

another shade of red

Vivienne Baillie Gerritsen

There is more to red than meets the eye. The colour has probably been around for as long as plants have, spreading red across stalks, leaves, fruits and flowers to seduce the incidental pollinator or ward off predators. Surprisingly, although Nature usually tends towards the most economical, in plants there are two ways of making red by using either of two biosynthetic pathways: the betalain one, or the anthocyanin one. While the anthocyanin pathway only produces reds, the betalain pathway supplies both red and yellow pigments. But anthocyanins and betalains are never synthesized within the same plant; it is one or the other. This probably has to do with evolution and the choice of favouring one pathway over another. One protein which has a key role in triggering off the betalain pathway has recently been revealed – transcription factor MYB1.



Hopi Amerindian design on pottery for which amaranth betacyanins are the source of red

In: Pueblo Indian Pottery, C.Szwedzicki, 1933-36

Reds are spread all over the plant and the animal kingdom, but are also found in many minerals. So it must be a colour that appeals to Mother Nature. It certainly is a hue that does not go unnoticed, and besides being used in Nature as a means of attraction or warning, humans have found ways of extracting red pigments from animals, plants and minerals to use in their very varied forms of art besides dying cloth and

colouring food for instance. Over time, the colour red has been invariably associated with feelings such as passion, love, seduction, sexuality, courage, determination, anger, danger and war which, in their own way, echo their particular use in Nature.

Beetroots, otherwise known as *Beta vulgaris*, are a source of red betalain that has been used as food and beverage colouring for centuries. Their juice was also used by women during the 19th century to redden their cheeks and lips. The red of beetroots is the characteristic deep burgundy which could easily be taken for purple depending on its concentration in the beet's epidermis. The betalain pigment which gives this particular red, or violet, has been coined betacyanin, while its yellow counterpart is called betaxanthin. Depending on their concentration, the plants they colour range from deep purple to orange and yellow.

Both betalain pigments are the end product of the same biosynthetic complex which begins with an upstream tyrosine. Though the pathway is still far from understood, the main steps – and the key enzymes involved in these steps – have been characterised. Although researchers are well aware that there are many side reactions that remain to be uncovered. One of the key enzymes involved is transcription factor MYB1, which is an anthocyanin MYB-like protein. MYB1 most probably activates the expression of betalain biosynthetic genes – the existence of

which had already been described in the 1930s – and are essential in processing tyrosine to give the downstream betacyanin red and betaxanthin yellow. A plant which uses the betalain biosynthetic pathway does not encode the anthocyanin pathway. In a nutshell, plants that belong to the order Caryophyllales – to which belong cacti, beets and carnivorous plants for instance – use (save two exceptions) betalains for their reds, while all other plants use anthocyanins.

But why would Nature design two different pathways for synthesizing reds? It is currently believed that both pathways have a common ancestor, and that the anthocyanin biosynthetic pathway was probably the first to exist. Indeed, the two pathways are regulated by similar – though not interchangeable – transcription factors. What may have happened is that the more complex anthocyanin pathway was traded for the more straightforward betalain pathway

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another shade of red

Vivienne Baillie Gerritsen

There is more to red than meets the eye. The colour has probably been around for as long as plants have, spreading red across stalks, leaves, fruits and flowers to seduce the incidental pollinator or ward off predators. Surprisingly, although Nature usually tends towards the most economical, in plants there are two ways of making red by using either of two biosynthetic pathways: the betalain one, or the anthocyanin one. While the anthocyanin pathway only produces reds, the betalain pathway supplies both red and yellow pigments. But anthocyanins and betalains are never synthesized within the same plant; it is one or the other. This probably has to do with evolution and the choice of favouring one pathway over another. One protein which has a key role in triggering off the betalain pathway has recently been revealed – transcription factor MYB1.



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In: Pueblo Indian Pottery, C.Szwedzicki, 1933-36

Reds are spread all over the plant and the animal kingdom, but are also found in many minerals. So it must be a colour that appeals to Mother Nature. It certainly is a hue that does not go unnoticed, and besides being used in Nature as a means of attraction or warning, humans have found ways of extracting red pigments from animals, plants and minerals to use in their very varied forms of art besides dying cloth and

colouring food for instance. Over time, the colour red has been invariably associated with feelings such as passion, love, seduction, sexuality, courage, determination, anger, danger and war which, in their own way, echo their particular use in Nature.

Beetroots, otherwise known as *Beta vulgaris*, are a source of red betalain that has been used as food and beverage colouring for centuries. Their juice was also used by women during the 19th century to redden their cheeks and lips. The red of beetroots is the characteristic deep burgundy which could easily be taken for purple depending on its concentration in the beet's epidermis. The betalain pigment which gives this particular red, or violet, has been coined betacyanin, while its yellow counterpart is called betaxanthin. Depending on their concentration, the plants they colour range from deep purple to orange and yellow.

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