The Pharma Innovation Journal 2023; 12(8): 395-398

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 395-398

www.thepharmajournal.com
Received: 20-05-2023
Accepted: 24-06-2023

Yogita Jureshiya
M.Sc. (Hort.), Department of Floriculture and Landscape Architecture, Pt. K. L. S. College of Horticulture and Research Station, IGKV, Raipur Chhattisgarh, India

Neel Kusum Tigga
M.Sc. (Hort.), Department of Floriculture and Landscape Architecture, College of Agriculture, IGKV, Raipur Chhattisgarh, India

Corresponding Author:
Yogita Jureshiya
M.Sc. (Hort.), Department of Floriculture and Landscape Architecture, Pt. K. L. S. College of Horticulture and Research Station, IGKV, Raipur Chhattisgarh, India

Role of biotechnology for modifications in floral characteristics

Yogita Jureshiya and Neel Kusum Tigga

Abstract
The Biotechnology can help to create variability, preserve biodiversity, and select superior genotypes that are crucial for attractive plant growth**.** The flower industry demands the emergence of novel traits in decorative plants. However, the majority of ornamental plants have minimal genetic information and high heterozygosity, which has hindered breeding efforts. Consequently, using biotechnological methods like genetic engineering offers a different way to get flowers with altered traits. A new realm of possibilities regarding plant sciences has opened up with the development of CRISPR/Cas9, and it has promising uses in floriculture. Future advancements in genome editing techniques will change the market for ornamental plants. Traditional breeding techniques and biotechnological approaches have been combined to improve floral color, appearance, and disease resistance.

Keywords: Biotechnology, heterozygosity, CRISPR/Cas 9, genome editing, resistance

Introduction
In the field of horticulture known as "floriculture," decorative plants and flowers are grown, sold, and displayed for commercial purposes. Compared to most other field crops, commercial floriculture has a larger potential per unit of land and is significant from an export perspective. Due to genetic engineering's expansion of the floricultural gene pool and promotion of the development of innovative varieties of cut flowers, the worldwide floriculture industry thrives on novelty. Gene silencing methods including RNAi, CRES-T, and miRNA alter flower characteristics. Similar to this, genetic engineering can be used to address floricultural qualities such as flower color, smell, resilience to biotic and abiotic stress, and post-harvest survival. The benefits of transgenic cut flower harvests could increase.

Biotechnological approach
1. Micropropagation: The rapid multiplication and propagation of disease-free floriculture crops has long been accomplished through the use of tissue culture. (Mousavi *et al*., 2012) [7]. Genotype, media, carbohydrates, growth regulators, explants type, etc. all have a significant impact on the effectiveness of tissue culture propagation.

2. Somaclonal variation: During adventitious shoot regeneration from callus, somaclonal variation may occur. Its promise as a source for cultivar development has been disputed ever since somaclonal variation was discovered in the 1970s. Regardless of the debates, it is true that somaclonal diversity has been a key factor in the development of cultivars in crops used in floriculture. This particular crop group's *in vitro* cultivation produces somaclonal variants that could be unique and can be stabilized through vegetative propagation.

3. Polyploidy breeding: Ploidy manipulation has been considered as a valuable tool to improve ornamental characteristics and facilitate breeding programs (Roughani *et al*., 2017) [9].

4. Mutation: Any program for plant breeding to improve crops must incorporate genetic diversity. Induced mutation has been utilized as a tool to generate variation and breeding. Gamma rays have been commonly used effectively among all mutagens for mutation induction.

5. Genetic Modification: While Genetic modification provides other pathways for the development of new varieties of significant floricultural plants, conventional breeding techniques have been quite effective in producing novel blooms.

6. Haploid breeding: By using this method, haploid breeding disease free can be obtained resulting in dwarfed ornamentals such as the Pelargonium variety "Kleine Liebling" and the rose hybrid "Sonia". After chromosome duplication, homozygous individuals can be produced by haploid breeding with ease, speeding up the breeding process.

1. Flower color

The colour of flowers is one of the most important key characteristics of many ornamental plants (Chandler *et al*., 2012) [2]. Majority of the pigments are responsible for their attractiveness of flower colors i.e; anthocyanins, flavonoids, carotenoids, and betalains. Anthocyanins are primarily based upon six anthocyanidins types i.e., peonidin, cyanidin, delphinidin, malvidin, and pelargonidin petunidin.

While red flower colour is caused by pelargonidin acting as an anthocyanidin base, blue flowers typically feature a high degree of delphinidin and derivatives. In many ornamentals, color range is limited by the genetics of the plant species and genetic modification is an effective way to overcome this limitation.

As a result of the identification of the important genes in the biosynthesis and metabolism of anthocyanins, flavonoids, and carotenoids, it is now possible to alter flower color in a variety of ways.

Examples

Azadi *et al*. 2010 [1] revealed that the extensive pigments in the transgenic lily calli and leaves following the *35S CaMV* transfer of the essential genes for the carotenoid production pathway.

Delphinidin derivatives make up around 70% of the anthocyanins in petals when a petunia F3'5'H gene is overexpressed in a pelargonidin-producing carnation cultivar under the control of a constitutive promoter.

Chrysanthemums have a variety of hues that are mostly caused by carotenoids and/or red malonylated cyanidin glucosides. Only the white chrysanthemum ray petals express the *CmCCD4a* gene. The suppression of the production or accumulation of carotenoids in petals is caused by a single dominant gene.

Solimon *et al*. (2014) [10] confirmed that the impact of gamma radiation on the production of mutation in chrysanthemum (Chrysanthemum morifolium Ramat cv. Youka) white petals *in vitro*. Semi-quantitative RT-PCR analysis revealed that the majority of genes are involved in synthesis of carotenoids, with exception of violaxanthin deepoxidase (VDE) and lycopene ε-cyclase (LCYE), displayed comparable expression patterns in the petals of the original 'Youka' and its mutants. Results from VDE and LCYE indicated that yellow petal mutants had high expression levels compared to controls. Conclusion: Chrysanthemum cv. Youka flower color can be *in vitro* induced by gamma radiation at a level of 15 Gy.

A mutant variety of rose known as "Wouburn Gold" was reported to have the highest levels of flavanol, anthocyanin, luecoanthocyanin, and total carotenoids, which resulted in tangerine orange petals.

2. Induction of early flowering

One of the main goals in breeding ornamental plants is to shorten the flowering period by creating cultivars with early blooms or plants that can produce flowers even in the middle of the day.

The ability to operate floral traits genetically by altering key genes related to flowering appears to be a beneficial advancement.

MADS box gene family e.g., *AP1* control the floral organ development as well as flowering time.

Examples

When *AP1* is overexpressed in transgenic chrysanthemums during short days, bud initiation can begin 14 days earlier than in non-transgenic plants. Exogenous LFY over-expression enhances early flowering, according to transformation carried out by Agrobacterium in *Siningia* sp.

miRNA159 was overexpressed or inhibited in transgenic Gloxinia plants, resulting in late or early flower emergence, respectively.

The *GSQUA2* gene transformation in Gerbera promoted flowering.

OMADS1 transformation in lisianthus resulted in a noticeably shorter flowering period and more flowers overall as compared to non-transformed plants.

3. Flower morphology and plant architecture

The use of homeotic genes that control floral growth may be especially intriguing in decorative flower crops where flower morphological variation might be commercially valuable.

Table 1: Modification in floral morpholgy and palnt architecture by biotechnolgical tools

Crops	Introduced	Successful
Chrysanthemum	tobacco phytochrome b1 gene over-expression	larger branch angles, small sized plants
Chrysanthemum	Arabidopsis GA insensitive gene	Decrease in plant height
Gloxinia	gamma irradiation	funnel-shaped leaves, fluffy leaves, short inter nodal length, change of color flowers and double-flowered
Chrysanthemum	Transformation of DgLsL gene with vector antisense DgLsL and pCAMBIA1301-sense	abundant branches
Gypsophilla	*rol C* gene	increased lateral branch and bud formation
Transgenic Carnations	Promoter *35S* CaMV with rol C gene	High in stem cutting yield and flowering stems

4. Fragrance engineering

Floral smells play a significant economic role as well as being essential to plant reproduction. Many volatile components of floral scents belong to the terpenoid, phenylpropanoid/benzenoid, and aromatic amino acid classes.

Key genes related to the production and regulations of fragrance have been identified and the ability to manipulate fragrance genes through genetic engineering has shown promise for use in increasing the potential of floral scents.

The *Clarkia breweri BEAT* gene (benzyl alcohol acetyl transferase for benzyl acetate synthesis) was inserted into lisianthus to induce scent in the petals.

5. Biotic & abiotic stress tolerance

Both abiotic and biotic stressors have a negative impact on plant growth and productivity. It is challenging to breed ornamental plants for stress resistance or tolerance since there aren't enough resistance genes.

By using biotechnology techniques for resistance to abiotic and biotic stressors, including as drought and pathogens, has garnered attention in recent years. The critical significance that many genes from various origins play in maintaining plant life under stressful circumstances has been confirmed.

Numerous transcription factors, including as *ZIP*, *WRKY*, and *NAC* as well as their byproducts, play a critical role in how plants react to environmental stresses like drought and high temperatures. Different reactions are displayed by ornamental plants in the presence of abiotic stressors.

Table 2: Biotechnolgical strategy for biotic and abiotic stress tolerance

S. No.	Crops	Gene incorporated	Resistant against
1.	*Dendranthema grandiflorum* cv. Shinba	CaXMT1, CaMXMT1 and CaDXMT1	*Botrytis cinerea*
2.	*Chrysanthemum morifolium*	Integration of *cp* gene	No or least CMV (Cucumber mosaic virus) symptoms.
3.	Chrysanthemum	expression of *cry1Ab* gene	*Spodoptera litura*
4.	*R. chinensis* Jacq.	Medicago gene MtDREB1C	Cold stress

6. Shelf life enhancement

Long vase life is an important quality for cut flowers, and it is chosen during breeding. It is crucial that cut flowers have the ability to resist senescence-promoting agents like ethylene and bacterial infection since they must be able to survive for several weeks in the distribution chain before they are in the hands of consumers.

Fruit vase life has been discovered to be improved by suppressing the genes for producing ethylene pathways i.e; *ACO* (ACC oxidase) or *ACS* (1-aminocyclopropane-1-carboxylic acid synthase), which reduce autocatalytic ethylene synthesis.

By inhibiting the ACO gene, transgenic carnation plants with delayed petal senescence have been created. (Noman *et al*., 2017) [8].

Major Genetically Modified Ornamentals

Carnation

The only GM ornamental items that have seen substantial commercial success are those in the "Moon" series from Suntory Limited and Florigene Pty Ltd. Since the late 1990s, countries like Australia, the European Union, Japan, and the USA have sold the Moon series carnations commercially. It has been approved in early 2000 at Coloumbia. The 4 new carnations have just been introduced to the "Moon" series: Moonvelvet (dark purple). Moonique (purple), Moonberry (light purple) and Moonpearl (lavender). These four most recent events have been commercialized for use at 2012.

Roses

The blue rose is currently the most well-liked transgenic. Three genes are present in this transgenic rose: a synthetic RNA interference gene to turning off DFR gene, a gene of delphinidin from a blue pansy, and a second DFR gene with an affinity for making delphinidin from an iris. Suntory introduced the blue rose "APPLAUSE" in Tokyo, Japan, in 2009, despite the fact that the finished product is more lavender than blue. The blue rose was introduced to North America by Suntory in November 2011.

Suntory researchers are currently studying several strategies, including additional bluing components, for the development of a true blue rose. Since most rose cultivars descended from hybrid tea roses unintentionally lost their scent due to selection criteria that were more focussed on shelf life and flower form and less on fragrance, fragrance is also a feature that is being explored.

Petunia

The only petunia event now offered commercially is the Petunia-CHS, an event with a modified floral hue created by Beijing University. In Germany, Ornamental Biosciences is now concentrating on increasing abiotic stress resistance, particularly frost tolerance.

Conclusion

Commercialization of GM crops will continue to outpace horticulture and only just a few of new GM ornamentals reaching the markets. Due to their lengthy life spans and complex genetic backgrounds, ornamental plants' study will continue to lag behind despite the extensive research being done on decorative features.

However, since biotechnologies advance every day, researchers in ornamental horticulture should take advantage of these advancements for their own purposes in order to advance the field's advancement. Consequently, it is reasonable to assume that additional GM decorative goods will be introduced in the future. Public awareness will rise when more GM cut flower cultivars are made available. The growth of secondary metabolites, including pharmaceuticals, may also be compatible with some characteristics of decorative gardening.

Reference

1. Azadi P, Bagheri H, Nalousi AM, Nazari F, Chandler SF. Current status and biotechnological advances in genetic engineering of ornamental plants. Biotechnology Advances. 2016;34(6):1073-1090.
2. Chandler SF, Sanchez C. Genetic modification; the development of transgenic ornamental plant varieties. Plant Biotechnology Journal. 2012;10:891-903.
3. Gantait S, Mandal N, Bhattacharyya S, Das PK. Induction and identification of tetraploids using *in vitro* colchicine treatment of Gerbera jamesonii Bolus cv. Sciella. Plant Cell Tissue and Organ Culture. 2011;106:485-493.
4. https://www.frontiersin.org/articles/10.3389/fpls.2017.00530/full.
5. https://www.isaaa.org/resources/publications/pocketk/47/default.asp
6. https://www.scielo.br/j/oh/a/ptQQzkkpC8TccHHdfxq4QBk/?lang=en&format=pdf
7. Mousavi ES, Behbehani M, Hadavi E, Miri SM, Karimi N. Plant regeneration in *Eustoma granditlorum* from axillary buds (Gentinaceae). Trakia Journal of Sciences.

2012;10(2):75-78.
8. Noman A, Aqeel M, Deng J, Khalid N, Sanaullah T, Shuilin H. Biotechnological advancements for improving floral attributes in ornamental plants. Frontiers in Plant Science. 2017;8(530):1-15.
9. Roughani A, Miri SM, Kashi AK, Naserian Khiabani B. Increasing the ploidy level in spinach (*Spinacia oleracea* L.) using mitotic inhibitors. Plant Cell Biotechnology and Molecular Biology. 2017;18(3&4):124-130.
10. Soliman TMA, Lv S, Yang H, Hong B, Ma N, Zhao L. Isolation of flower color and shape mutations by gamma radiation of *Chrysanthemum morifolium* Ramat cv. Youka. Euphytica. 2014;199:317-324.