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Medicinal & Aromatic Plants

Brief Note

# Aromatic Amino Acids Plants and its Biosynthesis

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## BRIEF NOTE

An Aromatic Amino Acid (AAA) is an amino acid that includes an aromatic ring. Among the 20 standard amino acids, the following are aromatic: phenylalanine (Phe), tryptophane (Trp),and tyrosine (Tyr), are formed from E4P in the PP pathway and PEP in the glycolysis. Tyrosine can be classified as a polar amino acid. The first reaction of this synthesis is catalyzed by deoxyalabino hepturose phosphate synthase (DAHPS), where this is an important regulatory enzyme. L-tryptophan, L-phenylalanine, and L-tyrosine are aromatic amino acids (AAAs) that are used for the synthesis of proteins and that in plants also serve as precursors of numerous natural products, such as pigments, alkaloids, hormones, and cell wall components. The aromatic amino acids phenylalanine, tyrosine and tryptophan in plants are not only essential components of protein synthesis, but also serve as precursors for a wide range of secondary metabolites that are important for plant growth as well as for human nutrition and health.

### Biosynthesis pathways

- Aromatic amino acids as precursors
- Shikimate pathway
- Nutritional requirements

Aromatic amino acids absorb ultraviolet light at a wavelength above 250 nm and produce fluorescence. This characteristic is used in quantitative analysis, notably in determining the concentrations of these amino acids in solution. The aromatic amino acids are synthesized via the shikimate pathway followed by the branched aromatic amino acid metabolic pathway, with chorismate serving as a major branch point intermediate metabolite. The major biosynthesis route of phenylalanine in plants occurs via arogenate. Recent studies suggest that an alternative route of phynylalanine biosynthesis via phenylpyruvate may also exist in plants, similarly to many microorganisms.

Aromatic amino acid biosynthesis is regulated largely by two mechanisms. First, at the level of transcription and, to a lesser extent, translation of the enzymes involved in aromatic amino acid biosynthesis. Second, amino acid biosynthesis is controlled by modulating the enzyme activities that dictate whether Phe, Tyr, or Trp or some combination thereof is made.

Aromatic amino acids, like other proteinogenic amino acids, are the building blocks of proteins and include tryptophan, phenylalanine, and tyrosine. All plants and micro-organisms synthesize their own aromatic amino acids to make proteins. The aromatic amino acids are synthesized via the shikimate pathway followed by the branched aromatic amino acid metabolic pathway. The shikimate pathway, also known as the chorismate biosynthesis pathway, converts two metabolites, phosphoenolpyruvate (PEP) of the glycolysis pathway and erythrose 4-phosphate (E4-P) of the non-oxidative branch of the pentose phosphate pathway, into chorismate. The first enzyme of the shikimate pathway is 3-deoxyd-arabino-heptulosonate-7-phosphate synthase (DAHPS) converting PEP and E4-P into 3-dehydroquaianate. The second enzyme of the shikimate pathway is 3-dehydroquinate synthase, which converts 3-deoxy-d-arabino-heptulosonate-7-phosphate into 3-dehydroquinate. The third and fourth enzymatic steps are catalyzed by the bi-functional enzyme 3-dehydroquinate dehydratase/shikimate 5-dehydrogenase. The fifth enzymatic step of the shikimate pathway is catalyzed by shikimate kinase (SK) which converts shikimate to shikimate 3-phosphate. The sixth enzymatic step of the shikimate pathway is catalyzed by 5-enolpyruvylshikimate 3-phosphate synthase which leads to the synthesis of enolpyruvylshikimate 3-phosphate (EPSP) The Arabidopsis EPSPS is encoded by one functional gene and perhaps also by a second putative gene. The final step in the shikimate pathway is catalyzed by chorismate synthase (CS), which converts EPSP to chorismate. This enzyme was first characterized in *Corydalis semoervirens* and is proposed to have been derived from a common ancestor for bacteria, plants and fungi.

### Key points

- The shikimate pathway is the only known pathway for biosynthesis of chorismate and the aromatic amino acids Phe, Tyr and Trp.
- The shikimate pathway is a bridge between central metabolism and specialised metabolism.
- The shikimate pathway occurs in various groups of microorganisms, plants and parasites, whereas it does not occur in animals.
- Shikimic acid is an essential metabolite that may balance the metabolic status of the pathway.

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- Chorismate is a branch point metabolite for aromatic amino acids and phenolic compounds.

The shikimate pathway and aromatic amino acids, and the specialised metabolites derived from them, simultaneously respond to periodic changes.