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Review of Research on Polysaccharides and Dendrobine of *Dendrobium nobile* Lindl

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Review Article

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ABSTRACT

Dendrobium nobile Lindl. is a precious traditional medicinal plant, with the active ingredients polysaccharides and dendrobine. More and more attention has been paid on the *D. nobile* because of its effective biological function, and related research has gradually increased in rent years. In the current paper, the research progresses concerning some aspects of polysaccharides and dendrobine of *D. nobile* especially the metabolism were reviewed in order to promote the development and utilization of polysaccharides and dendrobine, and then protect the resources of *D. nobile* in a better way.

INTRODUCTION

Introduction: *Dendrobium nobile* Lindl. is a perennial herb of Orchidaceae. It is used as a traditional medicinal plant and recorded in the "Shen Nong's Herbal Classic" initially. It was named as "Jinchai" in Chinese due to its similar shape with the ornaments that the ancient women wore (An *et al*., 2014). With the effect of maintaining gastric tonicity, enhancing production of body fluid, relieving symptom of dryness and curing the symptom of body heat (Ng *et al*., 2012), *D. nobile* has been certified as the source of medicinal plant "Shihu" in different editions of "Pharmacopoeia of the People's Republic of China".

A variety of bioactive constituents exist in *D. nobile*, including polysaccharides, alkaloids, phenanthrenes, bibenzyls etc. (Zhang *et al.*, 2007; Lu *et al.*, 2014). Dendrobine, a kind of alkaloid, has been considered as the main active ingredient, and an important indicator for the quality of *D. nobile*. In addition, polysaccharides, one of the active ingredients, play a vital role in immunomodulatory, antioxidant and neuroprotection properties etc. (Table 1). The purpose of this article is to review the progress of research on polysaccharide and dendrobine from *D. nobile*.

Table 1. The effective components and bioactivities of *D. nobile*

Ingredient	Bioactivity	Author and year
polysaccharides	Immunomodulatory	Ye *et al*., 2002
	Antioxidant	Deng *et al*., 2016
	Neuroprotection	Zhan *et al*., 2017
alkaloids	Antitumor	An *et al*., 2015
	Anti-cataract	Wei *et al*., 2008
	Anti- Alzheimer's disease	Jiang *et al*., 2016
phenanthrenes	Anti-inflammatory	Yang *et al*., 2006
bibenzyls	Cytotoxic, Antifungal Activities	Zhou *et al*., 2016

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Progress of research on polysaccharides from D. nobile

Polysaccharides are a class of saccharides with complex and large structure, which formed by a number of monosaccharide molecules through losing water, and then condensing the substance. They are divided into two categories--homopolysaccharide and heterosaccharide, and the latter is the active part. Polysaccharides of *D. nobile* are mainly composed of rhamnose, arabinose, xylose, mannose, glucose and galactose through the analysis of the obtained polysaccharides (Luo *et al.*, 2011). Different proportions and combinations of those monosaccharide formed abundant polysaccharides, resulting in the various pharmacological activities in *D. nobile*. Xu *et al*. (2014) revealed that mannose has a significant advantage in the composition of *D. nobile* polysaccharides besides glucose during every growth period, indicating that glucomannan has a large proportion of *D. nobile* polysaccharide. In this case, such glucomannan should be further studied.

Metabolism of polysaccharides from D. nobile

Plant polysaccharides are extremely important for the metabolism of plants. It is the product of photosynthesis as well as the substrate of respiration. Numerous life processes are involved in the accumulation of polysaccharides, such as photosynthesis, the supply of monosaccharide and the rate of respiration.

Thus far, few studies on the metabolic pathways of *dendrobium* polysaccharides have been reported, and only a small number of genes related to polysaccharides metabolism were successfully identified from *Dendrobium officinale*, such as phosphomannomutase, GDP-Mannose pyrophosphorylase and 4-beta-Mannosyl-transferase (He *et al*, 2013). Yang and Wei *et al.* (2012; 2007) confirmed that the polysaccharides content of *Dendrobium officinale* and *Dendrobium huoshanense* was positively correlated to the sucrose synthase. However, the research on *D. nobile* in this area has not been reported. For this reason, the research gap of *D. nobile* polysaccharides metabolic pathway need to be filled.

Research progress on dendrobine of D. nobile

Dendrobine is a compound isolated from *D. nobile* by Suzuki in early 1932, whereas its sesquiterpene skeleton structure was not determined until 1964 (Onaka *et al.*, 1964). It is a picrotoxane-type sesquiterpene with 15 carbons, containing a five-membered lactone ring, a five-membered heterocyclic ring formed by nitrogen and the C-2 and C-11 of the heterocyclic stem nucleus, in general, the nitrogen is usually attached to a functional group like methyl. More alkaloids whose structures like dendrobine have been isolated from the *dendrobium* plants by domestic and foreign scholars. According to the general statistics, 34 alkaloids have been obtained from 14 species of *dendrobium* plants, of which 21 are dendrobine alkaloids.

The research on pharmacology of dendrobine has been frequently reported in recent years. Song *et al.* (2016) proved that dendrobine restrained the growth of A549 cells, which was related to lung cancer. Li et al. (2017) found that dendrobine had potential to be a promising agent treating the virus infection such as H1N1. In contrast, there is almost no new progress in the biosynthetic pathway of dendrobine.

Biosynthetic pathway of dendrobine

Despite the shortage of research about biosynthetic pathway of sesquiterpene, the biosynthesis of dendrobine can be outlined according to the reported biosynthetic pathway of vinblastine and wilfordine. And then the conclusion can be drawn that the biosynthetic pathway of terpene alkaloid is divided into upstream and downstream. The former is the mutual precursor for the synthesis of terpenoid alkaloids, and the latter are multiple types of alkaloids, generated by the precursor through a variety of different reactions (Zhang *et al.*, 2012). The terpene-type pathway has become a conservative path of the upstream phase, because it provides basic skeleton for terpenoid alkaloids.

The type of terpene pathway is composed by the mevalonate pathway (MVA pathway) and the 2C-methyl-D-erythritol-4-phosphate pathway (MEP pathway) (Ma *et al.*, 2006). MVA pathway synthesizes sesquiterpenes, triterpenes and sterols of plant. Monoterpenes, diterpenes and tetraterpenes are mainly synthesized by the MEP pathway. The two pathways exist in the cytoplasm and plastids of plant are separated from each other but not absolutely independent. Isopentenyl diphosphate (IPP), the metabolite of both pathways, is the precursor of synthetic terpenes that can be exchanged on the plasma membrane (Zhang *et al.*, 2007). Yamazaki *et al.* (1966) found that mevalonate-2-^{14}C was in involved in the biosynthesis of dendrobine through the radioactive element tracer technology. In this case, it is suggested that MVA pathway participate in the biosynthesis of dendrobine. Some research about the intermediate material and the structural changes in the synthesis process of the dendrobine MVA pathway has been carried on (Corbella *et al.*, 1973), but there is still no report on the function of each gene in the pathway, and it is worth to study whether the MEP pathway is involved in the biosynthesis of dendrobine through the exchange of IPP. In hence, it is necessary and prospective for us to study the biosynthetic pathway of dendrobine in a further way.

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