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# Metabolomics Study in Vegetable Crops

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Vegetables are an important part of the human diet and a major source of biologically active substances such as vitamins, dietary fiber, antioxidants, and cholesterol-lowering compounds. Nutrients have traditionally been viewed as food components that either cannot be synthesized in the body or whose synthesis requires a specific factor that may in certain circumstances be absent or inadequate. Plants synthesize hundreds of chemical compounds such as dietary fiber, flavonoids, sterols, phenolic and glucosinolates are associated with lower discase risk and defence against insects, fungi, diseases, and herbivorous mammals. These phytochemicals have been linked to many positive effects on human health, including coronary heart diseases, diabetes, high blood pressure, degenerative diseases and obesity. The links of vegetable consumption and protection against cancers of stomach, esophagus, lung. Pharynx, endometrium, pancreas, and colon have also been extensively reported.

## Metabolomics

Metabolomics aims at study of metabolites and determining a sample's profile of compounds at a specified time under specific environmental conditions. Plant Metabolomics is the study of metabolic processes through the use of analytical methods in plant. Plant metabolomics helps to understand that how plants grow and carry out physiological functions, as well as improve the quality of food or medicines. Due to advancement in biochemical and analytical techniques several plant secondary metabolites have been well characterized that led to several new discoveries in plant sciences.

## Types of Metabolites

1. Primary metabolites: Primary metabolites are microbial products produced continuously during the exponential phase of growth. Primary metabolites are involved in physiological process, thus it is referred to as central metabolites. It is essential for cell viability, proliferation, growth & development of organism. Eg. Amino acids, phytosterols, acyl lipids, nucleotides, etc.
2. Secondary metabolites: Secondary metabolites are organic compounds produced by plants. Also termed as specialized Metabolites or natural plant products. Plants will survive without most of them but will be damaged. It playsAn important role in the interaction between plants and the environment (biotic and abiotic stresses). Utility as Dyes, polymers, fibers, glues, oils, waxes, flavouring agents, perfumes and drugs etc.

## Metabolomics Techniques

1. Separation Techniques 1. Gas Chromatography (GC), 2. High Performance Liquid Chromatography (HPLC), and 3. Ultra Performance Liquid Chromatography (UPLC)
2. Detection Techniques: 1. Nuclear Magnetic Resonance Spectroscopy (NMR), and 2. Mass Spectrometry
3. Combination of Techniques: 1. Gas Chromatography Mass Spectrometry (GC-MS), 2. Liquid Chromatography Mass Spectrometry (LC-MS), and 3. Tandem Mass Spectrometry (MS-MS)

## Case Study

Tamura *et al*. (2018) studied quality of vegetables grown in plant factories under hydroponic and soil cultivation using GCMS and LCMS. The metabolite profiling by comprehensive gas chromatography-mass spectrometry (GC-MS) and liquid chromatography- mass spectrometry (LC-MS) resulted in the annotation of 101 metabolites from 223 peaks detected by GC-MS; LC-MS yielded 95 peaks. The principal component analysis (PCA) scatter plot showed that the most distinct separation patterns on the first principal component (PCI) coincided with differences in the cultivation methods. There were no clear separations related to cultivar differences in the plot. The level of amino acids such as lysine, phenylalanine, tryptophan, and valine was significantly increased in hydroponically grown leaf lettuce, while soil cultivation derived leaf lettuce samples contained significantly higher levels of fatty-acid derived alcohols and lettuce-specific sesqui-terpene lactones. The findings recorded that the metabolite composition of leaf lettuce is primarily affected by its cultivation condition.

Kim *et al*. (2019) worked on metabolite profiles of mixed vegetables, therefore and after fermentation by Lactobacillus plantarum, using gas chromatography/time-of flight-mass spectrometry (GC/TOF-MS). To analyze health benefits of fermented vegetables. Anti oxidative and anti inflammatory activities were measured using RAW 264.7 cells. Among 78 metabo- lites identified by GC/TOF-MS in this study, those significantly increased after fermentation include anti-oxidative and/or anti-inflammatory agents such as lactate, 3-phennyllactate, indole-3- lactate, B-hydroxybutyrate, y-aminobutyrate, and glycerol. These metabolites may have been either newly synthesized or depolymerized from high molecular weight polymers from vegetables during fermentation.

Jo *et al*., (2022) carried out an experiment to study metabolomics of three different cucumber cultivars (Chuichung, White Dadagi, and Mini) and their parts (peel and flesh) coupled with antioxidant activities. The amino acids, sugars, flavonoids, carotenoids, and chlorophylls were upregulated in Mini flesh; however, in the case of peel, they were highly expressed in Chuichung. The highest antioxidant activity was observed in the peel of Chuichung and flesh of Mini. Through correlation analysis between metabolites and antioxidant activity, apigenin and quercetin derivatives, chlorophyll a, chlorophyll b, lutein, re-carotene, and B-carotene were found to be significantly positively correlated with antioxidant activity.

## Conclusion

Metabolites are indispensable component of plant metabolism owing to their influence on plant biomass and architecture. Metabolomics has the ability to detect a vast array of metabolites from a single extract, thus allowing speedy and precise analysis of metabolites. Metabolomics study of plant secondary metabolites is a powerful tool to for system biology and to predict food quality. With the availability of highly sensitive and selective analytical techniques, metabolic changes in plant systems can be followed in a comprehensive way. The analysis of nutritional value of foods and identification of pharmaceuticals in plants is increasing by using metabolomics technology

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