The complex origins of Apiaceae and the current state of research
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Recently, scientists from Nanjing Agricultural University summarized the current state of Apiaceae research, including traditional and molecular breeding practices, bioactive compounds, medicinal applications, nanotechnology, and omics research. Current trends in Apiaceae application and research were also described, including the mining of new functional genes and metabolites using omics research, the identification of new genetic variants associated with important agronomic traits by population genetics analysis and genome-wide association studies, and the use of genetic transformation, CRISPR-Cas9 gene editing, and nanotechnology.

According to previous studies, the main nutraceuticals in Apiaceae plants include polyphenolic compounds, polyacetylenes, and terpenoids. Phenolic compounds contribute to the nutritional qualities of vegetables and medicinal plants, and the antioxidant activity of many Apiaceae plants has also been attributed primarily to phenolic compounds.

Several polyacetylenes isolated from Apiaceae plants have high toxicity to bacteria, fungi, and mammalian cells, as well as neurotoxicity, inhibitory effects on platelet aggregation, and potential to cause allergic skin reactions. Some terpenoids are specifically distributed in Apiaceae plants. The antioxidant effects of terpenoids have led to their use in treating some diseases. Vegetables in the Apiaceae family can also produce many secondary metabolites such as carotenoids, anthocyanins, terpenes, and dietary fiber. Carotenoids are natural pigments that are widely distributed in photosynthetic organisms and may provide health benefits.

Anthocyanins protect plants from UV radiation, contribute to plant adaptation to abiotic and biotic stresses, and delay plant senescence. Terpenes are an important group of secondary metabolites.
and are widely distributed in many plants. The plant cell wall, which contains lignin and cellulose, is the source of most dietary fiber in plants. Hormones play important roles in lignin biosynthesis in celery and carrot, and transcription factors are important regulators of lignin biosynthesis in these species. Hypoxia caused by elevated CO$_2$ concentration can also affect their lignin content.

Many diseases can cause fatal damage to Apiaceae vegetable crops; these include powdery mildew (Blumeria graminis f. sp. hordei), Alternaria radicina, early blight, late blight, and fusarium yellows disease. The selection of disease-resistant germplasm resources has been the most effective method of reducing disease occurrence in vegetables and other food crops. Some arthropod pests can also cause major economic losses in vegetable crops; examples include carrot fly (Chamaepsila rosae), carrot weevil (Listronotus oregonensis), celery fly (Euleia heraclei), aphids, cutworms, and beet armyworm.

Modern molecular markers have been widely used in breeding members of the Apiaceae family. Many molecular markers have been used alone or in combination to explore genetic diversity. Agricultural biotechnologies use different techniques to produce genetically modified plants. Transgenic technology can be used to improve plant traits and solve agricultural problems.

The CRISPR/Cas9 system has been used in plants for targeted mutagenesis, including gene knockout, multiplex gene editing, and insertion and deletion of large fragments. Based on previous studies, nanotechnology plays a vital role in agricultural production, especially for gene modification and pest control. It is necessary to reduce nutrient waste and increase crop yield through the use of nanomaterials.

Although members of Apiaceae have a wide geographic distribution and rich nutritional and medicinal value, little research has been performed on their genomes. Many studies have revealed that plant genomes contain abundant repetitive sequences. Genomic sequences and annotation have provided important information for studies on the functions of genes involved in regulating yield and quality traits of horticultural crops.

Further study of important gene functions and breeding, as well as comparative genomic analysis of Apiaceae, will provide new methods for genetic and breeding research on Apiaceae vegetable crops and medicinal plants. The use of transcriptomics also allows researchers to explore phenotypic characteristics of Apiaceae vegetables and medicinal plants and physiological functions of Apiaceae genes. Transcriptome technology has been used in research on stress responses, root development, and lignin biosynthesis in carrot.

Proteomics is now considered one of the most important 'post-genomic' approaches for better understanding gene function. Proteomics is widely used to study Apiaceae plants, and comparative proteomic analysis has provided new insights into gene mining in carrot. Metabolomics encompasses all chemical reactions occurring in cells, and plant metabolites have been used as chemical markers to distinguish differences among vegetables and medicinal plants in the Apiaceae family. Metabolomics analysis revealed that wild and cultivated carrots showed differences in metabolites that were consistent with their genotypes.

"Vegetables and medicinal plants are essential foods for human health and can provide various necessary nutrients and nutraceuticals. With the strengthening of people's health consciousness, the diversification, quality, nutritional value, and medicinal value of vegetables and medicinal plants are increasing. Vegetable and medicinal plant research has become increasingly important," Prof. Xiong said. This research provides a reference for basic and applied research on Apiaceae vegetable and medicinal plants.

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