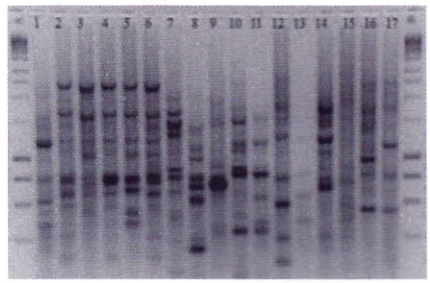
Crocus: research into the origin of saffron

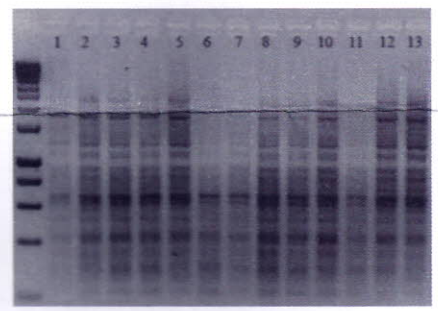
The genus *Crocus* has nearly 100 species, each with unique characters of colour, flowering time or geographical distribution. We are aiming to understand the relationships of the different species, the diversity within species, and in particular the origin and diversity of the most valuable *Crocus* species, the spice saffron.

Saffron is the dried stigmas of the flower from *Crocus sativus*, which is grown commercially in many countries, from Iran to Mediterranean Spain and Greece, with significant production also in Kashmir. It is highly prized as a spice and colouring, used in both sweet and savoury dishes, teas, and also with medical applications. About 200 stigmas from 70 flowers go into a gram of the spice. Flowers are picked in the early morning, and the stigmas removed on processing tables in the shade, before the drying process which differs between producers. Despite the high price, though, only a few stigmas are needed to flavour a dish. Saffron does not produce seeds, so is only propagated vegetatively, by separation of corms from the parent. Our research is asking the following questions. How many times has saffron originated in nature? What are the ancestors? How different is saffron from different geographical areas? Is it possible to resynthesize the species to breed improved saffron with better disease resistance, easier harvestability, and better use of water in dry areas?

> *"Many of the plants grown in the botanic gardens are used for research within the University"*



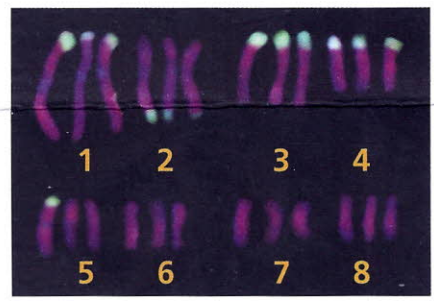
We have analysed the DNA from 21 species, representing the diversity of *Crocus*, and the 'barcodes' from the DNA show substantial differences between the species, shown in an example above where the code is different in each lane (left and right and lane 13 are DNA reference markers). Analysis of several wild accessions of species also shows considerable variation: lanes 3 to 5 are different collections of the ornamental species *Crocus thomasii*.



In contrast, when we looked at saffron, each barcode was identical (above), whether the plant was obtained from Spain, Iran, Holland, Greece, the UK or Kashmir. We conclude, therefore, that there is very little, if any, genetic variation in saffron from across the world and the cultivated species only arose once before being distributed widely.

Processing and growth conditions do vary – from sea level to more than a mile high in Kashmir, or from moist to desert conditions, for example – so quality may vary. Adulteration of saffron with dyes and other fibres is also a big problem commercially, and our barcoding work is helping develop tests for authenticity, although not geographical origin!

Saffron has three sets of chromosomes (illustrated below), so can be thought of as having three parents (direct ancestors)! Sequencing the three sets of genes shows that two are like the wild species *Crocus cartwrightianus*, while the other set is more similar to *C. pallasii ssp. pallasii*. These findings have given a strong indication of the answers to questions about saffron's origin and diversity that have been asked for one and a half millennia!



Many of the plants grown in the botanic gardens are used for research within the University. This work was conducted in the context of the EU project Crocusbank.org and the ESF network Saffronomics.org

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Saffron Crocus, showing the dark orange stigmas (left) and the harvested stigmas (right).