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Effects of Different Cultivation Substrates on the Growth and Quality Formation of *Dendrobium officinale*

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Abstract *Dendrobium officinale* Kimura et Migo is an important medicinal and edible traditional Chinese medicinal resource. During artificial cultivation, substrate conditions directly affect plant growth, bioactive compound accumulation, and medicinal quality formation. This review systematically summarizes the types, characteristics, and application effects of different cultivation substrates, including sphagnum moss, bark, coconut coir, peanut shells, rice husks, perlite, ceramsite, and composite substrates. It focuses on their effects on seedling survival, plant vigor, root development, biomass accumulation, and dry matter distribution in *D. officinale*, and further discusses the regulatory effects of substrates on the formation of quality-related constituents, such as polysaccharides, dendrobine, flavonoids, and phenolic compounds. Studies have shown that suitable cultivation substrates can promote root growth and nutrient uptake by improving rhizosphere moisture, aeration, nutrient supply, and microbial environment, thereby increasing plant biomass and the accumulation of medicinally active compounds. Composite substrates have great application potential in high-quality and efficient cultivation of *D. officinale* because they integrate water retention, aeration, physical support, and nutrient buffering functions. However, current research still faces problems such as inconsistent substrate evaluation standards, insufficient elucidation of quality formation mechanisms, and weak integration between substrate formulations and industrial applications. Future studies should strengthen the development of environmentally friendly composite substrates, further investigate substrate-microbe-quality formation mechanisms, and integrate smart agricultural technologies to establish standardized, large-scale, and sustainable cultivation systems for *D. officinale*.

Keywords *Dendrobium officinale*; Cultivation substrate; Growth and development; Quality formation; Bioactive compounds; Composite substrate

1 Introduction

Dendrobium officinale Kimura et Migo is a perennial epiphytic herb of the genus *Dendrobium* in the family Orchidaceae. It is also a valuable traditional Chinese medicinal plant and a medicinal-edible resource in China. Its stems have been officially recorded in the *Chinese Pharmacopoeia* and can be developed and utilized as both Chinese medicinal materials and functional food resources. Traditional medicine holds that *D. officinale* has the effects of nourishing Yin, clearing heat, benefiting the stomach, promoting fluid production, and strengthening the viscera. Modern studies have further shown that it is rich in various bioactive components, including polysaccharides, alkaloids, flavonoids, bibenzyls, phenanthrenes, and phenolic compounds, and exhibits multiple biological functions such as antioxidant, anti-inflammatory, immunomodulatory, gastrointestinal-protective, hypoglycemic, antitumor, cardiovascular-protective, and neuroprotective effects (Xu et al., 2022; Wang et al., 2025). In recent years, with the rapid development of the health industry, traditional Chinese medicine industry, and functional food market, the demand for *D. officinale* has continued to increase. It has gradually transformed from a rare wild resource into a large-scale artificially cultivated crop and has become an important medicinal plant industry with high economic value (Hou et al., 2025).

However, due to long-term overharvesting, habitat destruction, and slow natural regeneration, wild resources have declined significantly, and artificial cultivation, facility cultivation, and wild-simulated cultivation have gradually become the main sources of raw materials for *D. officinale* production (Chen et al., 2021; Liu et al., 2025). Alongside rapid industrial development, differences in cultivation regions, cultivation modes, harvest years, and