E-ISSN: 2788-9297
P-ISSN: 2788-9289
SAJAS 2021; 1(2): 35-38
Received: 15-05-2021
Accepted: 18-06-2021

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Plant genetic engineering for medicinal and aromatic plants (MAPs)

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Abstract
Genetic improvement of medicinal and aromatic plants (MAPs} has become necessary in recent years to broaden the relatively narrow genetic base of modern MAPs cultivars. Such broadenings is needed to supply kinds of cultivars of MAPs for exploitation. Biotechnology will provide essential and innovative support to standard plant breeding in the coming years, bringing in new generic systems, new techniques for selection and identification of genotypes, for making improved hybrid plants, and most importantly, deeper understanding of plant gene action, biochemistry and physiology for the human welfare. Progress in plant genetic engineering has been dependent on efficient methods of introducing new gene (exotic), or DNA fragment into plant cells. There are two methods of gene transfer that can be achieved by, a) either direct uptake of DNA by Shot-gun method and other is the natural process of gene transfer by *Agrobacterium tumefaciens* using different types of vectors based on the vector genome (Bhojwani, S.S., 1990) [3]. The plant containing foreign gene called transgenic plant. Today, many transgenic plants have been engineered by the biote-hnologists with particular beneficial properties, such as, improvement of nutritional quality, resistance against herbicide, resistance against pest, resistance against viral infection, resistance against fungal pathogen, production of secondary metabolites, storage protein, extended shelf life of fruits, tolerance to environmental stresses, production of pharmaceutical products etc.

Biotechnology or Plant Genetic Engineering will have a major impact on improvement of MAPs in coming years. The synergistic techniques of *in vitro* culture and genetic engineering techniques have made it actually or potentially to transfer any natural or *In vitro* modified gene to many MAPs species. Everyone who has studied organic chemistry knows that esters and aldehydes have smells or aromas. The flavor industry is dependent upon aroma chemicals, which are either extracted from natural sources or synthesized in the laboratory. The flavors industry is competitive and complex. The major companies achieve success through heavily supported research and development programmes linked to extensive market and consumer research. When several thousand tones of essential oils are produced the price are reasonable. It has been estimated that to produce a material by plant cell tissue culture with today's technology would mean selling prices of $1,000 to $5,000 per kilo (Allen &Fowler, 1985). So that, there is an aptly need of plant genetic engineering for the production of oil more than enough.

Transgenic plants in addition to enhancing crop productivity provide a means to understand the mechanism of gene expression such as tissue specific expression of light regulated genes etc. plant genetic engineering of plants will depend upon the successful transfer of a desired gene. Therefore, plant genetic engineering is surely beneficial alternative if appropriate technologies are employed for specific problems in medicinal and aromatic plants too.

Keywords: Plant Genetic Engineering, Exploitation, MAPs, Plant improvement Plant Genetic Engineering and MAPs

Introduction
Recently, biotechnology has become grouped into two categories *viz*., plant tissue culture and plant genetic engineering has been constituted the modification of plant genes or the introduction of foreign or exotic genes from different sources such as bacteria, fungi, virus and even animal for the better use of that plant for the welfare of human being. Progress in plant genetic engineering has been dependent on efficient methods of introduction of foreign DNA or fragment into plant cells. Gene transfer into plants cells can be achieved by two ways such as direct introduction of foreign DNA into plant cell by Shot-gun method, it is very expensive and other is by the soil bacterium *Agrobacterium* with the suitable vectors. Recently, these vectors for gene transformation have become available (Bhojwani, S.S., 1990) [3]. The transgenic plants obtained by this technique contain a gene (s) usually from other unrelated species, which are called ‘transgene’ and plant containing transgene are transgenic plants (Lycatt, G. W., and Grierson, D. leds (eds.).

This great potential of plant genetic engineering will be helpful for the improvement or enhancement of MAPs for our benefits The following examples shows how genetic engineering can be helped to some of the specific characters / problems of plants.

Plant Genetic Engineering for production of medicinal products

Manipulation of nuclear and plasmid genes which define early maturation, chill resistance, or the production of these materials how focused only in mature woody plants may be amenable to translocation to rapidly growing herbicious species, adapted to marginal growing conditions. Manipulation of cultured plant cell nuclear and plasmid genomes for the growth of improved entire plants may well, therefore, have an immediate as well as long term application. For instance, *Paoaver somniferm* is an annual plant which produces morphine, codeine, and thebaine- but only low levels of codeine, the morphinan alkaloid with the greatest legitimate market, *Paoaver somniferum* is a perennial plant, which produces thebaine as its major alkaloid. The pathway from thebaine to codeine is probably and three step process (Brochmann- Hanssesn, 1985) [6]. The possibility of genetically engineering *P. bracteatum* to produce codeine without the disadvantage of further transformation to morphine is not an unrealistic objective, given that the pathway has been resolved and the task, though hardly trivial is definable.

Plant Genetic Engineering for important industrial products

The plants contain important ingredients such as alkoloids, glycosides. phenols, saponnis, tannins etc. However, many of the plants still remain unevaluated for their medicial and aromatic properties. If the efforts are made in this direction, it is possible that scientists may discover plants which may cure hazardous diseases like AIDS, Cancer, and many heart disorders. The plant genetic engineering has to convert them into highly productive relatively cheap and easy to handle co-reactors is one of the pri- ce aim of many industries. It is believed that less than 10% medicinal plants have been identified and characterized and the potential exist to use genetic engineering that increases yields of their medicinal substances one identified. An anticancer antibody has recently been expressed in rice and wheat seeds.

Genetic manipulation of antibiotic production in *Streptomyces*

Streptomyces species produce the vast majority of antibiotics. Many of the secondary metabolites have important applications in medicine or agriculture. In addition to providing much needed information on the biochemistry and regulation of antibiotic synthesis, gene cloning in *Streptomyces* can be used to effect improve structures. The rational manipulation of antibiotic production will generally require the isolation of antibiotic biosynthetic genes. The approaches that have been used to isolate these genes are described; they often utilize the clustered nature of antibiotic biosynthetic and resistance genes. Using genetic complementation, all of the genes required for the production of actinorhodin, a polypeptide antibiotic made by *Streptomce*s *coeticolor A3* (Aguilar, A. and Hopwood, D.A. 1982) [1], were isolated. These genes were used to provide the first example of the production of novel antibiotics by genetic engineering and to affect a considerable increase in actinorhodin production.

Plant Genetic Engineering approaches for storage protein

Proteins are the integral part of the human diet Human nutrition requires a balanced source of protein and the major source of protein to human being are plants. The balance of protein of many plant products is u unsatisfactory. They are either harmful or in less quantity *viz*., lythyrus, soybeans etc. genetic engineering approaches may be carried out in three ways for plants and that will helpful in improvement of medicinal crop plant- 1) expression of desirable and heterologous storage protein 2) increasing a level of a desirable, but little expressed, endogenous protein and 3) suppressing the expression of antinutritional proteins (Joshi, P., Application of plant genetic engineering, 2001). Seed storage proteins, which constitute a major source of protein in the human diet and animal feed suffers from the disadvantages of having a very low levels of essential amino acid. Proteins of pulses are deficient in sulphur containing amino acid cysteine and methionine and cereal grains proteins are deficient in lysine and tryptophan (Brar, *et al*., 1995) [5]. The transgenic tobacco plants expressed the 2S protein in the seed tobacco plants expressed 2S protein in the seed resulting in a 30% increase in the levels of methionine. These experiments should the feasibility of improving the quality of seed storage proteins. Production of oils and carbohydrate with value addition have also useful in the lemon grass, *Rauwalfia serpentina, Jatropha curcas, chlorophytum borivilium, coleus.. vitex negunda* etc. This manipulation increased value of these important plants. Researchers have introduced gene from bacteria into the rice and exhibits an increased production of beta-carotene as a precursor of Vit. A and the seed is yellow in color, and that is 'Golden rice' (Xudongy *et at*, 2000) [23]. It is also reported that the variety 'Aalcha' is used for treatment of pimples while 'Baisoor' is used for chronic headache and epilepsy and 'Gathuan', 'Karhani' and 'Kalimooch' respectively for treatment of rheumatism, paralysis, and disease (Siddiq, 2004). To root out to fulfill this need the concept of genetic engineering in herbal plants should be proposed by the Biotechnology.

Plant Genetic Engineering approaches for storage oil

Plants are the major source of storage oil and it is major components of the human diet. Antisense approach of plant Genetic engineering has been used in rapeseed for high stereat production stearoyl-ACP desaturase is an enzyme which catalyzes into oleayl form in an inverted position to the napsin storage promoter gene and introduced into rapeseed. Therefore, the activity of desaturase enzyme is decreases in the plant seed. Due to tissue specific expression of antisense RNA, integrity of membrane lipid in leaf remained unaffected.

Plant Genetic Engineering approaches for herbicide resistance

The development of MAPs that are tolerant to herbicide is an important approach to control weeds. Specificity of the herbicides is the main limitation therefore; herbicide resistance can be conferred to on medicinal and aromatic plants by two ways, either by introduction of gene that allows the plant to detoxify the herbicide or addition of a gene that makes the target protein either in large amount or in resistant form. Transgenic plants carrying the genes for herbicide tolerance has been producer in tobacco, petunia tomato potato, populus etc transgenic tobacco plants resistant to glyphosate have also been developed by reproducing mutation in ESP synthase and making it insensitive to glyphosate. Plants such as Rape, Soybean, Cotton etc have been engineered and commercialized (Cook, R.J. 2000) [8].

Plant Genetic Engineering approaches for over-production

Random cloning of fragment of DNA from the producing organism into itself, or into a strain that makes the same antibiotic, may be used to clone antibiotic biosynthetic genes by assaying for increase in antibiotic production. These are two obvious ways in which this may occur, increased gene dosage may enhance metabolic flow through a pathway, either by affecting particular rate- limiting steps or by increasing the general levels of pathway enzymes, alternatively, the cloning of a regulatory gene may disturb the normal regulation of the pathway and an increase in production. This approach was used to isolate genes involved in the biosynthesis of undecylprodigiosin by cloning DNA from *S.* Co*elicolor* into the closely related strain *S. lividans* using a multi-copy plasmid vector; clones over producing the red-pigmented antibiotic could be readily identified (J. Niemi, *et al.*, personal communication).

Plant cell culture and flavor component production

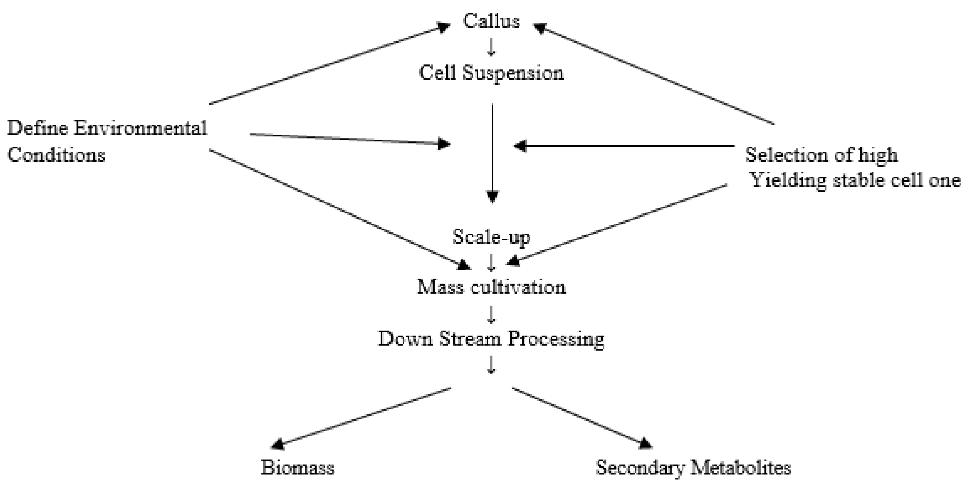
Plant tissue culture, can help to achieve the flavour components from cell culture. The oils we want don't come from the part of a plant. These oils can come from different parts of the plants and these plants and this presents problems (Table.1) for tissue culture to be successful requires the ability to grow all these types of cell. Perhaps many of the materials are produced in the plant at a central location and transported to a particular site where they are active in response to injury or infection or as an attractant for insects. According to Charwwood and Mustou, (1988) [7] indicated that some synthesis may occur locally *in situ*. Allan and Fowler (1985) [2] shows an ideal system and the target would be not the where oil, but a specific target molecule e.g. menthol, carvone or capsaicin. A recirculating system constantly producing the desired material present more problems in keeping the cells alive and extracting the product from the growth media whilst being attractive for production purposes. The harvesting and extraction of cells effectively already. The problems are producing in high yield, removing the product from the cell and coping with the biomass/ effluent, which are shown in Fig.1 and 2. According to Lewis anc Knstian (1985) [15], that even if we produced 10,000 tonne of peppermint oil by plant tissue culture techniques, the selling price would require the production of 750,000 tonnes per annum, for in excess of the current use for peppermint oil (Table.2) so that, there is an aptly need of plant genetic engineering for the production of oil more than enough.

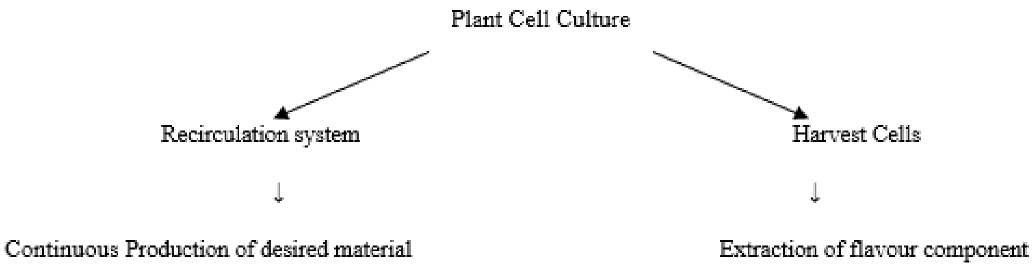
Table 1: Source of essential oils

Source	Examples
Leaves	Patchouli, Peppermint, Rosemary, Eucalyptus
Fruits	Lemon, Anise, Orange
Bark	Cinnamon, Sassafras, Birch
Root	Ginger
Grass	Citronella
Wood	Amyns, Cedarwood, Sandalwood
Berries	Pimenlo
Seed	Caraway, Corinder, fennel,Cardamon
Flowers	Rose Chamonile
Twigs	Clova Bud
Gum	Myrrh, Frankieense
Balsam	Tolu
Bulb	Garlic

Table 2: Major essential oils for the flavor industry

Oil	Volume (Tone)	Price (US $ / kg)
Clove leaf	2,000	3
Citronella	5,000	11
Eucalypyus	2,500	7
Lemon Grass	1,000	14
Lemon	3,000	9-20
Peppermint	6,000	11
Spearmint	1,500	10-20
Orange	10,000	1
Angelica	N/A	800





Conclusions

Plants employed in traditional medicine and aroma are frequently very restricted in their range, and commonly yield very limited amounts of active components, the possibility that plant genetic engineering development o: the plant sources for new pharmaceutical or herbal materials has a great potential Transgenic plants in addition to enhancing crop productivity, provide a means to understand the mechanism of gene expression such as tissue specific expression of light regulated gene, protein genes etc. plant genetic engineering of plants will depend upon the successful transfer of a deseed gene. Therefore, plant genetic engineering is surly beneficial alternative if appropriate technologies are employed for specific problems in medicinal and aromatic plants also.

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