Curr. Sci. **38** 503–505 (1969)

The colours of roses

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ABSTRACT

A spectrophotometer record of the absorption spectrum of an acetone extract of the pigments of a red rose is reproduced. It exhibits three peaks respectively in the yellow, in the green and in the greenish-blue regions of the spectrum, thereby indicating the identity of the pigment as florachrome B. The features observed in the record enable it to be inferred what colours a rose would exhibit if it contained varying quantities of the pigment. These are in agreement with the facts of observation.

1. Introduction

The popularity of the rose has led to great efforts being made towards the development of varieties exhibiting diverse habits of growth and flowering and especially those producing large blooms with numerous petals and attractive colours. Hundreds of named varieties have thus been created and widely distributed. They are to be found listed and illustrated in several publications. The colours which are forthcoming are so striking and so varied that considerable interest attaches to the problem of their origin.

The first step towards the elucidation of these colours is to classify them into distinct groups. We may begin with some familiar colours, viz., yellow, orange, scarlet, red and crimson—limiting ourselves to those cases in which these colours exhibit the maximum degree of saturation or fullness. But not all roses can thus be described. Many present similarity in colour to spectral yellow, orange or red, but are of less saturated hues. Other colours, again, bear no resemblance to any of the pure spectral colours. Various special names have been given to rose colours, viz., cream, pink, salmon, vermilion, mauve and lilac. To this list must be added the multi-coloured roses which display different colours on the front and reverse faces of the petals, e.g., scarlet and yellow, or red and white, while others present areas different in colour on the same side of the petals.

2. The genesis of the colours

We are chiefly interested here in the chemical problem, in other words, with ascertaining the nature of the pigments present in the petals which absorb the

light rays incident on them, the rays which escape such absorption and emerge as diffused light determining the observed colours. Observation of the flowers held in sunlight through a pocket spectroscope reveals that roses exhibiting vivid colours such as scarlet, red or crimson completely absorb most of the visible spectrum, allowing only limited regions of it to escape as diffused light. Similar observations with the less vividly coloured roses indicate only the parts of the spectrum which suffer the greatest measure of absorption. Thus, in either case, the information which is forthcoming does not enable any definite conclusions to be arrived at regarding the absorptive properties of the pigment over the entire range of the visible spectrum.

In these circumstances, it becomes necessary to rely on the study *in vitro* of the pigments extracted from the rose petals by solvents which do not fundamentally alter their optical behaviour. The two solvents which have been employed in the author's studies are ethyl alcohol and acetone respectively. Rose petals immersed in ethyl alcohol are bleached and given sufficient time become practically colourless. With yellow roses, or with multi-coloured roses exhibiting yellow faces or sectors, the alcoholic solution exhibits a golden-yellow colour. On the other hand, the alcoholic extract of other roses is quite colourless, from which we infer that the pigment responsible for the colour of such roses has gone into solution, but has simultaneously been transformed into a colourless product.

Rose petals immersed in acetone behave differently. Yellow roses, and the yellow areas in multi-coloured roses are not immediately affected. But roses of all other colours and the areas on multi-coloured roses exhibiting colours other than yellow are quickly decolourised, and as the pigment is extracted from the petals, it dissolves in the acetone which then acquires its colour. The acetone extract may then be transferred into an observation tube with flat ends. Viewed against a bright source of white light through a pocket spectroscope, the absorption spectrum of the solution is seen by the observer. The concentration of the acetone extract can be varied by using fewer or more petals as the case may be and adjusting the quantity of acetone used for the extraction. It is also useful to have observation tubes of greater or shorter length, as may be found desirable, depending on the strength of the coloured extract.

Observations made in this manner with the acetone extracts reveal that the extracted material is much of the same nature in all the cases which have been studied by the author. Crimson roses, red roses, scarlet roses, orange roses and roses which are a light pink or a deep pink, all present spectra which are very similar in appearance. The long wavelength region in the spectrum extending from 600 mμ upto the red end comes through in full strength. But the yellow and green sectors of the spectrum between 600 and 500 mμ are strongly absorbed. Darker bands in which such absorption is a maximum are clearly visible respectively in the green and yellow parts of the spectrum. There is also an observable transmission of light in the blue region of the spectrum.

The alcoholic extract from yellow roses examined spectroscopically exhibits an

absorption which covers the short-wave end of the spectrum and extends a little beyond the blue upto about 515 mμ.

3. Spectrophotometric study

Figure 1 is the spectrophotometric record obtained with the acetone extract from a rose of a deep red colour held in a cell of 1 cm thickness. The figures entered are wavelengths in Å. The extract had to be diluted with acetone to enable the nature of the absorption to be clearly recorded. It will be seen that the record exhibits three distinct humps appearing respectively in the yellow, in the green and in the blue-green regions of the spectrum. These features exhibited by the record indicate that the pigment responsible for the colour of the red roses may be identified with the material designated by the author as florachrome B.

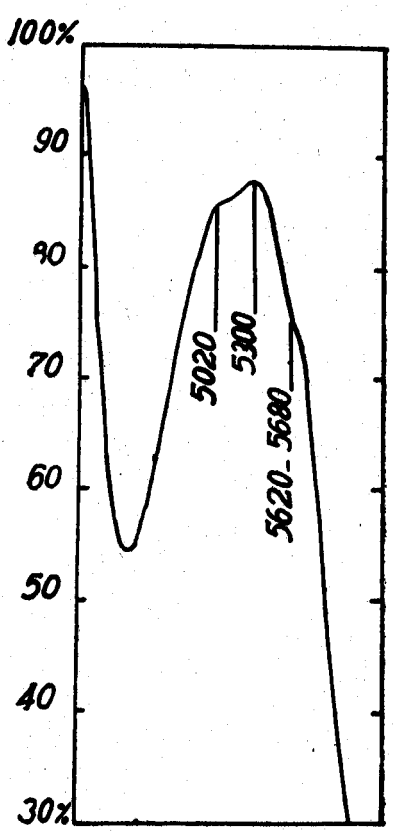

Figure 1. Absorption spectrum of red rose.

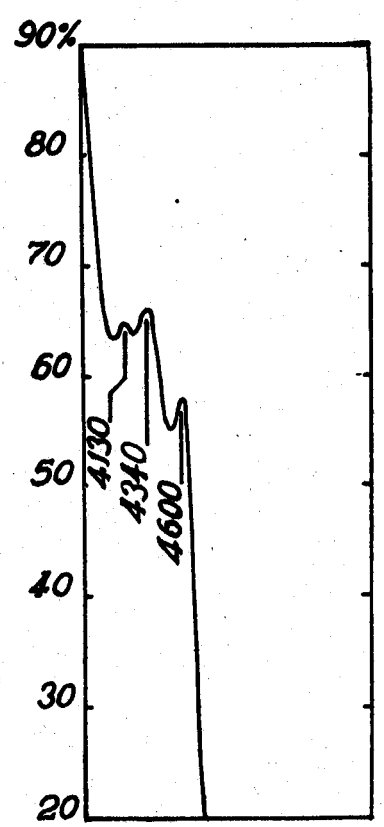

Figure 2. Absorption spectrum of yellow rose.

Figure 2 is the spectrophotometric record of the alcoholic extract from a yellow rose. The figures entered are wavelengths in Å. The absorption is manifested only in the blue region of the spectrum and the three peaks which appear in the record are an indication that the pigment which gives the characteristic golden-yellow colour to the extract belongs to the well-known class of organic compounds known as the carotenoids.

4. Explanation of the colour variations

The features noticed in the recorded curve of absorption appearing as figure 1 enable us to give a reasonable explanation of the great range of colours actually exhibited by roses. The factor which is different for the roses of different colour is the quantity of pigmentary material present in the petals. On the basis of such variation, it is possible to deduce the results to be expected and compare them with the actual facts of observation.

We may begin with the cases in which the pigment is present in minimal quantities. It is evident from figure 1 that in such cases, the absorption of light by the petals would be principally observed in the range of wavelength from 500 to 550 mμ and that it would be much less both at greater and smaller wavelengths, becoming altogether insensible as we approach the red end of the spectrum. Examination of pink roses held in bright light through a pocket spectroscope discloses just such a situation. Further, it is found that the deeper the pink colour of the rose, the greater is the absorption noticeable in the green sector of the spectrum between 500 and 550 mμ. But both the red and the blue regions of the spectrum persist.

We may next consider the cases in which the pigment is present in substantial quantities, sufficient to make the absorption by the petals completely effective except in the regions of the spectrum where the absorptive power is quite small. Referring again to figure 1, it will be seen that in such cases, the light which escapes such absorption could appear only at the extreme red end of the spectrum, and the rose would appear of a deep crimson colour. With less pigment available, wavelengths upto about 600 mμ could escape complete absorption and the colour of the rose would then be a bright red instead of a deep crimson. When the quantity of pigment available is still smaller, wavelengths between 570 and 600 mμ would commence to appear in the light diffused by the petals and the colour of the rose would alter from red to scarlet. With further diminution of the quantity of pigment available, the light diffused by the petals would extend further towards still shorter wavelengths and the colour of the rose would alter from scarlet to orange. Actually, when orange roses are viewed through a pocket spectroscope, we find that the spectrum from the extreme red upto 550 mμ comes through, while shorter wavelengths are absorbed. In all these cases, the blue region of the spectrum is scarcely to be seen.

The author has not had an opportunity of examining roses which have been described as exhibiting purplish hues. If blue roses were ever forthcoming, they would assuredly exhibit the spectrum of florachrome A, with its characteristic bands of absorption in the red, yellow and green regions.

The spectrophotometer records reproduced above were made in the Instruments Laboratory of the Indian Institute of Science, to the authorities of which the author's thanks are due.