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Effect of Drying Agents and Ethyl Alcohol on Change of Flower Color of Gentian (*Gentiana uchiyamai*) in Pressed Flower

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ABSTRACT

The effects of drying agents and ethyl alcohol treatment on the flower color of *Gentiana uchiyamai*. The flower color was not much changed in flower sheet, in the case of absorbtion papers only. The color was least changed in Korean and China hwasunjis, in the case of absorbtion papers and silica gel treatment. The color was less changed in flower sheets, window papers, and China hwasunjis, and was most changed in newspapers, in the case of absorbtion papers and Na_2SO_4 treatment. The color was least changed in China hwasunjis, and most changed in dampened papers, in the case of absorbtion papers and CaO treatment. The color tended to change far from the original one, as treatment time got longer, in the case of 0.01M and 0.1M of tartaric acid. The longer the treatment time and the bigger the concentration of ethyl alcohol, the bigger flower color.

Key Words : *Gentiana uchiyamai*, drying agents, ethyl alcohol, flower color, pressed flower,

INTRODUCTION

Gentian, which is distributed on grassy plains of mid-north areas of Korea, is a perenial herb. It' s height is about 1 meter, and there is no hair on the radical leaves. The length between the joints are same, and the front joint is 4 to 8 meters.

A gentian is sorted as *Gentiana algida*, a gentian, *Gentiana axillariflora*, *Gentiana uchiyamai*, and among the flowers Gentian uchiyamai, which is purple, is loved as cut flowers and cultivated, because of the shape and the color of the flowers. It flowers in August and September, and used as a medicine for a strong stomach, diarrhea, epilepsy, nervousness, a disease of the heart, and eczema (Kim, 1996).

For arranging flowers and making a bunch of flowers cut flowers are used, but it is not so easy to keep them long, and it is necessary to throw away them when they wither.

As science develops, people want to make the environment more beautiful. So they take interests in dried flowers that last longer.

But for drying flowers it is necessary to come up with proper dry methods, because when the flowers are dried, the color change.

The petals of a natural flower has a weak acid, and water in the cell combines with enzyme and protein, and it destroys the pigments. So most of the flowers change, when they are dried.

There are several dry methods such as silica-gel treatment, water absorbtion paper, warming(Park et al.,

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1998 ; Song et al., 1998).

Absorbents (Park et al, 1998) and size of silica gel (Sohn, 1994; Song et al., 1998) affects on the dry condition of plants on the folwer color changes.

Dried flower are used since 1960' s with the economic development, and were used in homes and companies as a decoration in 1970' s.

In 1980' s when the domestic products and foreign products were used at the same time, the basic research about dried flowers was started. In 1990' s academic research was started on drying and processing flowers.

The most important part of making dried flowers is drying and processing, because it decides the quality of the products.

In this experiment, how absorbents and ethyl alcohol affect on the color of flowers and drying are seen.

MATERIALS AND METHODS

The materials are purple *Gentiana uchiyamai* which is sold at market. They were very fresh and pre-treatment was done 20 times.

1. Materials treatment

The flowers that are more than half-flowered were chosen and cut vertically, and then a pistil and a stamen was got rid of. Water and pollen were got rid of too, and the strong color part, which was the two third center, was cut in 1cm × 1cm.

2. Water absorbtion paper and a drying agent treatment

1) Water absorbtion paper treatment only

Six kinds of absorbtion paper (flower sheet, newspaper, dampened paper, sliding screen paper, China hwasunji, Korean hwasunji) were used, and the weight of the papers were 50g, and the size was the same as the Sunchon University newspaper.

All the absorbtion papers were dried by irons. The six kinds of papers were put on and under the petals, and the papers were 50g each.

The papers except the newspapers were bought in the market, and covered with vinyl, and pressed by two red bricks and dried in order to keep the flowers from air.

2) Water absorbtion paper and a drying agent treatment

Blue silica gel, Na_2SO_4 and CaO were used as a drying agent. A bunch of absorbtion paper (50g) was placed on the bottom, and then petals, another bunch of absorbtion paper(50g), 23 grams of blue silica gel, Na_2SO_4 and CaO (thin and widely sprayed), and a bunch of absorbtion paper were placed in order. And then it was sealed up twice, and aired out, and pressed in order to keep the flowers from air contact.

3. Checking the flower colors

In order to check the flower color during the flowers are fresh, and during they are drying, dust and water and pollen on the surface of the petals were eliminated. The color was checked in the Electronic Balance of A & D in Japan six times at two-day intervals.

The Colorimeter for color checking was Japanese Juki (Model JK-777) Colorimeter, and the result automatically caculated from the colorimeter analysis system was used as the L * a * b * measuring result. The final analysis was done on the basis of comparing the result of $\Delta E^*(ab)$ (= $(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2$).

And the results of the absorbtion paper treatment only and the drying agent treatment were analysed. For the color change color solid was used.

It could be said that the less the $\Delta E^*(ab)$ result is, the less is result of color change.

RESULTS AND CONSIDERATION

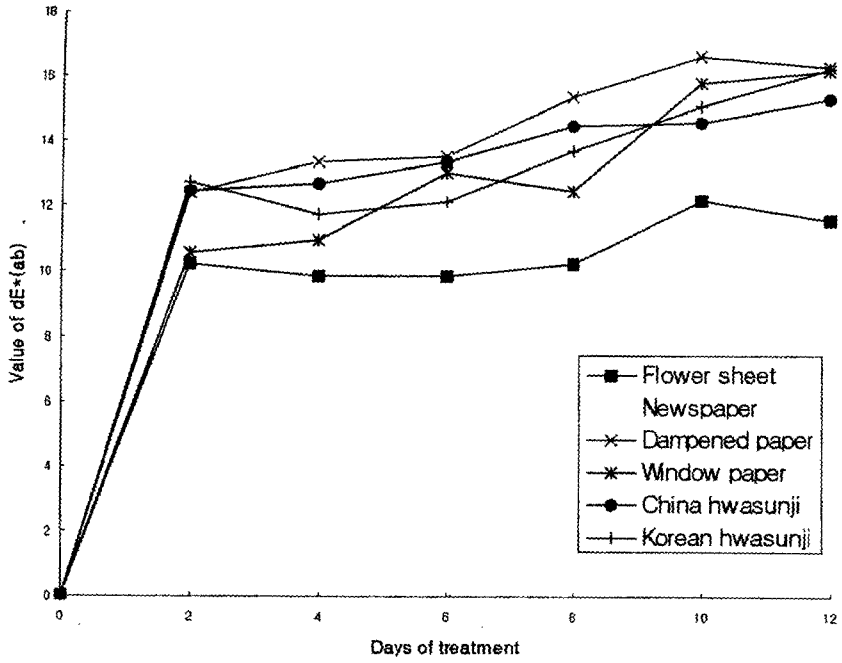

Fig. 1. Variation of ΔE*(ab) by treatment of absorbtion papers on flower color in *Gentiana uchiyamai*.

1. The flower color change by the absorbtion paper

There are reports that the contact of the water contents in the air and absorbtion papers, and the kinds of absorbtion paper, and its physical characteristics affect on the flower color change greatly (Song et al, 1998). Here is the result that how the kinds of absorbtion paper affect on the gentian (*Gentiana uchiyamai*) flower color change (Table 1, Fig 1).

In the case of flower sheet in blue gentian treatment, there was no treatment. In the second day ΔE* (ab) result was 10.26, and in the fourth day it was 9.88. In the 8th day it was 10.26, and in the 12th day it was 11.58. So it could be concluded that the fourth day is the best for flower color.

Song et al.(1998) reported that in the case of flower sheet in treatment of absorbtion paper, which affects on the flower color and the leaf color of pressed roses, ΔE* (ab) result was almost the same as treatment period went by, and then after a certain period the numerical value was getting higher. This means that the color almost was not changed. But in the case of the blue-purple gentian the ΔE* (ab) result was getting higher by time, but the color wasn' t much changed.

In the case of newspaper, the ΔE* (ab) result was 13.17 in the second day, 13.41 in the fourth day, 15.69 in the 8th day, and 16.65 in the 12th day. When newspapers were used as an absorbent, the color was changed a lot. So the fourth day would be the best time for drying. As time went by, the ΔE* (ab) result of the newspapers treatment for pressed roses was getting higher. But the treatment period was getting longer, the color was getting close to the original color (Song et al., 1998). On the other hand, For purple petunia flower color, the ΔE* (ab) result in the newspaper treatment was getting higher. So the color was much different from the original color (Song et al., 1998).

Table 1. Effect of papers on the change of flower color in *Gentiana uchiyamai*.

Days of treatment	Value of color	Flower sheet[v]	Newspaper r	Thin writing paper[u]	Window paper[t]	Chinese drawing paper[s]	Korean drawing paper[r]
0	L*[z]	43.30	42.97	42.45	42.37	44.34	41.94
	a*[y]	18.10	19.66	19.38	17.95	16.79	17.33
	b*[x]	-34.47	-35.34	-34.38	-34.06	-33.49	-33.39
2	L*	33.88	32.37	32.28	32.81	33.42	29.93
	a*	14.26	13.46	13.20	13.59	11.37	13.34
	b*	-33.08	-30.58	-30.95	-32.86	-31.00	-32.02
	⊿L*	-9.41	-10.60	-10.16	-9.56	-10.93	-12.01
	⊿a*	-3.83	-6.20	-6.19	-4.36	-5.42	-4.00
	⊿b*	1.38	4.77	3.43	1.20	2.49	1.37
	⊿E*(ab)[w]	10.26	13.17	12.38	10.58	12.45	12.73
4	L*	33.56	32.45	32.07	32.57	33.16	32.78
	a*	14.28	12.87	12.24	13.30	11.22	10.76
	b*	-33.03	-30.56	-29.97	-32.43	-31.44	-30.15
	⊿L*	-8.91	-10.53	-10.38	-9.80	-11.18	-9.16
	⊿a*	-3.96	-6.79	-7.14	-4.64	-5.57	-6.57
	⊿b*	1.59	4.78	4.41	1.63	2.06	-3.23
	⊿E*(ab)	9.88	13.41	13.35	10.97	12.66	11.72
8	L*	32.60	31.63	31.55	36.31	32.70	32.95
	a*	12.15	11.18	10.69	8.97	9.51	8.84
	b*	-31.46	-28.58	-27.98	-27.95	-28.97	-27.54
	⊿L*	-8.93	-11.34	-10.89	-6.06	-11.64	-8.98
	⊿a*	-4.05	-8.48	-8.69	-8.98	-7.28	-8.49
	⊿b*	3.01	6.76	6.40	6.11	4.52	5.85
	⊿E*(ab)	10.26	15.69	15.34	12.44	14.45	13.68
12	L*	34.41	33.11	33.07	34.59	33.35	33.67
	a*	12.13	9.23	8.71	6.86	7.88	6.46
	b*	-30.05	-26.91	-26.41	-25.17	-27.64	-24.58
	⊿L*	-8.89	-9.87	-9.38	-7.78	-10.99	-8.27
	⊿a*	-5.97	-10.43	-10.67	-11.09	-8.91	-10.87
	⊿b*	4.42	8.43	7.97	8.89	5.85	8.80
	⊿E*(ab)	11.58	16.65	16.29	16.20	15.31	16.25

[z]L* : Lightness

[y]a*, [x]b* : Chromaticity coordinates

(a* : Red direction, -a* : Green direction, b* : Yellow direction, -b* : Blue direction)

[w] $\Delta E^*(ab)=\sqrt{(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2}$

[v]Flower sheet : Paper made in Japan for Press flower, [u]Dampened paper : For practice in writing characters, [t]Window paper : Pasting Paper at room door to traditional house of Korea, [s]China hwasunji : Traditional drawing paper that made in China, [r]Korean hwasunji : Traditional drawing paper that made in Korea

In this newspaper treatment the ΔE^* (ab) result was getting higher, and the color was changed a lot.

In the case of dampened paper, the result was 12.38 in the 2nd day, 13.35 in the 4th day. 15.34 in the 8th day, and 16.29 in the 12th day. So it could be said that the result was almost the same as the newspaper treatment.

In the case of sliding screen paper, the result was 10.58 in the 2nd day, 10.97 in the 4th day, 12.44 in the 8th day, 16.20 in the 12th day. The color was changed much, and this is the same result as Yang' s flower and leaf colors of roses and the absorbtion paper, and Park (1998)' s flower and leaf color of yellow tulips and the absorbtion paper.

the ΔE^* (ab) result for China hwasunji was 12.45 in the 2nd day, 12.66 in the 4th day, 14.45 in the 8th day, and 15.31 in the 12th day. The color wasn' t changed that much this time.

The value for Korean hwasunji was 12.73 in the 2nd day, 11.72 in the 4th day, 13.68 in the 8th day, 16.25 in the 12th day. The color change was almost the same as the China hwasunji, but the change between the fourth day and the eighth day was bigger than the Chinese one.

The Gentian (*Gentiana uchiyamai*) flower color change by absorbtion papers was flower sheet (11.58), China hwasunji (15.31), window paper (16.20), Korean hwasunji (16.25), dampened paper (16.29), newspaper (16.65) in ascending powers.

In all the treatment except the flower sheet, the color change was not distinguishable with naked eyes.

This kind of result could tell that the kinds of paper could affect on the flower color change, as the other reports that absorbtion paper' s weight was heavier in Flower sheet, and absorbing speed and the amount was better in Flower sheet in the condition of saturation humidity (Song et al., 1998) showed.

2. The flower color change by the absorbtion paper and silica gel

There are two types of silica gel. One is O.C.I GelA, which colloid particles of silica are clustered, and absorbtion power in low humidity is very good due to the wide surface area and small work capacity. So water absorbtion could be observed from outside. Before water absorbtion, it' s blue, and then the color turns into pink as water contents get higher. The other silica gel is O.C.I. GelB, which it' s work capacity is big, so absorbtion power is high in high humidity. Because of the chemical structure, the water contents absorbed in high humidity is slowly released as humidity of relativiy gets lower. O.C.I. GelB is used as a humidity controller, because of this repetition of absorbtion and dehydration.

In this experiment O.C.I. GelA type silica gel, which is blue, was used, in order to absorb even small amount of humidity (moisture) (Allen et al., 1979 ;Hrazdina ,1982; Song et al., 1988; Taylor, 1992; Yoshida et al., 1995). It was researched that how blue silica gel affects on flower color change with the six kinds of absorbtion papers (Table 2, Fig. 2).

For flower sheet, there wasn' t a big change in color between the second day (12.71) and eighth day (13.56), but in the 12th day (15.16) the color was much changed. This result is little bit different from the report of Song et al. (1998) that the ΔE^* (ab) of flower sheet was getting lower as time went by, which means that the color got close to the original color in the experiment of flower and leaf color of roses.

In the case of newspaper, the result was 13.75 in the second day, and 13.10 in the 4th day, and then got higher with the time lapse. So it would be better to get rid of the newspaper in the 4th day.

The ΔE^* (ab) result of dampened paper was 12.83 in the 2nd day, 13.16 in the 4th day, 15.38 in the 8th day, and 15.52 in the 12th day. This contrasts with the reoort mentioned above, which said the result was getting lower, so the color wal close to the original

Table 2. Effect of papers with silica gel on the change of flower color in *Gentiana uchiyamai*.

Days of treatment	Value of color	Flower sheet[v]	Newspaper r	Dampened paper[u]	Window paper[t]	China hwasunji[s]	Korean hwasunji[r]
0	L*[z]	41.80	44.37	48.15	42.52	44.43	40.87
	a*[y]	21.71	19.91	16.44	18.05	15.92	16.303
	b*[x]	-37.11	-35.12	-31.67	-35.27	-32.56	-31.65
2	L*	32.29	32.77	36.30	33.00	33.42	30.49
	a*	14.45	13.40	11.74	12.49	10.36	11.40
	b*	-32.82	-31.62	-30.21	-31.82	-30.37	-29.63
	⊿L*	-9.51	-11.60	-11.85	-9.53	-11.02	-10.38
	⊿a*	-7.26	-6.51	-4.70	-5.56	-5.56	-4.90
	⊿b*	4.30	3.50	1.46	3.45	2.20	2.03
	⊿E*(ab)[w]	12.71	13.75	12.83	11.56	12.53	11.65
4	L*	31.36	32.90	36.03	32.15	33.27	30.04
	a*	14.96	14.20	11.18	12.41	11.24	12.12
	b*	-33.39	-32.39	-29.68	-31.81	-31.19	-30.78
	⊿L*	-10.44	-11.47	-12.12	-10.38	-11.16	-10.83
	⊿a*	-6.75	-5.71	-5.26	-5.64	-4.69	-4.19
	⊿b*	3.72	2.73	1.99	3.46	1.37	0.87
	⊿E*(ab)	12.97	13.10	13.16	12.31	12.18	11.64
8	L*	31.46	32.92	34.37	32.81	32.46	29.75
	a*	14.55	12.98	10.50	10.65	10.24	10.92
	b*	-32.05	-30.86	-28.26	-29.14	-29.46	-28.34
	⊿L*	-10.34	11.45	-13.77	-9.71	-11.98	-11.12
	⊿a*	-7.16	-6.93	-5.94	-7.40	-5.68	-5.38
	⊿b*	-5.06	4.26	3.41	6.13	3.10	3.31
	⊿E*(ab)	13.56	14.04	15.38	13.66	13.61	12.78
12	L*	31.69	33.26	35.85	33.01	33.05	31.13
	a*	12.67	11.14	8.49	9.12	9.42	8.87
	b*	-30.33	-29.50	-26.51	-28.36	-29.43	-27.33
	⊿L*	-10.11	-11.10	-12.30	-9.52	-11.38	-9.73
	⊿a*	-9.03	-8.77	-7.95	-8.93	-6.50	-7.44
	⊿b*	6.79	5.63	5.16	6.91	3.14	4.32
	⊿E*(ab)	15.16	15.23	15.52	14.76	13.48	12.99

[z]L* : Lightness

[y]a*, [x]b* : Chromaticity coordinates

(a* : Red direction, -a* : Green direction, b* : Yellow direction, -b* : Blue direction)

[w] $\Delta E^*(ab)=\sqrt{(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2}$

[v]Flower sheet : Paper made in Japan for Press flower, [u]Dampened paper : For practice in writing characters, [t]Window paper : Pasting Paper at room door to traditional house of Korea, [s]China hwasunji : Traditional drawing paper that made in China, [r]Korean hwasunji : Traditional drawing paper that made in Korea

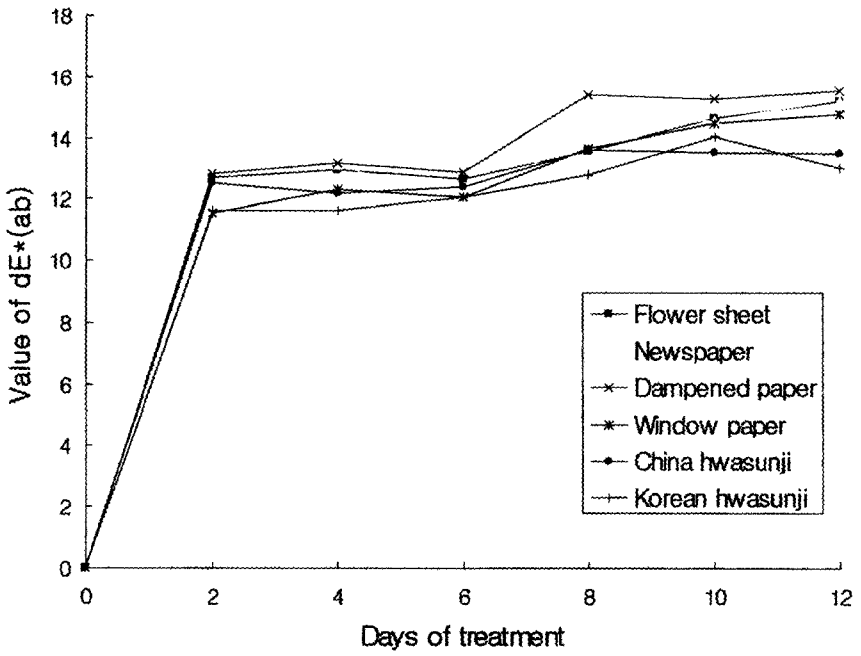

Fig. 2. Comparison of ΔE*(ab) by treatment of absorbtion papers and silica gel on flower color in *Gentiana uchiyamai.*

color at the end.

In the case of China hwasunji, in the 2nd day the result was 12.53, and 12.17 in the 4th day. From the 8th day there was a hardly change.

For Korean hwasunji, it was 11.56 in the 2nd day, 11.64 in the 4th day, 12.78 in the 8th day, and 12.99 in the 12th day. The change wasn' t almost happened with the time lapse.

In the experiment with the blue-purple Gentian, the ΔE * (ab) result got higher as the treatment period got longer in all the papers except the Korean hwasunji and China hwasunji. This means that the color got different from the original color, but it wasn' t much different with naked eyes.

The experiment that Song et al.(1998) did with the purple petunia was for flower color change by silica gel. The experiment showed that the mixed treatment with silica gel 23g and drawing papers changed the flower color more than the one with silica gel and flower sheet. But in the case of purple Gentian the treatment with silica gel and the Korean hwasunji showed hardly a change. These experiments show that using absorbtion paper is different according to the kinds of flowers.

Like the table 2 shows, the color was changed less with the silica gel, especially with the Korean hwasunji and the China hwasunji, followed by window paper, flower sheet, and newspaper. In the treatment with flower sheet, however, the color wasn' t change that much, even if silica gel was not put in.

Like the experiment Park did in 1998 this experiment showed that the mixed treatment with silica gel and absorbtion paper changed the flower color less. There was a report that silica gel greatly affects on flower color change in plane drying of plants, because silica gel' s primary element is a silicon dioxide that is non-crystal particle, porous structure is developed, is chemically stable, has wide surface area, and its chemical absorbtion capacity is good.

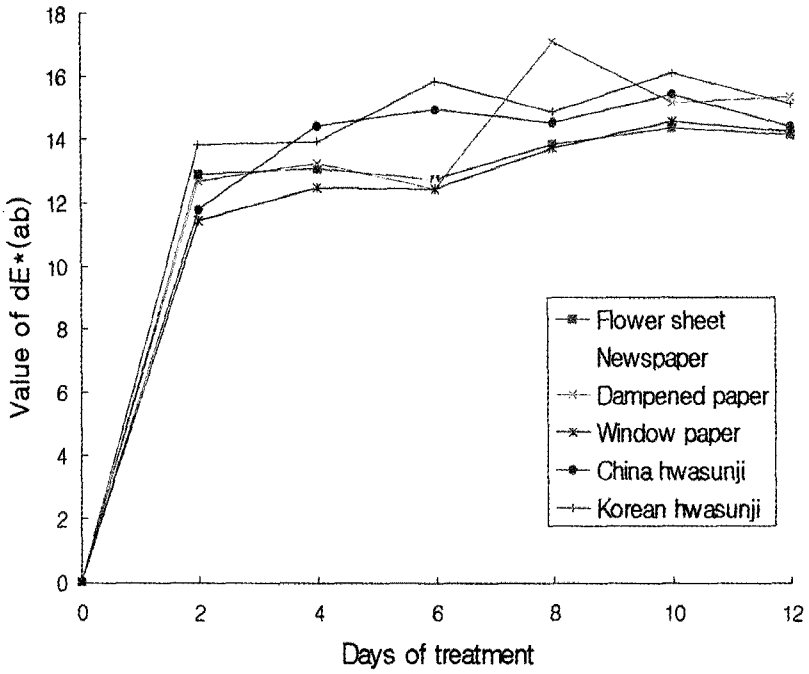

Fig. 3. Comparison of ΔE*(ab) by treatment of absorbtion papers and Na2SO4 on flower color in *Gentiana uchiyamai*.

3. The flower color change by the absorbtion papers and Na_2SO^4

This research is about the effect of the mixed treatment with absorbtion papers and Na2SO4, which is a drying agent, on flower color of blue-purple Gentian (Table 3, Fig. 3).

In the case of flower sheet, the ΔE * (ab) result was 12.89 in the 2nd day, 13.05 in the 4th day, 13.02 in the 8th day, and 14.11 in the 12th day. Even though the result showed the gradual increase, the color was not changed much with the naked eyes. This is similar with the experiment of Park et al. (1988) that was done to find out the effect of absorbtion paper on the flower and leaf color of yellow tulips. In this experiment mentioned above the ΔE * (ab) result was 6.02 in the 2nd day, and 6.83 in the 12th day.

In the case of newspaper, the result was 12.30 in the 2nd day, 13.30 in the 4th day, 15.15 in the 8th day, and 17.40 in the 12th day. It was not much changed between the 2nd day and the 4th day, but it was a lot different from the 8th day. So it is better to take out petals in the 4th day or 6th day. As time goes by the effect gets worse in the mixed treatment with Na_2SO_4.

In the case of dampened paper, the result got greatly increase from the sixth day, and then got decreased from the 10th day.

For window paper, the result was 11.44 in the 2nd day, 12.47 in the 4th day, 13.69 in the 8th day, and 14.21 in the 12th day. From the 8th day, there was a significant change.

For China hwasunji, it was 11.79 in the 2nd day, 14.42 in the 4th day, 13.69 in the 8th day, and 14.37 in the 12th day. So in this case it is better to take out petals.

In the case of Korean hwasunji, it was 13.81 in the 2nd day, 13.91 in the 4th day, which is not changed

Table 3. Effect of papers with Na_2SO_4 on the change of flower color in *Gentiana uchiyamai*.

Days of treatment	Value of color	Flower sheet[v]	Newspaper r	Dampened paper[u]	Window paper[t]	China hwasunji[s]	Korean hwasunji[r]
0	L*[z]	42.74	40.98	45.12	42.96	43.96	46.68
	a*[y]	20.40	21.29	16.60	16.39	15.14	17.35
	b*[x]	-36.41	-36.72	32.22	-32.53	-31.00	-33.58
2	L*	31.14	32.39	34.59	32.71	33.41	34.03
	a*	15.43	13.88	10.29	11.52	10.17	12.11
	b*	-33.77	-31.96	-29.09	-31.06	-29.30	-31.80
	⊿L*	-11.59	-8.59	-10.52	-10.25	-11.79	-12.65
	⊿a*	-4.97	-7.41	-6.31	-4.86	-4.97	-5.24
	⊿b*	2.64	4.76	3.12	1.47	1.70	1.78
	⊿E*(ab)[w]	12.89	12.30	12.66	11.44	11.79	13.81
4	L*	30.73	31.54	34.92	31.63	29.77	33.71
	a*	15.90	13.13	9.53	11.36	12.81	12.46
	b*	-33.98	-32.07	-27.64	-31.22	-31.96	-32.35
	⊿L*	-12.01	-9.44	-10.20	-11.33	-14.20	-12.97
	⊿a*	-4.50	-8.16	-7.06	-5.03	-2.34	-4.89
	⊿b*	2.43	4.64	4.57	1.31	-0.96	1.23
	⊿E*(ab)	13.05	13.31	13.22	12.47	14.42	13.91
8	L*	30.38	31.91	29.64	31.57	30.07	33.82
	a*	15.21	11.57	10.21	9.67	11.21	10.91
	b*	-33.04	-29.45	-28.86	-28.98	-29.60	-29.93
	⊿L*	-12.36	-9.07	-15.48	-11.39	-13.89	-12.86
	⊿a*	-5.19	-9.73	-6.39	-6.72	-3.94	-6.44
	⊿b*	3.36	7.26	3.36	3.55	1.39	3.65
	⊿E*(ab)	13.82	15.15	17.08	13.69	14.51	14.84
12	L*	30.90	32.63	33.15	34.00	30.88	35.43
	a*	13.90	9.30	8.19	7.26	9.70	8.62
	b*	-32.30	-27.29	-27.63	-26.34	-28.58	-28.61
	⊿L*	-11.83	-8.35	-11.97	-8.96	-13.08	-11.26
	⊿a*	-6.50	-11.99	-8.41	-9.13	-5.44	-8.73
	⊿b*	4.11	9.43	4.59	6.19	2.42	4.97
	⊿E*(ab)	14.11	17.40	15.33	14.21	14.37	15.09

[z]L* : Lightness

[y]a*, [x]b* : Chromaticity coordinates

(a* : Red direction, -a* : Green direction, b* : Yellow direction, -b* : Blue direction)

[w] $\Delta E^*(ab)=\sqrt{(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2}$

[v]Flower sheet : Paper made in Japan for Press flower, [u]Dampened paper : For practice in writing characters, [t]Window paper : Pasting Paper at room door to traditional house of Korea, [s]China hwasunji : Traditional drawing paper that made in China, [r]Korean hwasunji : Traditional drawing paper that made in Korea

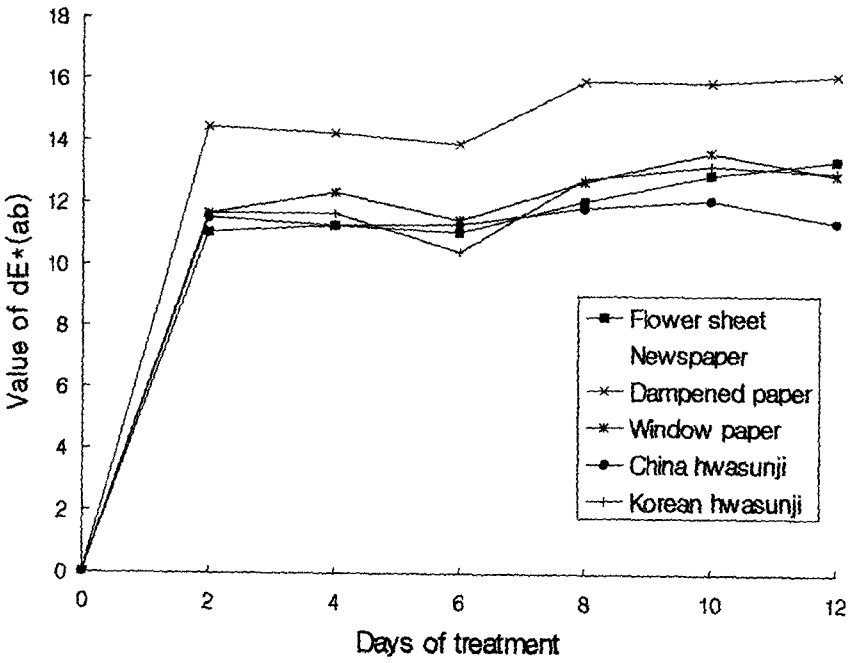

Fig. 4. Comparison of Δ E*(ab) by treatment of absorbtion papers and CaO on flower color in *Gentiana uchiyamai*.

much. And it was 14.84 in the 6th day. After that period the result was pretty much the same. Therefore, it is better to take out petals between the 2nd and 4th day from the Korean hwasunji, especially the 2nd day is even better.

When absorbtion papers and Na2SO4 was treated together, there was a big change in color in newspapers. But all the other papers didn' t show changes that much. This is because degree of strength and absorbtion capacity of recycled newspapers used for this experiment was lower than the flower sheet and drawing papers.

4. The flower color change by the absorbtion paper and CaO

Table 4 and Figure 4 show the result of the mixed treatment of alkaline CaO and absorbtion papers. In the case of drawing paper, it was 11.06 in the 2nd day, 11.28 in the 4th day, 12.09 in the 8th day, and 13.40 in the 12th day. So it could be said that it is better to take the petals out between the 2nd day and the 8th day. After that period, it' s not good.

In the case of newspapers, the result was 12.45 in the 2nd day, 12.66 in the 4th day, and 14.50 in the 12th day. Until 6th day, there was no significant change, and then after ten day it got higher.

For thing writing papers, it was 14.46 in the 2nd day, 14.26 in the 4th day, 15.94 in the 8th day, and 16.13 in the 12th day. The color change was very noticable in this case, because there were differences in materials, tissue, density, thickness, processing method when the writing papeprs were made. CaO was left on the surface and made the color muddy. This is related to the report of Song et al. (1998) that absorbtion amount of writing paper was the highest, but its water climbing power was very low.

For window paper, it was 11.65 in the 2nd day, 12.31

Table 4. Effect of papers with CaO on the change of flower color in Gentiana uchiyamai.

Days of treatment	Value of color	Flower sheet[v]	Newspaper r	Dampened paper[u]	Window paper[t]	China hwasunji[s]	Korean hwasunji[r]
0	L*[z]	41.33	44.34	46.59	45.18	43.84	43.78
	a*[y]	20.90	16.79	18.53	16.37	16.07	14.80
	b*[x]	-36.78	-33.49	-33.16	-32.20	-30.23	-30.57
2	L*	33.24	33.42	33.15	34.72	32.86	33.31
	a*	14.33	11.37	13.52	11.45	12.58	10.58
	b*	-33.05	-31.00	-31.29	-30.75	-30.44	-29.59
	⊿L*	-8.09	-10.93	-13.44	-10.46	-10.97	-10.38
	⊿a*	-6.56	-5.42	-5.01	-4.92	-3.49	-4.90
	⊿b*	3.73	2.49	1.87	1.45	-0.21	2.03
	⊿E*(ab)[w]	11.06	12.45	14.46	11.65	11.52	11.65
4	L*	32.63	33.16	32.99	33.68	32.99	32.75
	a*	14.67	11.22	14.38	12.01	13.46	11.42
	b*	-33.20	-31.44	-32.10	-31.65	-31.57	-30.70
	⊿L*	-8.70	-11.18	-13.60	-11.50	-10.85	-10.83
	⊿a*	-6.23	-5.57	-4.14	-4.36	-2.61	-4.19
	⊿b*	3.59	2.06	1.07	0.55	-1.34	0.87
	⊿E*(ab)	11.28	12.66	14.26	12.31	11.24	11.64
8	L*	34.02	32.79	31.90	33.62	32.56	32.63
	a*	13.49	11.08	13.17	11.45	12.55	9.57
	b*	-30.63	-30.19	-30.05	-30.20	-29.31	-28.44
	⊿L*	-7.31	-11.50	-14.69	-11.55	-11.28	-11.12
	⊿a*	-7.41	-5.72	-5.35	-4.92	-3.52	-5.38
	⊿b*	-6.15	3.30	3.11	1.99	0.92	3.31
	⊿E*(ab)	12.09	13.30	15.94	12.71	11.85	12.79
12	L*	33.45	32.59	32.63	34.44	33.64	33.16
	a*	12.54	9.59	11.67	10.12	11.35	9.19
	b*	-29.89	-28.98	-28.88	-28.63	-28.49	-28.11
	⊿L*	-7.88	-11.75	-13.96	-10.74	-10.19	-9.73
	⊿a*	-8.36	-7.21	-6.86	-6.25	-4.72	-7.44
	⊿b*	6.90	4.51	4.28	3.57	1.74	4.32
	⊿E*(ab)	13.40	14.50	16.13	12.93	11.37	12.99

[z]L* : Lightness

[y]a*, [x]b* : Chromaticity coordinates

(a* : Red direction, -a* : Green direction, b* : Yellow direction, -b* : Blue direction)

[w] $\Delta E^*(ab)=\sqrt{(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2}$

[v]Flower sheet : Paper made in Japan for Press flower, [u]Dampened paper : For practice in writing characters, [t]Window paper : Pasting Paper at room door to traditional house of Korea, [s]China hwasunji : Traditional drawing paper that made in China, [r]Korean hwasunji : Traditional drawing paper that made in Korea

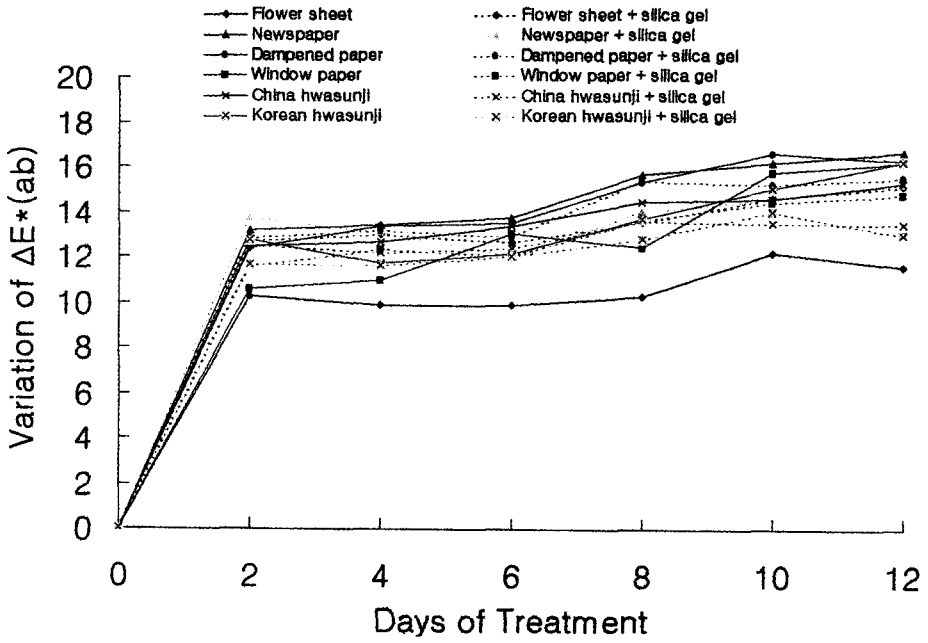

Fig. 5. Comparison of ΔE*(ab) on flower color with or without silica gel.

in the 4th day, 12.71 in the 8th day, and 12.93 in the 12th day. The color wasn' t changed that much.

In the case of China hwasunji, it was 11.52 in the 2nd day, 11.24 in the 4th day, 11.85 in the 8th day, and 11.37 in the 12th day. The color wasn' t changed at least with naked eyes.

In the case of Korean hwasunji, it was 11.65 in the 2nd day, 11.64 in the 4th day, 12.79 in the 8th day, and 12.99 in the 12th day. In the 6th day, the result was lower than the writing paper' s, so the color was almost same as the original one.

Out of the absorbtion papers, the China hwasunji got the best color, followed by window paper, Korean hwasunji, flower sheet, newspaper, and dampened paper.

From these results, it could be drawn that it is better to mix the absorbation papers with drying agents than single absorbtion paper treatment. Among the agents, CaO was the best, especially with China hwasunjis.

The second best was silica gel, and Na2SO4 didn' t affect on the colors that much.

There was a report that Na2SO4 and $CuSO_4$ took more drying times than silica gel (two times) in drying roses, and the color changed into brown. The effect was different, however, in drying Gentian, according to paper characteristics and agents mixing.

In drying Gentian, flower sheet with no agents, newspaper and window paper and Chinese and Korean hwasunji with CaO, writing paper with silica gel was the best cases to get good colors. So it could be concluded that CaO was the best agent in drying Gentian.

5. Comparison absorbtion only treatment with the mixed treatment with drying agents

A) Absorbtion paper and silica gel

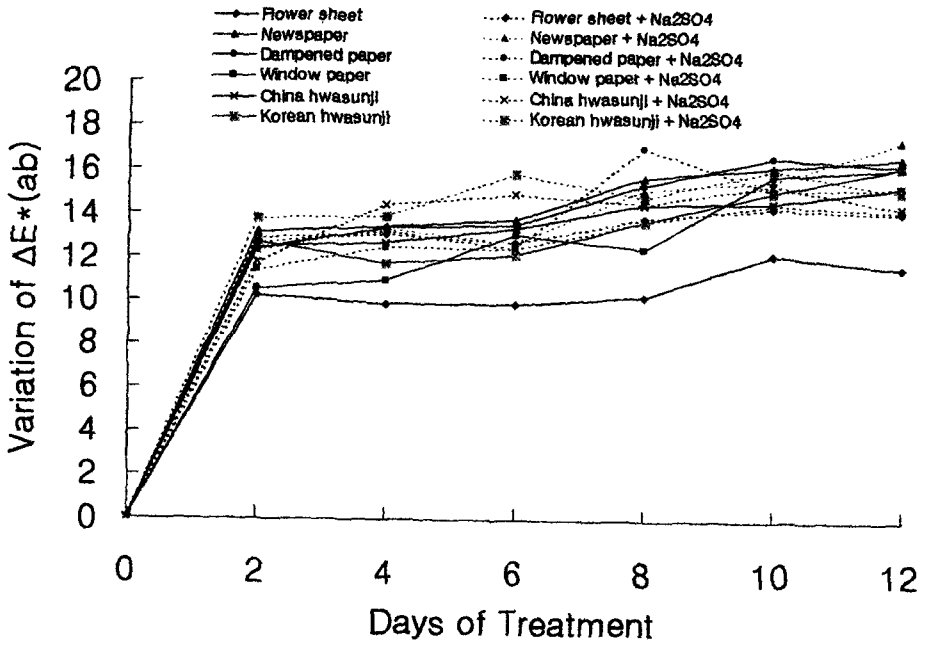

Fig. 6. Comparison of $\Delta E^*(ab)$ on flower color with or without Na_2SO_4.

After 23g of silica gel was put into the six absorbtion papers (flower sheet, newspapers, dampened paper, window paper, China hwasunji, Korean hwasunji), the color was checked every other day. As the result, the color changes were much smaller in the mixed treatment with agents(Fig. 5).

In the case of absorbtion paper treatment only, the color change of flower sheet was the biggest. This became certain as the treatment period got longer.

In the case of treatment with silica gel, the color change of Korean and China hwasunjis were the smallest.

Whether silica gel is put or not is important to the absorbtion capacity of papers. In the case of flower sheet, treatment without silica gel was effective, but in the case of Korean hwasunji, silica gel was more effective.

In the six day of treatment, the color change was almost same except the flower sheet. As the treatment period got longer, the colors were changed differently. So it could be concluded that treatment period is also important.

B) The mixed treatment of absorbtion papers with Na_2SO_4

After 23g of Na2SO4 was put into the six kinds of papers, the result was checked every other day (Fig. 6).

The color was less changed in the treatment of papers only. In the case of mixed treatment with Na2SO4, the color change was different according to the papers.

The color change of newsapers in the treatment with Na_2SO_4 were bigger than the papers only treatemtn, and vise versa in window papers and China hwasunjis.

From these results, it could be said that the effect of mixed treatment with Na2SO4 is different, according to papers.

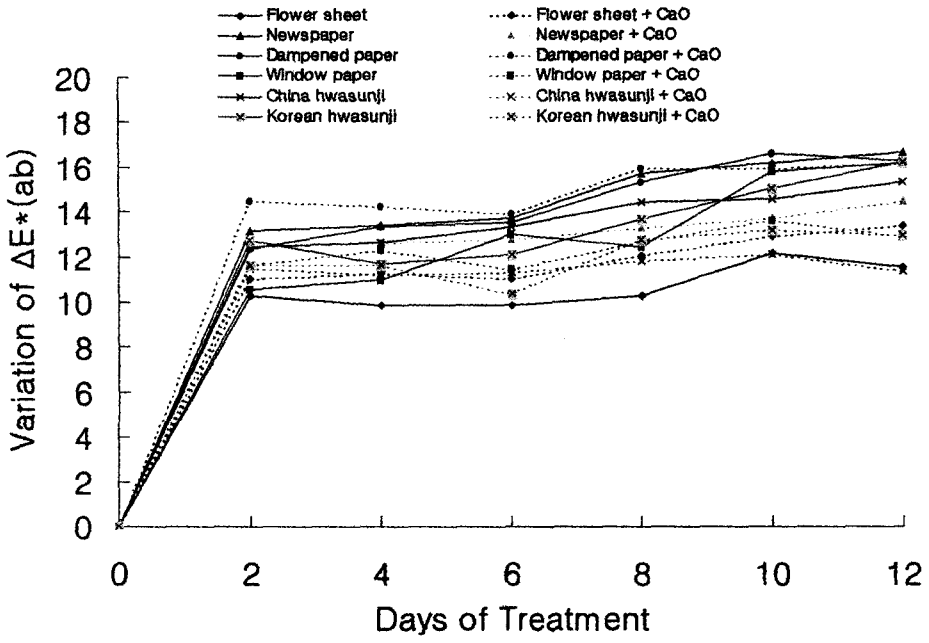

Fig. 7. Comparison of Δ E*(ab) on flower color with or without CaO.

C) The mixed treatment of absorbtion papers with CaO

After 23g of CaO was put into the six kinds of papers, the result was checked every other day (Fig. 7).

The color was less changed in the mixed treatment with CaO.

Unlike the silica gel or Na_2SO_4, the color was lest changed in China hwasunji, and was most changed in writing papers.

The mixed treatment with CaO was very effective in Chinese and Korean hwasunjis and window papers.

6. The effect of tartaric acid on flower color change

There was a report that pH in petal cells is normally a weak acid, and the pH degree affects on the color change of purple in acid In order to research the effect of tartaric acid ($C_6H_6O_6$) on the color change of Gentian, it was experimented by time and concentration (fig. 8).

The Δ E * (ab) result was 26.89 in ten minute section in 0.01M, and 27.04 in 20 minute section, and 27.44 in 30 minute section, and 29.15 in 40 minute section. As a result, the color was changed into blue-purple with tin of pink, which is little bit different from the original color. In the 0.1M treatment, the result was 27.78 in 10 minute section, 27.99 in 30 minute section, and 30.25 in 40 minute section.

When 0.1M of tartaric acid was put in the treatment, the petal tissue of Gentian was destroyed by the tartaric acid. so the color was changed into pink. In 0.01M of tartaric acid treatment, the color was not changed that much with time lapse, only slightly changed to dark blue-purple and pink.

7. The effect of ethyl alcohol on flower color change

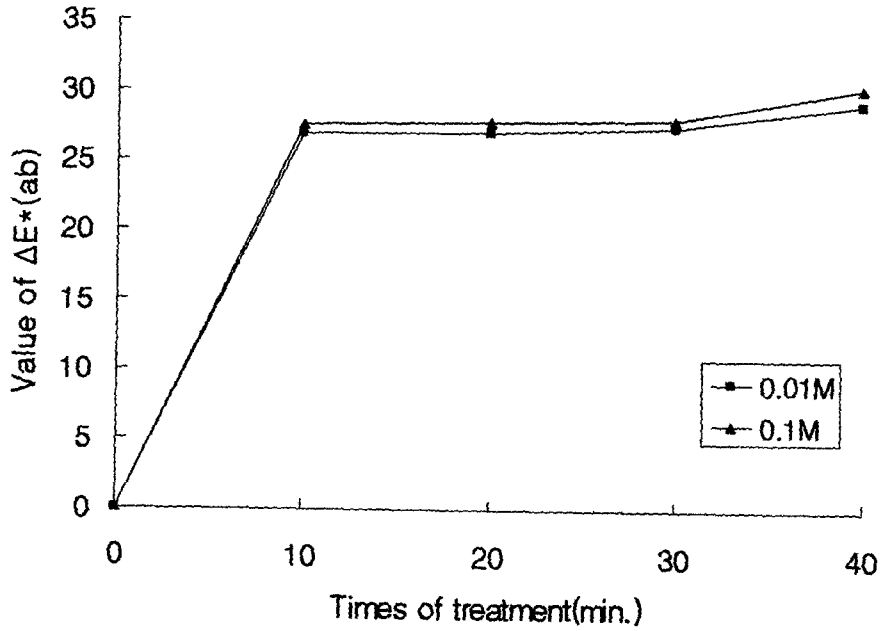

Fig. 8. Variation of ΔE*(ab) in tartaric acid on flower color of *Gentiana uchiyamai*.

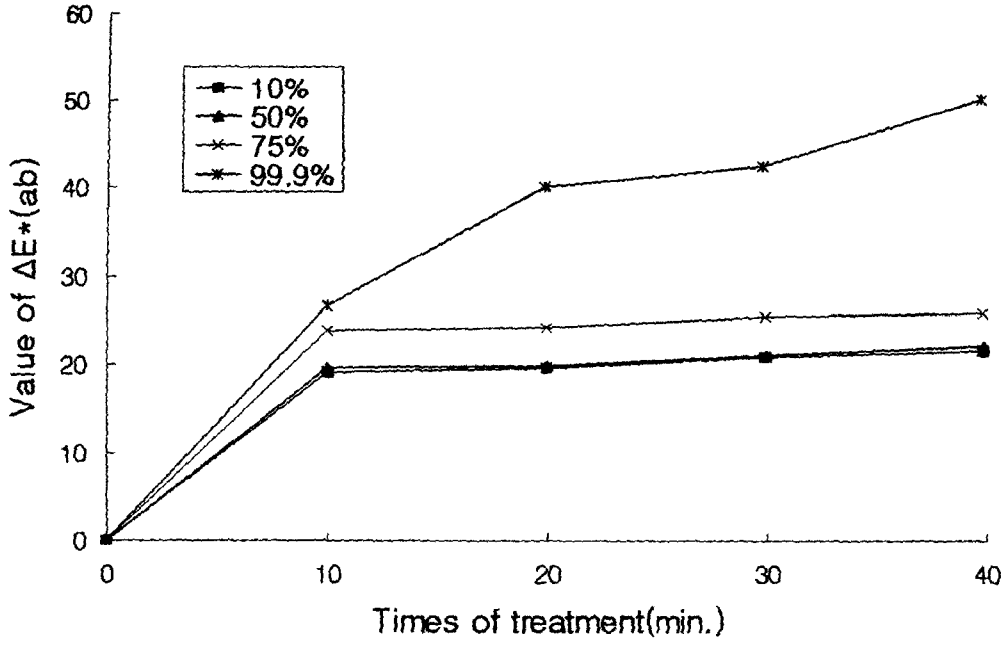

Fig. 9. Variation of ΔE*(ab) in ethyl alcohol on flower color of *Gentiana uchiyamai*.

Ethyl alcohol is a weak acid, and it was experimented by time and concentration, in order to check the effect of it on the purple Gentian color (Fig. 9).

In the experiment of 10% of ethyl alcohol, the ΔE^* (ab) result was 19.09 after 10 minutes, 19.55 after 20 minutes, 20.87 after 30 minutes, and 21.60 after 40 minutes. This means that there was not much color change with naked eyes. In the experiment of 50% of ethyl alcohol, the result was 19.59 after 10 minutes, 19.85 after 20 minutes, and 22.01 after 40 minutes. This result is almost same as the experiment above.

In the experiment of 75% of ethyl alcohol, the result was 23.80 after 10 minutes, 24.19 after 20 minutes, 25.29 after 30 minutes, and 25.17 after 40 minutes. It is concluded that from 75 % of ethyl alcohol the color was getting changed and then turned into another color.

In the case of 99.9% of ethyl alcohol, the result suddenly got higher as it was 26.53 in 10 minutes, 40.09 in 20 minutes, 42.09 in 30 minutes, and 49.90 in 40 minutes. After 20 minutes, the tissue of petals became stiff, and the color was changed into blue-purple.

As a result, the long chain coming from the organic acid and sugar which belong to an aromatic group was connected to sugar part of antocyanin. The organic acid worked as an auxiliary pigment, so Gentian changing blue to blue-purple showed pink in acid, and showed blue in alkali.

REFERENCES

Allen, J, C. Edwards, I. Finlayson, A. Johnson, and R. Schmitz.1979. Flower arranging. Octopus Book, London. pp.166-217.

Hrazdina G. 1982. Anthocyanin. In the Flavonoids-Advances in Research. J.B.Harborne and T.J.Mabry. pp.135-188.

Kim, T. J. 1996. Korean resources plants. Seoul National University Press. pp.278-279.

Park, Y. J., Jung, S. Y., Heo, B. G., and Song, C. E. 1998. The Effect of Silica Gel Size and Dry Oven Tempereture on Drying Roses to be Pressed. J. Kor. Soc. Hort. Sci & Technol. 16(1):75.

Park, Y. J., Jung, J. Y., Song, C. E., Heo, B. G., and Lee, E. S. 1998. Selection of Dryers and Investigation of Proper Quantity on Drying Hibiscus syriacus L. J. Kor. Soc. Hort. Sci & Technol. 16(3):413

Park, Y. J., Jung, S. Y., Heo, B. G., and Song, C. E. 1998. The Effect of Silica Gel Size and Dry Oven Tempereture on Drying Roses to be Pressed. Korean Journal of Horticultural Science & Technology 16(1):75

Park, Y. J., Jung, S. Y., Heo, B. G., and Jeong, J. H. 1998. The Effect of some Desiccants on Drying Roses to be pressed. Korean Journal of Horticultural Science & Technology 16(1):75

Park, Y. J., Jung, S. Y., Song, C. E., and Seo, C. S. 1998. The Effect of Using Microwave on Drying Roses to be presses. Korean Journal of Horticultural Science & Technology 16(1):76

Sohn, K. H., 1994. Studies on the Best Tempertures in Drying Flowers with Silica Gel. J. Kor. Flower Res. Soc. 3(1) : 45-52

Sohn, K. H., 1994. Studies on the Best Grades of Silica Gel in Drying Flowers. J. Kor. Flower Res. Soc. 3(1) : 35-44

Song, W. S., Kang, J. K., and Yang, K. H., 1998. Effect of papers and Silica Gel Treatment on Flower Color of Rose in pressed Flower. Korean Journal of Horticultural Science & Technology 16(2):294

Song, W. S., Kang, J. K., and Park, J. A. 1998. Effect of Papers and Silica Gel Treatment on flower Color of Tulip in Pressed Flower. Korean Journal of Horticultural Science & Technology 16(2):295

Song, W. S., Kang, J. K., Kim, Y. S., and Yoon, J. H. 1998. Effect of Papers and Silica Gel Treatment on

Flower Color of Petunia in Pressed Flower. Korean Journal of Horticultural Science & Technology 16(2):295

Taylor, C. 1992. Herbal Wreaths. Sterling Publishing Co. Inc. New York pp.10

Yoshida K., T. Kondo, Y. Okazaki., and K. Katou. 1995. Cause of blue petal colour. Nature. pp.291,327

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