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A REVIEW PAPER ON RECENT GROWTH IN THE BIOTECHNOLOGY DOMAIN

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Abstract

Plants belonging to the family of monocotyledonous Amaryllidaceae comprise approximately 1100 species split into 75 genera. Amaryllidaceae alkaloids have different biological functions, with their anti-acetylcholinesterase function, used to treat Alzheimer's disease, being the most important one. In vitro culture technology, due to the increased demand for amaryllidaceae alkaloids (mainly galanthamine) and the limited availability of plant sources, has attracted researchers' attention as a prospective alternative for their sustainable production. Plant in vitro systems have been used extensively for the continuous, sustainable and economically viable processing of secondary metabolites of bioactive plants. Important success in the production of in vitro systems synthesizing Amaryllidaceae alkaloids has been shown over the past two decades. The present review explores the state of the art of the production of in vitro amaryllidaceae alkaloids, summarizing the recently reported in vitro plant systems generating them, as well as the point of view of the authors on the advancement of biotechnological production processes, with an emphasis on the potential prospects for the commercial production of these useful alkaloids in in vitro cultivation technologies.

Keywords: *Amaryllidaceae, Alkaloids, Plants, Production, Vitro.*

I. INTRODUCTION

In vitro culture technology, due to the increased demand for amaryllidaceae alkaloids (mainly galanthamine) and the limited availability of plant sources, has attracted researchers' attention as a prospective alternative for their sustainable production. Plant in vitro systems have been used extensively for the continuous, sustainable and economically viable processing of secondary metabolites of bioactive plants. In the development of in vitro systems for the production of Amaryllidaceae alkaloids, substantial progress has been demonstrated. Optimization of the production process is also well known, beginning with optimization of the nutrient media, creation of the appropriate design of the bioreactor and optimization of the conditions of cultivation[1].

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This review discusses the state of the art of the production of in vitro amaryllidaceae alkaloids, summarizing the recently reported in vitro plant systems producing them, as well as the point of view of the authors on the advancement of biotechnological production processes, with an emphasis on the potential prospects for the commercial production of these useful alkaloids in in vitro cultivation technologies[2]. A dynamic and multi-stage method is the development of biotechnologies for the production of biologically active substances based on plant cells and tissues grown under in vitro conditions[3]. The bioengineering, physiological and phytochemical peculiarities of the particular in vitro culture as well as the subsequent analysis of the relationships in the in vitro system-product biological system should be based on algorithms for optimizing and regulating the biosynthesis process of the target metabolite in the in vitro systems under research[4]. The creation of an efficient cultivation system with properly constructed bioreactors, as well as unconventional techniques for optimizing the biological system, is a preliminary requirement for industrially significant yields of target biologically active substances from plant in vitro systems.

Table 1: Depicts the recent reports on plant in vitro systems[5].

Species	Type of In Vitro Systems	Amaryllidaceae Alkaloids	Accumulated Concentrations
Narcissus pseuddonarcissus cv. Carlton	callus	Galanthamine	0–7 µg/g FW
	shoots	Galanthamine	40–130 µg/g FW
	bulbs	Galanthamine	10–215 µg/g FW
Narcissus tazetta var. Meskin	callus	Galanthamine	0.5–1.9 µg/g DW
		Lycorine	1.2–21.5 µg/g DW
	bulblet	Galanthamine	15–80 µg/g DW
		Lycorine	731–1900 µg/g DW
	roots	Galanthamine	5.2 µg/g DW
		Lycorine	131 µg/g DW
Narcissus confusus	shoots	Galanthamine	13.07 mg/g DW
		Tazettine	0.75 mg/g DW
		Haemanthamine	3.16 mg/g DW
Hymenocallis littoralis	callus	Lycorine	0.1–2.6 µg/g extract
Rhodophiala bifida	roots	Montanine	1.19 mg/g
	bulbs	Montanine	2.21 mg/g
	leaves	Montanine	2.10 mg/g
Pancratium maritimum	shoots	Lycorine	2.90 mg/g DW
	shoots	Haemanthamine	900 µg/g DW
		Lycorine	800 µg/g DW

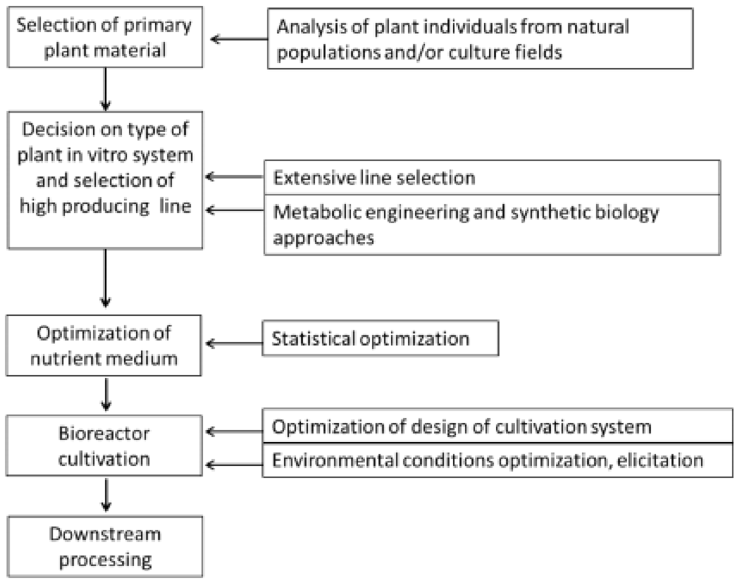

Figure 1: Integrated approach to biotechnological production[6].

II. DISCUSSION

The optimization of the production process of Amaryllidaceae alkaloids is well known, particularly in the case of galanthamine, as described in the introduction. It is clear that the key stages of such optimization are: optimization of the nutrient medium for the full yield of the target alkaloids; selection and enhancement of the required cultivation system; optimization of the environmental conditions for the monitoring, management and modeling of the cultivation and processes[7]. Recent published research has shown that statistical optimization of the key nutrient components is the most effective method for optimizing the composition of nutrient media for maximum biosynthesis of secondary plant metabolites through in vitro systems[8]. In this way, it is possible to define the most suitable type of carbon source, growth regulators, as well as biosynthetic precursors, and can subsequently use these independent variables in the multifactorial optimization experimental matrix[9]. Table 1 depicts the recent reports on plant in vitro systems. Figure 1 integrated approach to biotechnological production. Figure 2 five stages of the pathway are depicted.

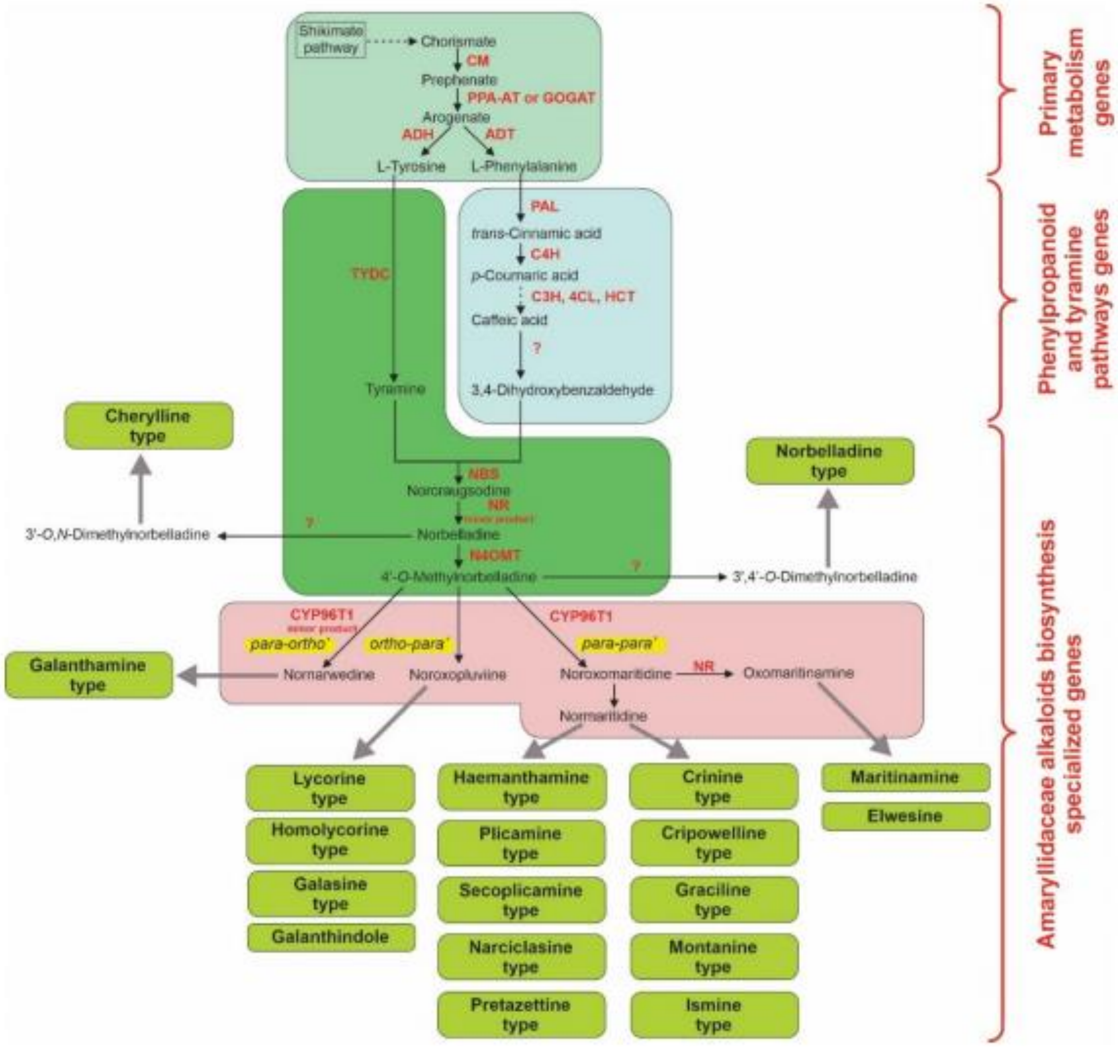

Figure 2: Five stages of the pathway are depicted[7].

III. CONCLUSION

Many of the known alkaloids of Amaryllidaceae exhibit remarkable biological activities and some of them are already used in medicine, such as galanthamine. However, in combination with the large diversity in the chemical structures of these alkaloids, the small quantities found in plants make their processing, isolation and purification very costly. An alternative approach to Amaryllidaceae alkaloid bio-production is plant in vitro systems. Alkaloid yields are still too poor today and are not attractive for industrial production, considering the considerable progress made in developing an integrated approach to biotechnology production. Using metabolic engineering to create powerful plant or microbial systems capable of generating a desirable molecule, it seems this drawback could be solved. Possible solutions may be: (1) the combination of chemical precursor synthesis of norcraugsodine and its conversion into nornarwedine by an engineered microbial system; or (2) the development of hybrid biosynthetic pathways for the synthesis of amaryllidaceae alkaloids by yeast or in vitro plant systems; or (3) the development of hybrid bioprocessing systems.

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