image-url)
4. Conclusion
In buffer solution with the pH range of 7-11 under natural light and in the dark, the spray-dried anthocyanins with maltodextrin presented more stable than the spray-dried anthocyanins with gum arabic under storage at day 0 to 14. This spray-dried anthocyanins could be applied for further packaging application by mixing with a biopolymer solid support that can be produced as natural color indicator film.

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References
[1] López Prado A S, ShenY, Ardoin R, Osorio L F, Cardona J, Xu, Z and Prinyawiwatkul W 2019 Int. J. Food. Sci. Tech. 54 424-431
[2] Hariadi H, Sunyoto M, Nurhadi B, Karuniawan J 2018 J. Pharmacogn. Phytochem. 7(4) 3420-3429
[3] Escher G B, Wen M, Zhang L, Rosso N D and Granato D 2020 Food Chem. 331 127341