

Epidermal Structure on Coloring in the Leaves of VELVET RAINBOW, a Coleus.

By HITOSHI YASUDA

Department of Biology, Faculty of Science, Shinshu University

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Abstract

The leaf surface of a coleus, *VELVET RAINBOW*, has somewhat velvety dark red color like the petal of some black roses.

The leaf structure of this cultivar is compared with that of *RED RAINBOW*, a cultivar not velvety dark red.

The results observed here are as follows:

(1) No essential difference in the leaf sections between two cultivars is recognized except for their surface structures. (2) In the surface structure the epidermal cells of the leaf of *VELVET RAINBOW* are of longer papillate form, their lateral walls are less slanting to the surface and the spaces among them are more narrow than in those of *RED RAINBOW*. (3) In the surface view of the leaf of *VELVET RAINBOW* the shadow is found on epidermal cell walls, when the surface is illuminated at angles of 25 and 20 degrees, at which the shadow is not visible in that of *RED RAINBOW*.

These facts can lead the author to the conclusion that the blackish appearance on the leaf of *VELVET RAINBOW* is mainly caused by the shadow of epidermal cells, and the surface structure of the leaf of this cultivar may be more suitable to form the shadow.

Introduction

HARA¹⁾ pointed out that in the certain plants the development of foliar variegation was not resulted from chlorophyll deficiency, but it depended upon the surface or inner structure of the leaves. Several years later the author stated that the blackish color in the petal of velvety dark red roses was noticed or not by the shadows, which were cast on the red petal surface, of the long papillate epidermal cells situated at some intervals, without dependence on the quality and quantity of the pigments contained in the petal tissues.²⁻⁴⁾

In most recent flower catalogues we may find a new coleus cultivar *VELVET RAINBOW* among the *RAINBOW* series. The leaf surface of this cultivar is somewhat velvety blackish, though being not so dark as the petal surface of black roses.

While there are several papers⁵⁻⁸⁾ concerning to the leaf form or structure of wild or familiar forms of coleus, no studies in this connection on the new cultivars, so far as the author is aware, are available.

Recently, the author had an opportunity to observe the leaf structure of some coleus. He found that the epidermal cells of the leaf of VELVET RAINBOW showed a relatively longer papillate form and that the shadow was abundant in the spaces among the epidermal cells, resembling the petal surface of the black roses.

These observations are reported in the present paper to provide an additional example of the structure effect on coloring.

Materials and Methods

The plant materials employed in the present experiment were two cultivars VELVET RAINBOW and RED RAINBOW. The seeds of these cultivars, obtained from SAKATA NURSERY, YOKOHAMA,* were sown on May. When the first leaves fully developed, the plants were transplanted into the pots containing well fertilized soil, and then allowed to grow outdoors in the garden of the Biological Institute of SHINSHU University.

The fresh leaves which were fully matured were collected from the plants and cut in $10\sim 20\mu$ sections by freezing microtome technique.⁹⁾ Freehand sections were also prepared. Longitudinal and cross sections were made in both cases.

The surface views were taken microscopically by illuminating the leaf surface at angles of various degrees, using a set showed in Fig. 1.

Observation

The general illustration of leaf section.

Chloroplasts are found in the cells of palisade parenchyma and of upper portion of spongy parenchyma. But in some parts of these tissues the masses of cells lacking in chloroplast are also recognized.

With VELVET RAINBOW leaf red pigment is present in both upper and lower epidermal cells, in contrast to that of RED RAINBOW which contained the pigment only in the upper epidermal cells.

In both cultivars any distinction in these anatomical respects between longitudinal and cross sections is not appreciated.

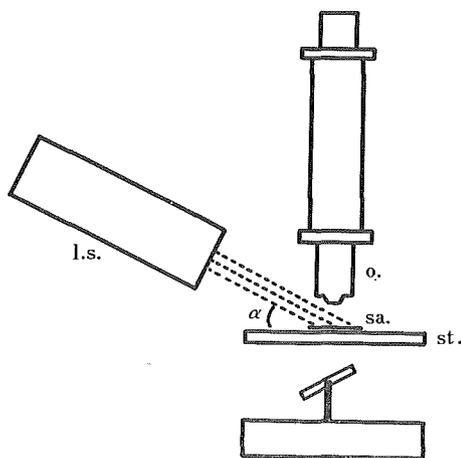


Fig. 1 Scheme of the set for the observation of surface view.
o. : objective, st. : stage, sa. : sample, l.s. : light source,
 α : angle of illumination

*The spring edition (1965 and 1966) of flower catalogues.

Epidermal structure of leaves.

Here the forms of epidermal cells and of space among them are especially observed. The figures of two cultivars, sketched from the microscopic observation of sections, are given in Fig. 2 A and B.

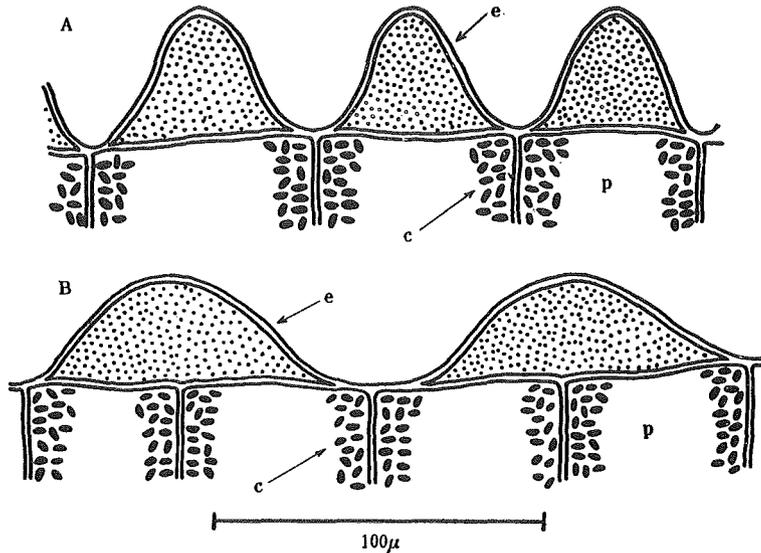


Fig. 2 The epidermal structure of coleus leaves.

A: VELVET RAINBOW B: RED RAINBOW
 e: epidermal cell c: chloroplast
 p: palisade parenchymatous cell

 : indicating that red pigment is contained.

In the VELVET RAINBOW leaf the epidermal cells take a long papillate shape, and their apical angles are $54^{\circ}\sim 62^{\circ}$. A space is framed up with the lateral walls of two epidermal cells and a part of upper wall of palisade parenchymatous cells. The intervals between the lateral walls are wider upwards.

The epidermal cells of RED RAINBOW is of flat papillate shape, their apical angles being $100^{\circ}\sim 112^{\circ}$. Not only the distance between two epidermal cells is wider at the base, but also is greater upwards than those of VELVET RAINBOW.

Surface view of leaf.

Plate 1 represents the surface view of a portion of VELVET RAINBOW leaf, where relative few chloroplasts are included, under the illumination at angle of 20 degrees.

The tops of epidermal cells are white or faint yellow, and another lateral wall of a cell that is not exposed to the illumination is blackish, while the other portions are reddish.

In the surface view of RED RAINBOW leaf, which is omitted here from the

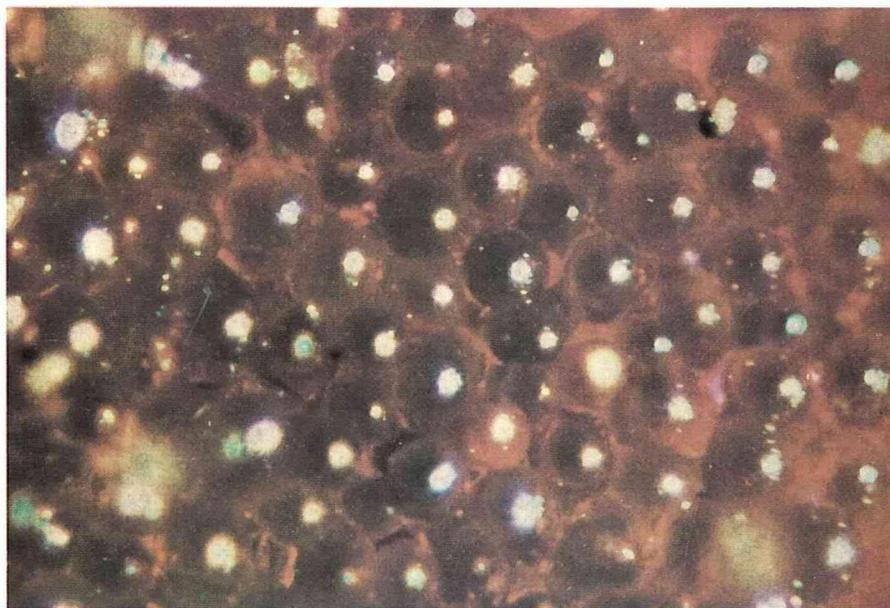


Plate 1 The surface view of the leaf of *VELVET RAINBOW*. ($\times 300$)
(Arrow indicates the direction of illumination.)

plates, the lateral wall of epidermal cells hardly give the blackish appearance, and whole surface is red in color, when the surface is illuminated at an angle of the same order.

This blackish appearance of the lateral wall of epidermal cells, however,

Table 1 The grade of blackish appearance on the lateral wall of epidermal cell under the illumination of various angles.

Angle of illumination	Grade of blackish appearance on the leaf surface*	
	VELVET RAINBOW	RED RAINBOW
30°	—	—
25	+	—
20	++	—
15	++	±

* — : Not blackish,
++ : Deeply blackish,

+ : Definitely blackish,
± : Slightly blackish.

occurs with the lower illuminating angle. This fact is well illustrated in Table 1. In the VELVET RAINBOW leaf the blackish appearance is noticed when it is illuminated at an angle below 25 degrees. When the illuminating angle exceeds 30 degrees, the whole surface looks red. On the lateral cell walls of RED RAINBOW leaf the blackish appearance is hardly shown on illumination at an angle over 20 degrees.

Generally speaking, when the angle between the incident ray and the lateral wall is akute or perpendicular, the blackish color is dark; when the angle obtuse or parallel, that color not appeared and seen red.

Discussion

From the fact that the blackish color yielded on the epidermal cell wall varied with the angle of illumination, it can be presumed that the darkness may be settled by the shadow of epidermal cell itself.

As the author pointed out in the previous papers,^{2,3)} when the papillate epidermal cells are arranged leaving some spaces between them, the longer papillate form can bring about the more suitable state to give their shadows among the spaces. From Fig. 2 the author can indicate that the epidermal structure of the VELVET RAINBOW leaf is under more favorable condition than the structure in the RED RAINBOW leaf, for the yield of shadow of epidermal cell among the spaces, when the light is projected at an angle below 25 degrees.

In this observation the quantity and quality of pigments contained in the leaf tissues, are not dealt with. But from the fact that the surface view of leaf presented in Plate 1 shows red color when the surface is illuminated at an angle above 30 degrees as shown in Table 1, it can be said that the leaf of this cultivar contains neither any blackish pigment nor so large amount of a red pigment that we felt it blackish.

From these points of view, the author has reached the conclusion that the blackish appearance of the leaf of the coleus cultivar VELVET RAINBOW is due to the shadow of epidermal cells, which being resulted from the characteristic surface structure of the leaf, a comparably long papillate form of epidermal cells arranged with some intervals.

Here, the author would like to exemplify the blackish appearance of the VELVET RAINBOW leaf as a proof of structural effect on coloring additional to the velvety dark red petal of black roses.

The blackish appearance of the VELVET RAINBOW leaf is the same to that of the petal of black roses, though the surface structure of the coleus leaf seems to be less appropriate to form shadow in comparison with that of the black rose petal, because in the coleus leaf the shadow does not come in sight when the surface is illuminated at angle of 30 degrees (Table 1), at which the shadow are easily visible in the black rose petal as shown in the previous paper.²⁾ This may be imputable to that the lateral wall of epidermal cell in the VELVET RAINBOW

leaf is more oblique to the surface than that in the black rose petal.

As the epidermal structure of the area abundant in the chloroplasts is identical with that of the portion lacking in them, the shadow of the epidermal cell is also expected to appear in that area. But the shadows formed there fail to be perceived distinctly, probably because the blackish tone on the reddish dark green background is not so striking as that of the red one.

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