

The gene for red

CSIRO researchers have located the gene that controls colour in apples.

Anthocyanins are natural plant compounds responsible for the blue, purple and red colours in many flowers and fruits, including the red colour in apple skin. In apples the coloured skin evolved as a way to attract animals to eat the ripe fruit and then scatter the seed.

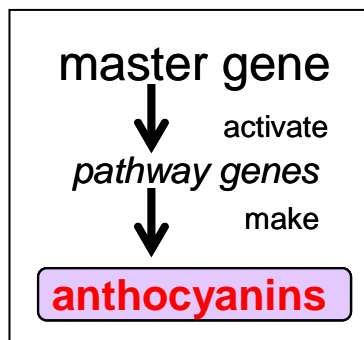
Fruit colour is also an important part of fruit marketing for humans. Consumers generally associate bright, shiny red fruit with better taste and ripeness than similar green or yellow fruit.

The success of Pink Lady™ apples is a good example; their attractive and distinctive pink hue has made them a very strong seller.

As well as improving the appearance of fruit, anthocyanins are also antioxidants and beneficial to human health, making them even more interesting to scientists.

Tracking the gene down

The biochemical pathway that produces anthocyanin has been studied in many plants, particularly petunia, maize, and Arabidopsis, and it has been shown that master genes control the activation of the pathway genes that produce anthocyanin in these plants.



However until recently little was known about the pathway in apples.



A CSIRO Plant Industry research team, led by Dr Mandy Walker, has been examining the colour pathway in apples to see how apple colour is regulated.

Shedding light

Apple growers have always known that apple colour is dependant on light. Apples grown in darkness or shade don't turn red when they ripen. That made it very likely that the master gene for apple colour requires light to be activated.

To take advantage of this fact, fruit on trees was covered with bags early in the season to exclude sunlight and prevent anthocyanin production.

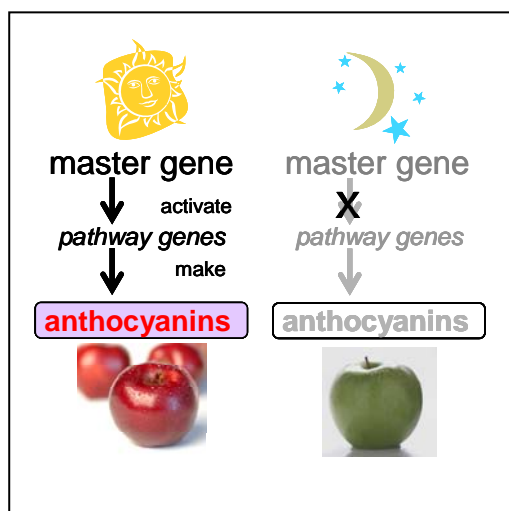
When the bags were removed during the fruit ripening phase, re-exposure to sunlight induced anthocyanin synthesis.

Post Doctoral Fellow Dr Adam Takos used the latest molecular technology to measure how much particular pathway genes were activated, or expressed, in apple skin as the fruit ripened and coloured.

In a previous report (Takos *et al.*, 2006a) the CSIRO team showed that as anthocyanin synthesis was induced in response to sunlight, the genes responsible for the synthesis (the pathway genes) were activated.

The next step in the research was to identify the controllers or master genes of the pathway genes.

By identifying the master genes from other species such as petunia, Adam was able to pinpoint the master gene that controls the formation of anthocyanins in apples. This gene is responsible for using the light signal from the sun to activate the pathway genes.



The identity of this gene was confirmed in a series of tests including the examination of a wide range of apple varieties to establish that the gene is not expressed as much in green apples as in red apples. In laboratory tests, the master gene was also able to control the synthesis of coloured anthocyanins in grape cells which are normally not coloured.

Breeding for future apples

In collaboration with apple breeders at the Department of Agriculture and Food in Western Australia, the scientists were able to show that fruit colour can be predicted even in seedling apple plants, long before they bear fruit, by determining whether the gene for red colour was present.

The new knowledge about how apple colour is regulated will give plant breeders the opportunity to use these molecular marker tests to speed up apple breeding and select for improved fruit colour. Dr Walker believes that this research could open the way to new apple varieties.

With a better understanding of how apple colour is controlled, plant

breeders will be able to breed apples with new and interesting colour variations or with better, more reliable colour in a range of environmental conditions.

The research is a collaboration between CSIRO and the Department of Agriculture and Food Western Australia, who have partly funded the project with a voluntary contribution.

The project has been facilitated by Horticulture Australia Ltd in partnership with industry and has been funded as part of the across industry program. The Australian Government provides matched funding for all Horticulture Australia's R&D activities.

References:

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