UNIQUE ILLUMINATION TO BRING OUT THE ATTRACTIVENESS OF PLANT COLOUR WITH WHITE LIGHT SOURCES OF VARIOUS SPECTRAL DISTRIBUTIONS

M. Ishii* and T. Bando

Dept. of Intelligent Information Eng. & Sci., Doshisha University, Japan

*Corresponding author: Michitomo Ishii, +81-774-65-6961, +81-774-65-6801, dun0109@mail4.doshisha.ac.jp

Keywords: White light of different spectral distribution, Change of plant colour, Attractive plant presentation

ABSTRACT

Colour illuminations are able to give physically different colours to illuminated objects. But perceived colour changes of objects are not so effective because we have colour constancy. On the other hand, if the colours of the objects have changed without light source colour change, we should believe that colour appearance changes are the changes of objects colour themselves and colour change would be very impressive. We can realize this situation if we design appropriate combination of spectral distribution of light sources and spectral reflectivity of objects. In this study, we investigated colour changes of plants under the white illuminations with various spectral distributions. As the results of the experiments, we can find out various and distinct perceived colour changes of flowers and leaves under certain combinations of illuminations and plants. If we use this illumination technique to the flower arrangement lighting or to the lighting of the garden, we can enjoy another colour world of plants.

INTRODUCTION

We generally appreciate white lights with the high colour rendering property that reproduces original colour of the object under the sunlight. If we change our point of view, however, colour change of the things is sometimes very attractive for us as in the case of colour design in the entertainment space or in the commercial facilities. In this study, we tried to find out good combinations of white lights with low colour rendering property and corresponding colour materials to induce distinct colour change, using ornamental flower plants, to utilize colour change as good tools to appeal colour of flowers.

METHODS

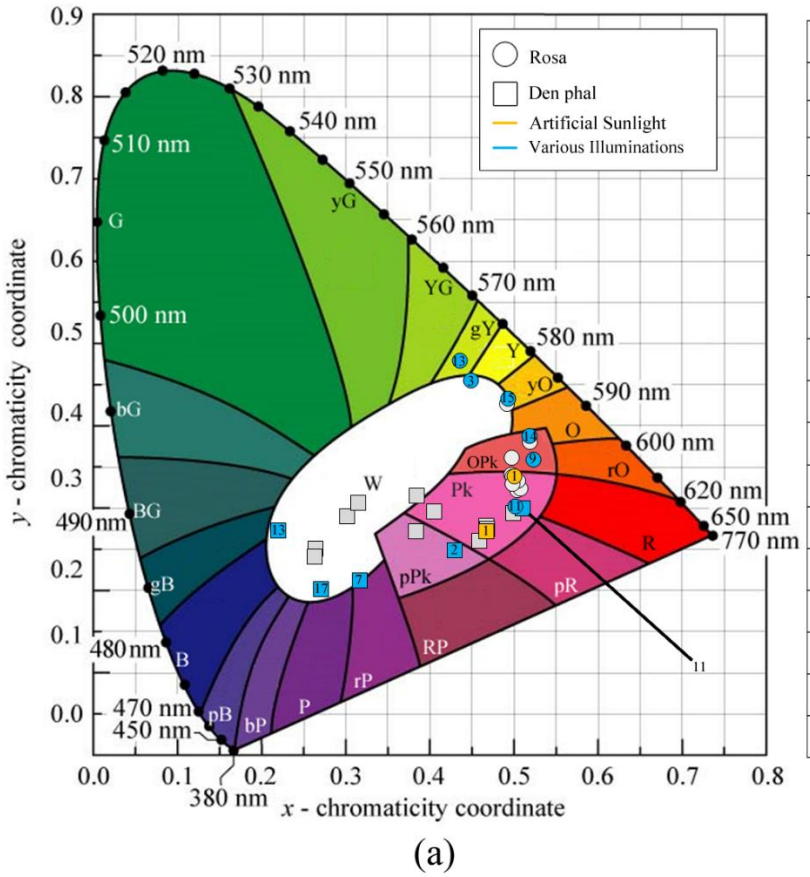
To prepare a lot of low colour rendering property white lights, we generate spectral distributions of white lights with 3 or 4 narrow band spectral components on our colour simulator, controlling spectral distribution of lights. We checked chromaticity of the lights with spectral distributions generated on the colour simulator, using high-speed programmable light source (Gooch and Housego, OL490) and colour spectrometer (UPRtek, MK-350). We compared measurement data and the white light data, and selected by regulation of ANSI.C78.377. We can find out prepare 13 low colour

rendering property white lights to use, colour assessment of flowers under illumination. On the other hand, we prepared the artificial sun light (XC-100), imitated white LED 1 to 3 which makes refer to Kyosan Corporation LED, Panasonic LED and D65 as the white light having a continuous spectrum. We prepared 17 white lights in all, and using these lights, we made the experiment for two dozen kinds of plants.

In darkroom, OL490 (It delivers an unprecedented level of flexibility and power providing high speed programmable spectral illumination.) irradiated 17 white lights to each experimental objects. The digital still camera (Canon EOS kiss x6i) took pictures of changing colour appearance about objects. ColourChecker Passport (x-rite) adjust a white balance. Using GIMP, we trimmed the photograph of the petal part and recorded a mean RGB level of the range. As to calculate colour difference, we were based on a photograph when I irradiated artificial sunlight XC-100.

RESULT AND DISCUSSION

It also confirmed that the colour appearance of leaves and flowers have changed by white illumination of various wavelength composition. And, dramatically changing of colour appearance was characterized by depending on the combination white illuminations and flowers.



(a)

light No.	Constitution of Light	CCT	CRI
1	Artificial Sunlight	5292K	97
2	Imitated White LED 1	5036K	79
3	Imitated White LED 2	4273K	81
4	Imitated White LED 3	3950K	92
5	440-510-580-630 (95-85-55-40)	4319K	82
6	470-510-590 (80-70-80)	4375K	32
7	470-540-600 (100-70-70)	5090K	67
8	440-480-540-620 (90-50-100-70)	5021K	58
9	460-500-570-630 (40-100-90-70)	3686K	80
10	490-570-620 (95-65-50)	3218K	65
11	470-540-620 (84-70-70)	3823K	54
12	470-560-640 (75-70-60)	4788K	62
13	480-560-610 (50-45-40)	3422K	60
14	480-570-590 (85-30-100)	3363K	17
15	490-570-610 (60-35-35)	2938K	49
16	490-590-680 (80-85-10)	2972K	20
17	540-530-610 (80-100-80)	4028K	66

(b)

Figure 1. Change of the Colour Appearance and Illuminations Property

Especially, Den phal and Rosa were observed great change of the colour appearance. Figure 1, Figure 2, and Figure 3 show these change of the colour appearance. As to figure1, we plot the data of the relation white illuminations and the flowers of the colour appearance on the xy chromaticity diagram. Den phal colour appearance varies from greenish blue to pink. Rosa colour appearance varies from pink to greenish yellow. On the right of figure 1 shows the property (illumination number, wavelength constitution, correlated colour temperature, colour rendering index) of the white light. Figure 2 and figure 3 show the practical change of the colour appearance with these photographs. The data of under these photographs show colour, chrominance, illumination number, light constitution, xy-axis of the xy chromaticity diagram.

Moreover, Cyclamen persicum Mill, Celosia argentea, Chrysanthemum, Gentiana scabra var. buergeri, Dianthus superbus, and Hedera helix were observed significant change of the colour appearance.

From this result, we found that the white light without appropriate wavelength composition cannot express an object original colour exactly. Above all, we found that the white light has low colour rendering property express the system colour which is exactly different from an object original system colour.

flower name	Forever Rose						
							
color-change	Pink	Pink	Orange Pink	Orange	yellowish Orange	Yellow	greenish Yellow
chrominance	0	21	21	39	70	84	99
illumination number	1	12	10	15	16	6	14
CCT(K)	4312	4788	3218	2938	2972	4375	3363
CRI	93	62	65	49	20	32	17
xy-axis	(0.50, 0.33)	(0.50, 0.30)	(0.52, 0.63)	(0.51, 0.39)	(0.49, 0.43)	(0.45, 0.46)	(0.43, 0.48)

Figure 2. Change of the Colour Appearance of Rosa

flower name	Den phal					
						
color-change	Pink	greenish Blue	Purple	reddish Purple	purplish Red	purplish Pink
chrominance	0	101	68	53	19	15
illumination number	1	14	17	8	12	5
CCT(K)	4312	3363	4028	5021	4788	4319
CRI	93	17	66	58	62	82
xy-axis	(0.47, 0.27)	(0.22, 0.27)	(0.27, 0.20)	(0.32, 0.21)	(0.51, 0.30)	(0.41, 0.25)

Figure 3. Change of the Colour Appearance of Den phal

CONCLUSION

In conclusion, it also confirmed quantitatively that the illuminations of lower colour rendering property have expressed the colour is different from an object original colour under the daily sun light. We have produced the colour appearance quite different from the appearance of the flower original colour under the daytime light of the sun at all by putting wavelength composition of the white illumination light and the spectral reflectance of the pigment of the flower together appropriately. And, as to the flower arrangement and the Ikebana, we confirmed that that result is useful method to bring out the attraction of flower colour structure.

Hereafter, to achieve item ①～③ of Introduction, we will approach paints, dyestuffs, and plant pigments with this research methods. Moreover, we will analyze into chronological change of the sun light spectrum, and we will arrange the association with this study.

REFERENCES

1. Ku, G. (2008). Learning to de-escalate: The effects of regret in escalation of commitment. *Organizational Behavior and Human Decision Processes*, *105*(2), 221-232. doi:10.1016/j.obhdp.2007.08.002
2. Gibbs, J. T., & Huang, L. N. (Eds.). (2001). *Children of colour: Psychological interventions with culturally diverse youth*. San Francisco, CA: Jossey-Bass.