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Evaluation of Red Pigment of Cockscomb Flower in Model Food Systems as a Natural Food Colorant

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Abstract

To evaluate a pigment of the flower of cockscomb, *Celosia cristata*, as a natural food colorant, jelly-po, candy and sherbet were chosen as model foods and colorized to red with the pigment of the flower. Color changes were evaluated by analyses with Hunter color difference colorimeter, Lovibond tintometer and UV-visible spectrophotometer. Also sensory evaluation was carried out. The results obtained indicated that the red pigment of the flower had a good potential as food colorant, when it is utilized under the certain limited conditions: low water activity such as candy or low temperature. Data obtained indicated good correlation between instrumental analyses and sensory evaluation as well.

Introduction

Great attention has been paid during recent years to the usage of natural food pigments as permitted colorants. This interest was manifested by the growing restrictions in the usage of synthetic coloring compounds as food additives.

Red beet is one of the most logical sources for water-soluble red colorants. The properties of this red pigment, betacyanin, were well characterized both chmically and physically[1-3]. It has also been studied as colorants in several foods[4-6] and has been available in the market as a beet concentrate. Nevertheless, its source is imited, according to the region of the world.

For a potential alternative for betacyanin of red beet, previously we have purified and characterized red pigment of cockscomb flower as betacyanin[7]. The flowers contain average 3-5% betacyanin in their dried flowers and this betacyanin is very similar but not identical to the beet betacyanin. The flower has been used for colorization of certain traditional Korean foods for long time and its source is plenty.

This communication describes evaluation of the red pigment of the flower in some foods as model system.

Materials and Methods

Pigment preparation

Fresh flowers of cockscomb, *Celosia cristata*, harvested in fall were air-dried in the absence of light and ground to pass through a 80-mesh screen. Twenty g of the powder were extracted three times with 200 *ml* H_2O and filtered using a Whatman #1 filter paper. The combined filtrates were lyophilized and yielded 6 g of a crude pigment preparation. This dried preparation of the pigment was used in this experiment.

Preparation of model foods

As model foods, commercially available colorless jelly-po (Sam-Rip Foods Co.), candy (Hai-Tai Confectionary Co.) and sherbet (Sam-Rip Foods Co.) were chosen for an intermediate-moisture food, a solid food and a frozen food, respectively. For colorization with the red pigment, different concentrations of pigment were used depending on the characteristics of the products as follows;

1) Jelly-po: 300 *g* jelly-po (colorless) were melted by heating at 60°C, mixed homogeneously with 100 *mg* red pigment before solidification, and solidified in round shape.
2) Candy: 500 *g* candy (colorless) were melted by heating at 130°C, mixed homogeneously with 1 *g* red pigment before solidification and solidified in round shape.

3) Sherbet: 100 *g* powder-sherbet (colorless) in 500 *ml* H_2O were mixed thoroughly with 30 *mg* red pigment, filtered with Whatmen #1 filter paper, frozen in 50 *ml* beaker and stored at −20°C.

For stroage, the colored jelly-po were stored at 4°C and 30°C; the colored candy at 20°C, wrapped with and without aluminum foil; the colored sherbet at-20°C.

Color

For color measurements, 3 kinds of methodology were utilized; Hunter color difference, Lovibond tintometer, and UV-visible spectrophotometer methods, depending on the charcteristics of the model foods. Color measurements of jelly-po were made with a Hunter color difference meter (Hunter Assoc. Lab, Fairfax, Va.). The instrument was standardized with the gray standard plate (L = 33.2, a = 0.0, b = 0.5). Results were expressed with parameters, L, a, and b which represent brightness, redness, and yellowness, respectively. From those values obtained, ΔE, total color difference was calculated from the equation, $\Delta E = [(L_1-L_2)^2 + (a_1-a_2)^2 + (b_1-b_2)^2]^{1/2}$, where (L_1-L_2), (a_1-a_2), and (b_1-b_2) represent the difference of the corresponding color stated above, respectively. Also the changes of color of jelly-po, candy and sherbet during the storage were examined by the conventional Lovibond tintometer (Tintometer Co. Model E, USA) and UV-visible spectrophotometer (Beckman Model G-24) as well. For the spectrophotometric analysis, each sample was dissolved in the appropriate volume of water and centrifuged after it was dissolved completely. Using the clear supernatant, the % residual was calculated by comparing the changes of absorbance at 537 *nm*[8].

Sensory evaluation

The colored model foods were evaluated for color using a semitrained 20-member panel. For the evaluation, 3 kinds of sample according to the time schedule were presented to the panel under full or subdued lighting using a standard day light type lamp system. The sample was scored on a 9 hedonic scale from 1: dislike extremely to 9: like extremely. Mean scores and analysis of variance were determined. With these results, the correlationship between the scores of panel test and instrumental data were analyzed by statistical method of Parzen[9].

Results and Discussion

Instrumental analyses

The color changes of jelly-po were measured directly during the storage at 4°C and 30°C with a constant time interval by using Hunter Lab Colorimeter. As shown in Table 1, a value was decreased remarkably and the b and L values were increased gradually with the lapse of storage time when jelly-po was stored at 30°C. This result indicates that the color was changed gradually from red to yellow or to more bright colors. For the case of storage at 4°C, however, the L, and b values were relatively constant and these indicates that the original red color was not changed. The total color difference for jelly-po colorized with the flower pigment can be compared by ΔE values obtained from the instrumental analysis. The data obtained indicate that total change of color was relatively negligible when the jelly-po was stored at 4°C, where as the change was significantly serious during the storage at 30°C. Analyses of candy and sherbet with Hunter color difference meter were not

Table 1. Color changes of jelly-po colorized with red pigment of the cockscomb flower measured by Hunter color difference colorimeter

Measurement	Storage temp. (°C)	Storage time (days) 0	7	14	30
L	4	10.6	10.8	11.3	12.2
	30	10.6	15.0	15.9	17.3
ΔL	4	0	0.2	0.7	1.6
	30	0	4.4	5.3	6.7
a	4	10.1	9.9	9.6	7.4
	30	10.1	1.2	−7.8	−8.4
Δa	4	0	0.2	0.6	2.7
	30	0	8.9	17.9	18.5
b	4	−1.1	−0.7	−0.4	0.6
	30	−1.1	4.2	5.8	8.1
Δb	4	0	0.4	0.7	1.7
	30	0	5.3	6.9	9.2
ΔL*	4	0	0.489	1.15	3.78
	30	0	11.25	19.9	21.72

$^*\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$

carried out because of the instrumental limitation.

When color changes were evaluated with Lovibond tintometer as shown in Table 2, the value of red color indication of jelly-po stored at 30°C was decreased markedly and that of yellow color was increased significantly, although the product stored at 4°C showed that the pigment was relativley stable. However, the changes of color of candy or sherbet determined by tintometer were not changed during the storage, no matter the products were stored with Al-wrapping or without wrapping. The results obtained by tintometer also revealed the same tendency in color changes for jelly-po stored at 4°C.

The facts that the pigment of the flower was stable in case of candy, sherbet or jelly-po stored at 4°C and unstable in those jelly-po stored at 30°C were also confirmed when the % residuals were determined by the UV-visible spectrophotometer. As can be seen in Fig. 1, the % residual of jelly-po stored at 30°C was decreased significantly, up to 30% within two week-storage, while the other samples were not changed (decolorized) until 30-day storage.

Table 2. Color changes of model foods colorized with red pigment of the cockscomb flower measured by Lovibond tintometer

Model foods	Measurement	Storage temp. (°C)	Storage time (days) 0	7	14	30
Jelly-po	Red	4	11.1	10.7	9.8	8.6
		30	11.1	2.8	2.0	1.4
	Yellow	4	0.7	0.8	1.0	1.3
		30	0.7	4.6	6.5	8.9
Candy	Red	20 + light	19.6	19.2	18.4	18.1
		20 - light	19.6	19.6	19.0	18.8
	Yellow	20 + light	1.3	1.6	1.6	1.8
		20 - light	1.3	1.5	1.5	1.6
Sherbet	Red	-20	24.9	24.3	22.7	20.8
	Yellow	-20	3.3	3.5	3.9	4.2

\+ light: presence of light
\- light: absence of light

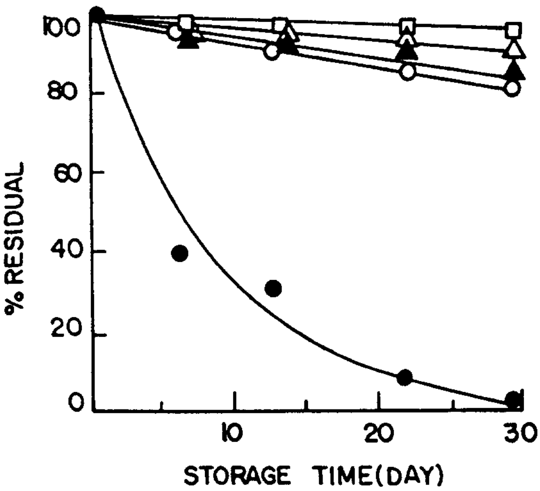

Fig. 1. Residual (%) of red color during the storage of model foods colorized with red pigment of cockscomb flower
(o-o: jelly-po at 4°C, ●-●: jelly-po at 30°C, Δ-Δ: candy with Al-foil at 20°C, candy without Al-foil at 20°C, □-□: sherbet at -20°C)

Table 3. Sensory evaluation of model foods colorized with red pigment of the cockscomb flower by nine hedonic scale tests*

Model foods	Storage temp. (°C)	Storage time (days) 0	7	14	30
Jelly-po	4	7.18 ± 0.93	6.83 ± 1.21	6.50 ± 1.62	5.82 ± 1.45
	30	7.18 ± 0.93	3.40 ± 1.82	1.20 ± 0.96	1.10 ± 1.36
Sherbet	-20	8.12 ± 0.43	7.69 ± 0.56	7.42 ± 0.37	7.01 ± 0.94
Candy	20 + light	7.41 ± 1.31	7.13 ± 1.35	7.20 ± 1.34	7.12 ± 1.47
	20 - light	7.41 ± 1.31	7.30 ± 1.06	7.24 ± 0.87	7.38 ± 1.24

*9 hedonic scale; 1: dislike extremely, 2: dislike very much, 3: dislike moderately, 4: dislike slightly, 5: neither like nor dislike, 6: like slightly, 7: like moderately, 8: like very much, 9: like extremely.
\+ light: presence of light, - light: absence of light

Sensory evaluation

Sensory evaluation scores for color changes of model foods are shown in Table 3. In general, the color acceptance for the sample stored at lower temperature (sherbet) or lower water activities even at higher temperature (candy) were higher than the reverse conditions during storage times. These results were well conicided with that of Rockland and Nishi for the red beet pigment[10]. However, even in the sample of jelly-po, the initial sensory score of red color had very high absolute hedonic values.

Relationship between analyses

The correlationship between the values of instrumental analyses and panel test for jelly-po as an example were calculated as shown from Fig. 2 to Fig. 4 by regression analyses. The results showed that they had very close-relationship. According to the findings obtained, therefore, any method for the color changes among these instrumental analyses and sensory evaluation, can be utilized to represent the typical color changes for this food system.

Previously, we have found that a red pigment of cockscomb flower is a betacyanin[7]. Since the flower contains very attractive red color and its content is relative ly high, it has a good potential as a natural food colorant, specially as an alternative for beet betacyanin. In this study, therefore, we aimed to evaluate the red pigment of the flower in food systems. Experimental findings obtained in this study on the red pigment of the flower open its application to food systems as a natural food colorant under the certain limited conditions: low water activity such as candy or low temperature. Such probelems also encountered with the betacyanin of red beet as reported as Pasch *et al*[4] and von Elbe *et al*[5]. They found that the beet pigment is fairly stable in the conditions of lower water activity and lower temperature. Previous result[7] also revealed that the aqueous pigment solution was stable at low temperature.

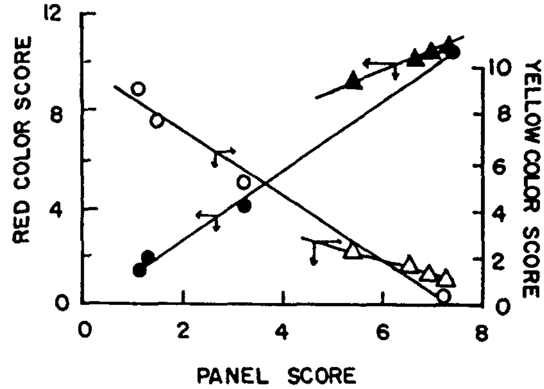

Fig. 3. Regression line between panel score and Lovibond tintometer score for jelly-po
(●-●: red at 30°C, o-o: yellow at 30°C, red at 4°C Δ - Δ: yellow at 4°C). Arrows indicates the corresponding axes

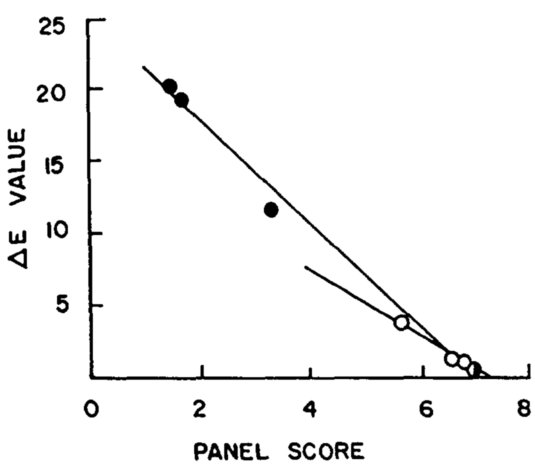

Fig. 2. Regression line between the panel score and total color difference colorimeter(ΔE) of Hunter color difference colorimater for jelly-po
(o-o: 4°C, ●-●: 30°C)

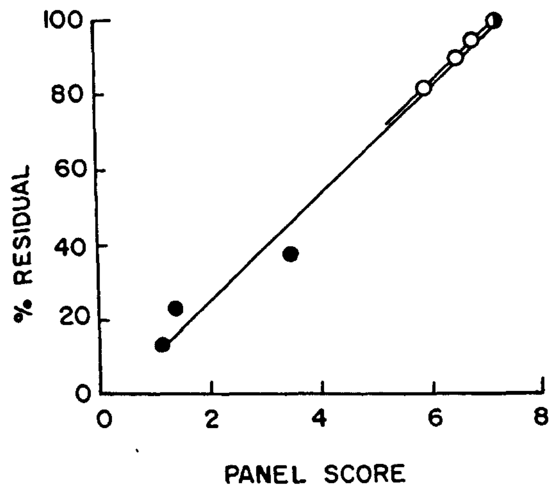

Fig. 4. **Regression line between the panel score and the residual (%) of absorbance at 537 *nm* for jelly-po**
(o-o: 4°C, ●-●: 30°C)

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모델식품을 이용한 맨드라미 적색색소의 식품학적 평가

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맨드라미 붉은 색소의 식품학적 평가를 위하여 모델식품으로 젤리포(중간수분 식품), 캔디(고상식품) 및 샤베트(냉동식품)를 선택하여 맨드라미 붉은 색소로서 빨갛게 착색시켰다. 저장중 색도변화는 Hunter 색도계, Lovibond tintometer 및 분광광도로서 측정 분석하였고 아울러 색도관능 시험도 행하였다. 실험 결과로서 맨드라미 붉은 색소는 특정한 조건의 식품; 수분 활성도가 낮은 식품 및 냉동 식품에 성공적으로 활용할 수 있음을 알았다. 각 측정기기 사이에서 얻은 실험 결과는 밀접한 상관 관계가 존재하였다.