Genetic engineering of floricultural crops: current status and future prospects

Yoshikazu Tanaka & Steve Chandler

Suntory has been using genetic engineering to develop and commercialize floricultural crops with a focus on novel flower colour. Red, violet and blue-coloured flowers are derived from anthocyanins, a class of flavonoids. The structure of anthocyanins, especially the hydroxylation pattern of the B-ring, affects their colour to a great extent. The colour shifts bluer when the number of hydroxyl groups on the B-ring increases. Flavonoid 3,5-hydoxylase (F3'5'H) catalyzes hydroxylation of the B-ring and is the key enzyme for biosynthesis of delphinidin-related anthocyanins, which most blue flowers contain. By expressing the F3'5'H gene properly in carnation, rose and chrysanthemum, transgenic plants with flowers with novel bluish hue have been developed. Currently 8, 4 and 2 transgenic carnation (Moon carnation) varieties are sold in the USA, Japan and EU, respectively. The difference in the number of varieties in each market is directly related to the requirements for molecular characterization to achieve deregulation. A transgenic rose variety (Applause™) has been commercialized in Japan and is about to be launched in the USA. Field trials are necessary to evaluate the commercial value of the transgenic chrysanthemum.

Field trials are a critical step in the commercialization process. We generated various transgenic pink and white-flowered torenia from blue or violet varieties. Lines which showed good growth and stable flower colour in the glasshouse did not necessarily perform satisfactorily in hanging basket trials. In particular, a white-flowered transgenic line exhibited strong growth retardation in outdoor conditions.

Modification of flowering and plant and flower morphology is also an attractive target for genetic engineering of floricultural crops. The *Arabidopsis FT* gene induces early flowering. Transgenic carnation, rose and chrysanthemum expressing this gene flower *in vitro*, suggesting proper expression may result in commercially useful varieties Constitutive expression of chimeric repressor of *Arabidopsis* TCP3 in rose resulted in interesting morphological changes; the number of leaflet and the size of leaf teeth increased, and the petals were wavy and notched. Unfortunately the roses grew very slowly. Again, proper regulation of the transgene may yield commercially useful varieties

Genetically engineered varieties account for a considerable share of total production in soybean, maize, canola and cotton. In contrast, commercial application of genetic engineering to floricultural crops is still very limited. This may be because the potential market for each floricultural crop sale is not big enough to justify the cost of development and especially regulatory approval. Easing the heavy burden of regulatory approval is essential if genetic engineering of floricultural crops is to flourish.