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Anthocyanidin Dye and Al/Fe-Containing Mesoporous Silica Composites and their Color Properties

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Abstract

The composites of an anthocyanin dye and a metal-containing mesoporous silica (MPS) were studied in order to obtain a brightly colored powders with high photostability. The MPS or Al-containing MPS barely adsorbed the anthocyanin dye (extracted from grape skin) present in an aqueous solution. Therefore, a hydrophobized anthocyanin (anthocyanidin) dye, prepared by removing the sugar chain of the anthocyanin via hydrolysis, was required to make the MPS adsorb the dye. Although the MPS did not adsorb the anthocyanidin dye present in an ethanol solution, the Al-containing MPS adsorbed the dye and yielded a bright red powder. The Fe-containing MPS adsorbed the anthocyanidin dye much more efficiently compared to the Al-containing MPS, and afforded a bright blue powder. Despite using the anthocyanidin dye without the sugar chain, which has an inhibiting effect on decomposition, the stability of the Al- or Fe-containing MPS composites under light irradiation was improved compared to that of an anthocyanin dye (not existing in the mesopore). The stability of Fe-containing MPS composite was particularly enhanced. In conclusion, we succeeded in obtaining a "blue pigment" derived from anthocyanin which is known to be difficult to stabilize.

Key-words: *Anthocyanin, Anthocyanidin, Mesoporous silica, Light fastness, Liquid dissolution*

1. Introduction

Anthocyanins are a class of natural dyes widely distributed in nature and are extracted from grapes, berries, roses, apples, red cabbage, etc[1]. Anthocyanins are known to be nontoxic and used as a food colorant; however, their application as cosmetics or ink materials is limited because of their poor stability, especially against light[2-5].

There have been some reports[6-8] on enhancing the stability of natural dyes, including anthocyanins, by forming composites with clay minerals. After the dyes are intercalated into clay minerals, their stabilities are improved. However, under highly humid conditions, the colored powder containing clays easily transforms to a sticky paste — a serious drawback, especially for cosmetics applications. To resolve this drawback, mesoporous silica (MPS) having a wide surface area and homogeneous mesopores was proposed as the adsorbent for organic dyes[9,10]. In previous studies[3,10], we reported that the photostability of the flavylium dye adsorbed on metal containing MPS was enhanced and the composite can be used as a photochromic powder.

In this study, the composites of natural anthocyanin dyes and MPS were investigated in order to obtain bright and variously colored powders with high photostability.

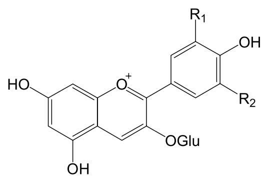
2. Experimental

2.1 Sample preparation

A commercially available food dye extracted from grape skins (Grape Color BC-120 supplied by Kiriya Chemical Co.) was used as the anthocyanin (AN) dye and was used as received. The molecular composition of the AN dye analyzed by HPLC is listed in **Table 1**. The AN dye was found to be a mixture of five anthocyanin molecules, with malvidin-3-glucoside being the main component.

The anthocyanidin (AD) dye, i.e., the AN dye without the sugar moiety (glucose), was prepared as follows. The AN dye

Table 1 Components of anthocyanin (AN) dye.



Compound name	Substituents		Ingredient
	R_1	R_2	(%)
Maleidin-3-glucoside	OMe	OMe	49
Peonidin-3-glucoside	OMe	H	20
Petunidin-3-glucoside	OMe	OH	15
Delphinidin-3-glucoside	OH	OH	13
Cyanidin-3-glucoside	OH	H	3