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Color – Chlorophyll Relationship of Some Indoor Ornamental Plantsity

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Abstract

In this study, we purposed to determine the relationship between color and chlorophyll of some plants are used to as indoor ornamental plant. The measurements made with this purpose are interpreted and the relationship between the color and shades occur on leaves and chlorophyll concentration has been tried to demonstrate.

The results of study demonstrate that the amount of chlorophyll varies by the green color and the parts with darker color on the same plant have higher chlorophyll concentration. In addition, no chlorophyll has been determined on the yellow and white parts on the green leaves - of those which are generally used as ornamental plant and have multicolored leaves. Moreover, chlorophyll content has been determined as nearly minute amount on green leaves which act as a petal of different-colored petals or of some plants have no petal. In addition to these, it has been determined that the color variance on the leaves signals the chlorophyll concentration and that the chlorophyll concentration doesn't decrease on the leaves which don't lose their green colors.

Keywords: Chlorophyll, Plant color, Ornamental Plants

Introduction

The urbanization rapidly increases in particular developing countries. It is predicted that 60% [1] or 90% of world's population will live in the cities in the 2030s. More than two third of the population has been living in the cities in European countries today [2]. According to the data from the year 2008, nearly 71% of population has been living in cities in our country [3]. Today, almost 90% of all human life is spent indoors [4].

The city people who is a part of the nature has been begun to decorate their residences and environments because of the reasons such as longing for the nature, absent of sufficient places for their recreational demands; as a result of this situation, many species of plants have been used as an indoor ornamental plant [3]. In this period, especially the many plants have high visual quality have been used as indoor ornamental plants because of their color, form or tissue. It is more an increase in both the varieties and number of ornamentals that has increased. Especially, extraordinary plants (in terms of their color and form) have taken more attention and has been begun to be more preferred indoor.

Pigments provide pigmenting for plants; pigments are classified as chlorophyll, carotenoid, fikobilin, flavonoid, betalain ve betacyanin [5]. The most important of these pigments is chlorophyll and it provides the occurring of photosynthesize. For the living organisms which have chlorophyll, photosynthesize is the production of organic compounds through using luminous energy. For the photosynthesizing, both chlorophyll and sun are required. Chlorophyll absorbs the luminous energy and turns it into chemical energy [6]. Thus, chlorophyll provides photosynthesizing which produce the oxygen and nutrients are required for all other living creatures to live. In addition, chlorophyll is the pigment which gives the green color to plants.

The leaves that present different colors apart from green in development period have a great importance as ornamental plant. Many of them have yellow, red or lavender colors [5]. Chlorophyll, carotenoid and anthocynanin are responsible for formation of these colors [7]. These plants have sufficient chlorophyll for photosynthesizing, but these include high rate of carotenoid and anthocynanin that could be continued their characteristic colors even the existing of chlorophyll. In addition, the color of plants may occasionally vary by increasing or decreasing in amount of chlorophyll. In autumn, for example, chlorophyll formation decreases as decreasing of sunshine concentration or its amount. As the autumn passes, pure rate of chlorophyll fractionally decreases. The carotenoids, which occurs in development season, doesn't resolve in that period; when the chlorophylls are broken down, the leaves become fractionally yellow [5].

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The amount of chlorophyll is also important not only for pigmenting on plants but also its effectiveness in photosynthesis. Plants are living organisms. They need to formation of various conditions in order to continue their lives and they change the atmospheric conditions through their metabolic activities. By changing of conditions, this situation becomes reversed to the plants which make oxygen oscillation to environment and absorbs the carbon dioxide of the environment in suitable atmospheric conditions to development of plant; this situation may negatively affect to human health especially indoors (are limited areas) [3].

In this study, we purposed to determine the relationship between color and chlorophyll of some plants are used to as indoor ornamental plant. The measurements made with this purpose are interpreted and the relationship between the color and shades occur on leaves and chlorophyll concentration has been tried to demonstrate.

Material and Method

In study, the different-colored parts on the plants were classified and some measurements had been done and then results were evaluated. The measurements were practiced on at least 5 individuals from each species and on at least 5 leaves of these individuals. The measurements were again practiced as repeatedly at least 5 times on the leaves of the same individuals which have different colors and shades or on the parts of the same leaf which have different colors and shades. Experiments were made to determine how the chlorophyll content vary in the situations such as water shortage, being damaged, leaving as breaking from main root and etc.; the plants were left without water and were damaged and their measurements were practiced during this processing. In addition, the leaves broken from the plants were left to be dry in room conditions and both their variances of color and chlorophyll concentrations during drying process were observed. In these processes, measurements were practiced at the same points of the marked parts of the leaves.

The measurements were practiced with an Apogee CCM-200 chlorophyllmeter between the 10.00 a.m.-14.00 p.m. within the same day; the results obtained from Chlorophyll Concentration Index (cci) Unite [12].

Results

It was observed that the nascent leaves are light green in development process and then their colors become darker; thus, it is obvious that young leaves are light green and old leaves are dark green. Then, measurements were made on leaves with light green and with dark green – their results are in Table 1.

When the results (on Table 1) are examined, we see big differences in terms of chlorophyll concentration among the species. On leaves with dark green, *Ficus elastica*, *Sanseveria trifasciata* and *Yucca elephantipes* have chlorophyll higher than 100 cci; *Hedera helix* has 37,3 cci and *Viola tricolor* has 21,3 cci. According to the Table, chlorophyll concentration of the all leaves with light green lower than the leaves with dark green. This situation indicates that the amount of chlorophyll of young leaves is at low level; the more they get older, the more amount of chlorophyll increases.

Color and form are too important and reasons for preferences as to indoor plants. Especially, the species such as *Sanseveria trifasciata*, *Schefflera arboricola*, *Diffenbachia anoena* are preferred which have different colors on their leaves. There are also different patterns of green on leaves of these plants in question. The relationship between the color at stake and chlorophyll was tried to determine with measurements on the plants such as *Codiaeum variegatum, Diffenbachia anoena*, *Schefflera arboricola* and *Sanseveria trifasciata*. The results of these measurements are presented on Table 2.

Table 1. Chlorophyll consantration of dark or ligth green leaves on some ornamental plants

	Dark gren leaves			Light gren leaves		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Achmea fasciata	109,1	47,4	**86,9**	27,2	7,8	**13,6**
Diffenbachia anoena	89,7	30,6	**60,9**	27,3	5,6	**14,3**
Dracena marginata	98,2	56,9	**78,6**	50,7	10,7	**31,9**
Anthurium andraeanum	119,7	49,5	**89,9**	45,3	7,9	**22,8**
Ficus benjamina	156,4	50,1	**111,9**	46,5	12,6	**21,8**
Guzmania lingulata	90,0	32,8	**51,3**	28,2	7,2	**14,4**
Viola tricolor	42,6	14,7	**21,3**	9,9	7,1	**8,6**
Orchide dendrobium	101,9	66,6	**82,3**	50,9	19,4	**39,1**

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Hedera helix	59,9	21,9	**37,3**	17,8	12,6	**13,9**
Spathiphyllum floribundum	126,5	61,6	**89,7**	40,2	6,4	**24,2**
Schefflera arboricola	154,4	38,9	**99,3**	14,1	6,0	**9,1**
Ficus elastica	140,2	68,2	**97,3**	65,0	42,0	**52,7**
Sanseveria trifasciata	122,2	77,2	**103,2**	76,7	42,1	**65,7**
Yucca elephantipes	131,1	82,8	**104,2**	65,8	15,2	**36,3**

Color and form are too important and reasons for preferences as to indoor plants. Especially, the species such as *Sanseveria trifasciata*, *Schefflera arboricola*, *Diffenbachia anoena* are preferred which have different colors on their leaves. There are also different patterns of green on leaves of these plants in question. The relationship between the color at stake and chlorophyll was tried to determine with measurements on the plants such as *Codiaeum variegatum*, *Diffenbachia anoena*, *Schefflera arboricola* and *Sanseveria trifasciata*. The results of these measurements are presented on Table 2.

Table 2. Chlorophyll concentration of yellow or white leaves on some ornamental plants

	Dark gren leaves			Yellow or White leaves		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Codiaeum variegatum	81,8	18,1	45,7	4,9	1,1	2,2
Diffenbachia amonea	89,7	30,6	60,9	3,9	1,7	2,6
Schefflera arboricola	154,4	38,9	99,3	4,8	1,2	2,5
Sanseveria trifasciata	122,2	77,2	103,2	5	1,1	2,4

When the results on the Table 2 are examined, we see that chlorophyll concentration is quite low in the parts outside of the green parts on the leaf. According to the result of the measurements, it can be said that there is no chlorophyll on the parts with yellow and with white of the leaf. Similar results were obtained from measurements on *Codiaeum variegatum* individuals which have leaves with dark red. Average amount of chlorophyll was quantified as 101,7 cci (dark green parts) and 1,7 cci (red parts). According to the result of the measurements on young leaves with whole light green of the same individuals, the average amount of chlorophyll was 37,8 cci. These results are also similar with the results of the measurements which purposed to determine the amount of chlorophyll on the leaves with light and dark green of the other plants [12,43].

In the plant species (pollunation with insects), flowers are generally hermaphrodite and petals are colorful, sweet-smelling and garish [8]. These plants are preferred as indoor ornamental plants because of their aesthetics aspects; for example; *Orchid*, *Spathiphyllum*, *Guzmania*, *Achmea*, *Anthurium*. The chlorophyll concatration of different-colored petals of these plants were quantified – their results are presented on Table 3.

Table 3. The chlorophyll concatration of different-colored petals

	Dark green leaves			Petals		
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
Achmea fasciata	109,1	47,4	86,9	3,9	1,2	1,4
Anthurium andraeanum	119,7	49,5	89,9	2,1	1,2	1,5
Guzmania lingulata	90,0	32,8	51,3	4,6	1,5	3,0
Orchide dendrobium	101,9	66,6	82,3	2,3	1,0	1,6
Spathiphyllum floribundum	126,5	61,6	89,7	1,5	0,9	1,1

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When the results on the Table 3 are examined, it can see that the average amount of chlorophyll of petals is lower than 3 cci. According to these results, it can be said that the petals haven't got enough chlorophyll to photosynthesize. The measurements were repeated on the different-colored petals of *orchid* and similar results were seen. Thus, being different-colored of a petal doesn't affect to chlorophyll concentration.

Some plants such like *Poinsettia* have different structures than the others. They don't have calyx leaves and petals. The bracts near to flower vary and become colorful during inflorescence. Such leaves called as bractea. When the amount of chlorophyll of bracteas of *Poinsettia* was quantified, results demonstrated that the value varied between 1 cci and 2,7 cci and its average amount was 1,5 cci. According to the results, it can be said that colorful leaves have no chlorophyll. These leaves vary - as petals do - for practicing the pollination and taking attention of insects; they have no chlorophyll during this processing and they thus couldn't photosynthesize.

When the biological lives of leaves complete (undergoes senescence), they firstly become red or yellow, then they come down or become dry. According to the results of the measurements to determine the relation of this situation with chlorophyll, the amount of chlorophyll was quite low on leaves in question and for all leaves this value was lower than 5 cci. This situation demonstrates that the amount of chlorophyll begins to slowly decline when the leaves complete their biological lives; chlorophyll of leaf finally disappears.

A series of experiments were made to determine how the chlorophyll contain vary in the situations such as water shortage, being damaged, leaving as breaking from main root and etc. [12]. It has been demonstrated that when the leaves become dry because of reasons such as shortage etc., their chlorophyll concentration declines, color of the leaves changes and finally degraded.

However, decreasing of chlorophyll amount of the leaves, which are separated from main root while they do their normal activities, differs by the species of plants. On some plants, the amount of chlorophyll decreases and their leaves' colors changes – first they becomes light green and then yellow. Yet, especially in some coarse textured plants, chlorophyll concentration doesn't change and these leaves become dry as losing their water content. Despite that, they protect their green colors.

Discussion

The chlorophyll content is an important experimental parameter in agronomy and plant biology research [9]. The amount of chlorophyll of leaves differ by the influences of many environmental factors [10]. Besides, both species of the plant and position of the leaf influence the chlorophyll content of the leaf [11,12].

The chlorophyll content of plants not only varies by water stress [11,12,13,14,15,16,17,18,19], salt stress [20,21,22,23], and air pollution [24], but also it depends on time in the growing season [25]. Also various studies have demonstrated the relationship between nutrition situation and chlorophyll content of plants. The results demonstrates that chlorophyll content of plants related to magnesium [26], iron, humic acid [27], nitrogen [28], mercury, steel, cadmium and lead [29].

In the end of study, great differences were determined among the chlorophyll contents of light and dark green-colored leaves of the same plant. Karakurt and Aslantaş [5] indicate that chlorophyll is synthesized (depending on sunshine) and it is used by plant by during photosynthesizing; hence, it's required to being constantly synthesized. This situation may be interpreted that the nascent light-colored leaves have not yet enough chlorophyll and the more they become older, they have more chlorophyll.

The relationship between the chlorophyll content and light (or insolation) has been examined in also other studies [5,12,30,31,32,33,34]. Kurtar [35], indicates that the leaves, which take shadow and photo, have different internal and external structures, the tissues, which strengthen to resistances, of plants become well-developed, chloroplasts are less but big and chlorophyll content is high.

Chlorophyll content not only vary by species of plant, amount of photo, nutrition condition of plant and stress conditions but also the genetic. Darkness of leaf color is related to smallness of palisade cells. Chlorophyll grains of these cells are private to species and the cells become smaller, the number of chlorophyll on the surface of per unit leaf increases and color becomes darker [36]. Therefore, the amount of chlorophyll can vary by both among the species and into species. Criado et al. [37], suggest that there are differences between the Arbequina and Farga cultivars in terms of amount of chlorophyll. Canova et al. [38], suggest that the amount of chlorophyll differs by cultivars according to their study on Fagus sylvatica cultivars.

In addition, when we compare poliploid plants with the diploid plants, we see the poliploid plants have bigger members such as trunk, leaf, and flower and larger surface than the diploids'. These plants attract attention with their dark green colors are formed through their bigger cells and more chlorophyll content. They have more potential of photosynthesizing than diploids [39].

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Conclusions

Determination of chlorophyll content can be useful for various fields in practice. Foliage chlorophyll content determines the leaf absorption, and thus the fraction of light absorbed for any given incident light availability [40]. The amount of chlorophyll is a signal in determination the cold resistance of plant [41]. Demirel et al. [18], suggest that chlorophyll translations of watermelon plant may be used to determine water stress especially in inflorescence process and at the beginning of fruit generation process. Knudson [42], suggests that ozone damage occurs on bean leaves may be quantified as precise and practical through the determination of chlorophyll.

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