Varietal Differences in Flower Colors of Cattleya aurantiaca

Res. Bull. Fac. Agr. Gifu Univ. (57) : 181—185, 1992

Varietal Differences in Flower Colors of *Cattleya aurantiaca*

Shuichiro MATSUI

Experimental Farm
(*Received July 20, 1992*)

SUMMARY

Compared with typical orange petals in *C. aurantiaca*, yellow ones contained a markedly low amount of carotenoids and also showed a hypsochromic shift of the spectral absorption. These changes were ascribed to decreases in γ-carotene, a main component of the orange variety, and lycopene contents, and to relative increases in xanthophylls. A red variety showed a spectral absorption curve indicating the coexistence of carotenoids and anthocyanins. The rates of each carotenoid to total amounts contained in its petals were similar to those of the orange one.

INTRODUCTION

Orchid production has increased in Japan and other countries. Many hybrids have been produced to improve not only growth habits but also flower colors. Hybrids of *Cattleya* and allied genera are most popular. Their colors are mainly lavender, or orchid tone, but recently yellow and orange flowers are increasing. To obtain new hybrids with good qualities, excellent native species play an important role. *Cattleya* (*C.*) and allied genera include rare varieties bearing alba, semi-alba, concolor, splashed and veined flowers with different colors from typical ones. *C. aurantiaca* blooms attractive small orange flowers and produces hybrids with floribantam and yellow to orange flowers. Recently, some varieties blooming white, yellow, golden or red flowers have been included.

The aim of this study is to clarify the nature of these varieties in order to produce hybrids with new characteristics.

MATERIALS and METHODS

Four varieties of *C. aurantiaca* used bloom flowers with typical orange, golden('Miami'), yellow or red colors. The yellow one was obtained from the self crossing of the red. The red bears more reddish flowers than is typical. These flowers were obtained from the experimantal farm of our university and the greenhouse of Ohgaki Engei in Ohgaki city. Flower colors were determined by a chromaticity apparatus (Hayashi Denko,Ltd) (1). Then, absorption spectra were measured by a spectrophotometer (Hitachi Model 100) according to the opal glass method(2). Finally, petals were weighed and carotenoids were extracted with acetone using a motor and a pistle. The pigments in the acetone fraction were transferred to ether. The ether fraction was used for carotenoid analysis with a high performance liquid chromatography (HPLC) (3). Anthocyanins were extracted with 10% KCI for absorption spectrum measurement and with HCI-methanol for determination of their concentration.

RESULTS

Visual flower colors of 4 varieties were very evident from gross observations in a chromaticity diagram (Fig. 1). The yellow and the red ones were similar in color to *Laelia* (*L.*) *flava* and

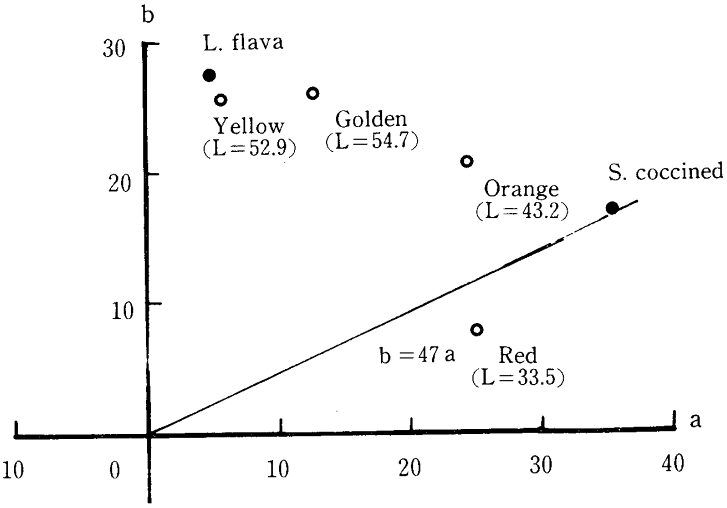

Fig. 1. Distribution of petal colors in four *C. aurantiaca* varieties on a Hunter's color chromaticity diagram.

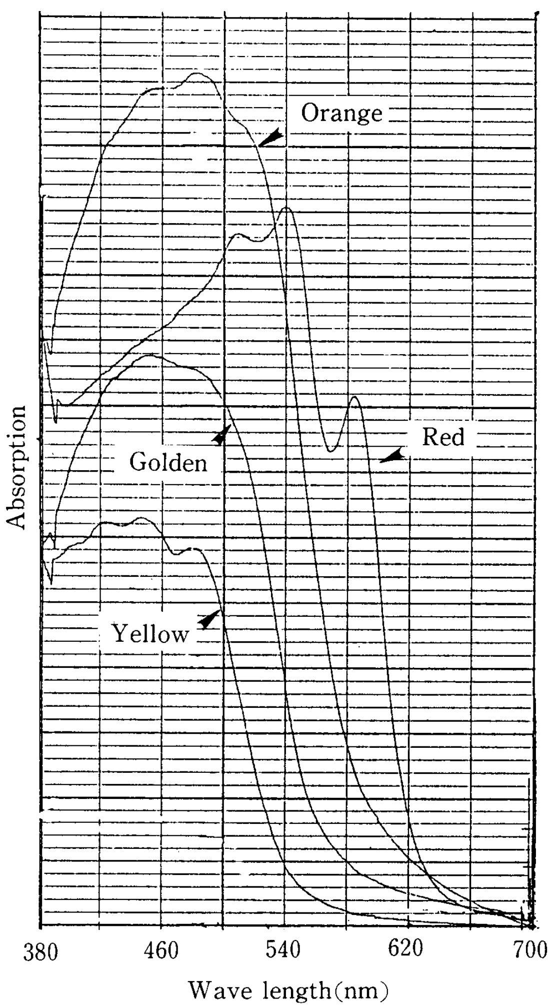

Fig. 2. Spectral absorption curves of petals in four varieties of *C. aurantiaca*.

Sophronitis (*S.*) *coccinea*, respectively, but different from the typical orange one. The red was distributed in a part below b=. 47a, indicating the coexistence of carotenoids and anthocyanins. The variety 'Miami' was distributed with the highest brightness (L=54.7) between the yellow and the red.

Fig. 2 shows the absorption curves of the flowers. The absorption curves of the yellow, golden and orange varieties were similar to each other because of the presence of only carotenoids and were classified into II. However, in the order of the orange, the golden and the yellow, peaks became low and shifted hypsochromically to short wave lengths (Fig. 2 and Table 1.) The curves of the red showed the peaks of carotenoids (509 nm) and anthocyanins (538 and 582) as well. The peaks in the KCI solution gave slightly longer waves than those of petals and were almost the same as usual lavender colors (4).

Table 2 shows the varietal differences of carotenoid contents in petals of 4 varieties. Total contents of three rare varieties were lower than that of the typical one. particulerly the yellow contained only one fifth of the orange. Also, the compositions of carotenoids in the yellow, the golden and the red varieties were different from those of the orange one. The latter variety contained the highest amount of γ-carotene, over 43% of the total, and high amounts of β-carotene

Table 1. Absorption spectra of petals in four varieties of *C. aurantiaca.*

Variety	Type of absorption spectrum[1]	Absorption maxima (nm)
Yellow	II	426 450* 481
Golden	II	454* 475
Orange	II	456* 480s
Red	III	509 538* 582
		(509 545* 587)[2]

1 : II, carotinoid only, III, carotinoid and anthocyanin
2 : In 10% KCl
* : Main peak

and lycopene. Hydrocarbone carotenoids were more than 70% in the orange one. Rates of the hydrocarbones in the yellow, golden and red varieties were 16, 44 and 72%, respectively. The yellow variety was very high in xanthophyll contents. The next was β-carotene, which was the highest in the golden variety.

In the red flowers the content of anthocyanins was 0.264 OD per g fresh weight measured at 520 nm. It was about quarter OD of carotenoids at 450 nm. This corresponds with the ratio of the area indicating carotenoids to the area of anthocyanins shown in the curve of the orange variety in Fig. 2.

Table 2. Carotenoid contents of petals in four varieties of *C. aurantiaca.*

Compound	Variety (mg/100g f.w.)			
	Yellow	Golden	Orange	Red
β-Carotene	.44	2.64	2.02	.51
γ-Carotene	.03	.73	6.28	2.15
Lycopene	tr	.22	2.33	.64
β-Cryptoxanthin	.29	.48	1.01	.17
Rubixanthin	.32	1.18	1.14	.15
Xanthophylls[1]	.95	2.31	1.11	.66
Others[2]	.86	.55	.77	.27
Total	2.89	8.11	14.66	4.55

1 : Diols and polyols
2 : Esters of xanthopylls

DISCUSSION

There are many species producing yellow to orange flowers: *L. flava, L. cinnabarina, L. xanthina, C, dowiana* and *C. aurantiaca.* However, no variety blooming flowers in different colors is known except *C. aurantiaca.* This species includes the 4 varieties mentioned above. The red flowers shown in Fig. 2 and Table 1 contain anthocyanins. Their occurrence is not clear, possibly because: 1) anthocyanins come from red spots which apppear on lips and sometimes on petals; 2) the tip of lip is somewhat round and different from typical flowers with a sharp tip, postulating hybridization with *C. skinneri* which contains anthocyanins (4, 5) and 3) the plant yielded from an apogamic seed. There is an observation that a seedling obtained from the crossing of *C. aurantiaca* and a yellow species, *Blc* Witbeck, bloomed yellow flowers in the same shape and size as *C. aurantiaca* parent. In any case, it is clear that the coloration of flowers may be ascribed to the coexistence of anthocyanins and carotenoids. The data corresponded with the results of microscopic observations (1). The anthocyanins contained in the red variety must be the same as those contained in the typical *Cattleya* such as *C. trianae* (4), since the spectrum of the former was different but that of the solution extracted with 10% KCI was similar to that of the latter.

The changes in the colors, red to yellow, shown in the chromaticity diagram corresponded well with the hypsochromic shift of the main peak in the absorption spectra. The absorption spectra were also examined by Yokoi (6). That of yellow petals belongs to the type expressed by only the carotenoid presence. The change in orange color of the typical variety to yellow is based on the change in carotenoid composition. Thus, the orange and yellow colors are mainly ascribed to γ-carotene and xanthophylls, respectively, Also, the total content of the yellow variety was one fifth of that of the typical. Comparing these two varieties with the golden one which shows content intermediate between both varieties and high amounts of β-carotene and rubixanthin, one may postulate a possible biochemical route of the changes. γ-Carotene in the orange can be oxidized enzymatically into rubixanthin in the golden and, in the yellow, both γ-carotene and rubixanthin are partially or completely oxidized into xanthophylls. β-carotene was not oxidized in the golden but in the yellow. Thus, the oxidation of hydrocarbones is considered to occur in the yellow and to yield many xanthopylls. These characteristics can be effectively utilized to obtain new hybrids.

LITERATURE CITED

1) Matsui, S. & Nakamura, M. : Distribution of flower pigments in perianth of *Cattleya* and allied genera I. Species. J Japan. Soc. Horo. Sci. **57** : 222-232, 1988.
2) Yasuda, H. : Physiology and biochemistry of flower colors. Uchida-Rokkakuho, Tokyo, 1973.
3) Matsui, S. : A yellow pigment, a group of carotenoids, contained in flowers of *Cattleya*s. Proc. Nagoya Intr. Nat. Orchid Show '91. 138-140, 1991.
4) Matsui, M. & Yano, M. : Absorption spectra of yellow, red and purple flowers in *Cattleya* and allied allied genera. Ann. Meeting of Japan. Soc. Hort. Sci. in Tokai and Kinki district p18, 1992.
5) Arditti, J. & Fisch, M.H. : 'Anthocyanins of the Orchidaceae' in "Orchid biology" Arditti, J. ed. Ithaca. London : Cornell Univ. Press, 118-215, 1974.
6) Yokoi, M : Flower colour and pigment distribution in the cultivated species and cultivars of 36 genera of orchids. Tech. Bull. Fac. Hort., Chiba Univ. **14** : 20-28, 1975.

Cattleya aurantiaca の変種における花色変化

松井鋳一郎

（附属農場）

（1992年７月20日受理）

摘　　要

普通のオレンジ色の花色の *Cattleya aurantiaca* 変種と比較し，黄色変種はカロチノイド含量が著しく低く，その吸収曲線は短波長側に移動した。これは普通種に多いγ-カロチンとリコピン含量が低下し，一方，相対的にキサントフィルが多くなったためである。赤色変種は吸収曲線からアントシアニンとカロチノイドが共存することがわかった。この変種のカロチノイド組成は普通種のものと類似していた。黄金色変種はβ-カロチンが多かった。

岐阜大農研報（57）：181—185，1992