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The Genetic Basis of Maple Leaf Color and Its Application in Landscape Design

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Abstract This study mainly analyzes the genetic causes of the color formation of maple leaves and its practical application in landscape design. Maple trees are an important ornamental tree species in temperate regions, and the leaf color changes significantly with the seasons. This change is mainly related to three types of pigments, namely chlorophyll, carotenoids, and anthocyanins. The content and proportion of these pigments directly affect the leaf color. Research has found that genes related to anthocyanin synthesis, such as *CHS*, *UFGT*, and *DFR*, as well as related transcription factors, such as MYB and bHLH, play an important role in the formation of leaf color. Different maple tree varieties have differences in the expression of these genes, thus showing various leaf colors such as red, yellow, and green. In addition to genetic factors, environmental conditions such as light and temperature also affect the accumulation of pigments and gene expression, thereby causing changes in leaf color. In landscape construction, maple trees are often used in parks, roads, and scenic areas. By reasonably combining different leaf-color maple tree varieties and combining with evergreen trees, water features, and other landscape elements, a landscape effect with clear layers and prominent seasonal characteristics can be formed. The relevant case in Kyoto, Japan, shows that when large areas of maple forests are combined with the natural environment, they can demonstrate high ecological value, cultural value, and economic value. In the future, using genetic information for targeted breeding is expected to provide more new maple tree varieties with both ornamental value and adaptability for urban greening.

Keywords Maple; Leaf color; Genetic basis; Anthocyanins; Landscape design

1 Introduction

Maple trees are very common ornamental tree species in temperate regions. People like maple trees mainly because of their attractive tree shape, wide range of heights, and rich leaf colors (Zhu et al., 2022). There are approximately 100 to 200 native species of maple trees, and many more are artificially selected varieties. They are commonly found along roadsides, in parks, residential areas, and botanical gardens, and are frequently used as tree species in landscaping. Maple trees grow quickly and have good shading effects. In autumn, the leaf colors become very vivid, so they play an important role in urban greening and seedling cultivation. Maple trees not only have strong ornamental value but also can improve the surrounding environment and provide habitats for animals. Therefore, they have both landscape value and ecological value (Luo et al., 2023a; Sun et al., 2024). In recent years, with the continuous emergence of new varieties such as dwarf Japanese maple and large shading maple, the application of maple trees in urban greening construction and garden cultivation has become increasingly widespread (Chen et al., 2019; Lin et al., 2022).

One of the most obvious characteristics of maple trees is that their leaf color changes significantly with the seasons. Different varieties of leaves can present various colors such as green, yellow, orange, and red. Sometimes, different colored patches can also appear on the leaves of the same tree (Chen et al., 2019; Gong et al., 2025). Many maple trees change from green to red or yellow in autumn, and this change directly affects their ornamental and economic value (Zhang et al., 2023). Studies have found that this leaf color change is mainly related to the decrease in chlorophyll content and the increase in anthocyanin content. This process also occurs in tree species such as ginkgo and red maple (Luo et al., 2023a; Fan et al., 2024; Sun et al., 2024). The same maple tree can have green, yellow, or red leaves in different seasons or branches, indicating that pigment metabolism is not only influenced by environmental conditions but also regulated by its own regulatory mechanisms (Yang et al., 2022;