Opinion Article

Elemental metabolomics in food science and technology

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ABOUT THE STUDY

Food safety and quality are promoted by elemental metabolomics, which thoroughly characterizes the elements in meals. Making advantage of this knowledge encourages authenticity and produces practical indicators like rare earth elements. While additional research is required to determine the connection to genetic origin, elemental profiles have been proven to be accurate markers for determining geographical origin. Numerous elements are evaluated in new investigations, but ultra-trace elements, primarily rare earth elements, and isotope ratios of heavy elements are given particular attention. In the future, high-resolution inductively coupled plasma mass spectrometry will be crucial. Although there is an obvious connection between soil and plant goods, there are more nuanced relationships between soil, plants, and animal products. Processes involved in processing food add complexity and should be researched. Future research should take into account the age of the organisms, contact materials, pollution, and seasonality. A sufficient number of samples are another crucial ingredient for a logical explanation of the relationship between elemental composition and geographic origin.

The detailed elemental characterization of foods using not only macro and trace elements but also ultra-trace elements like Rare Earth Elements (REEs) and valuable metals is known as elemental fingerprinting. Elemental fingerprinting is used to identify the geographical origin of food and may be connected to its genetic source and manufacturing process. Elemental metabolomics involves the measurement, analysis, and tracking of changes in the total element content in biological samples. Elemental metabolomics is a significant new technology that has applications in a wide range of fields, including food science and nutrition, medical diagnostics, agriculture, environmental research, and many more. For absorption and molecular interactions with proteins and nucleotide sequences, components in living things interact and compete with one another. In the subject of food science, metabolomics has been widely employed as a method for the quantitative evaluation of metabolites. As more and more derivatization techniques are developed, metabolomics-based Gas Chromatography/ Mass Spectrometry (GC/MS) is becoming a popular tool for evaluating both volatile and non-volatile substances. According to the literature, this approach has a strong capacity for assessing chemical and organoleptic changes that take place throughout food manufacturing. On process-composition-function links, current and prospective uses of metabolomics analysis will be discussed. the use of the metabolomics technique to assess changes in foods that have undergone minor processing, heat or cold treatments, drying, fermentation, chemical and enzymatic treatments, and processes employing cutting-edge technology, in addition to the most popular analytical platforms. Overall, metabolomics may be considered as a crucial tool to aid research in academia and industry that aims to understand how raw animal or plant ingredients are turned into finished foods. The most current developments in Mass Spectrometry (MS)-based methods and their use in food metabolomics. The focus is mostly on descriptions of innovative MS-based methodologies, including direct MS analysis employing ambient ionization techniques or MS imaging, because MS is a potent analytical technology with exceptional capabilities. A crucial area of systems biology is metabolomics, which can spot changes in the body's metabolism both before and after functional meals are consumed, identify useful metabolites, and forecast the intervention's effects and mechanism. The impact of these factors on the metabolites of functional foods may be determined using metabolomics techniques since they are potent methods for exposing the changes in bioactive substances of functional meals throughout processing and storage. After the use of functional foods, several endogenous metabolites linked to metabolic disorders have so far been identified. The capacity to completely comprehend the precise biological processes of

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functional dietary intervention on metabolic illnesses may be enhanced by the integration of metabolomics with other omics technologies. Measuring changes throughout growth and food processing, monitoring changes in reaction to stress, improving postharvest operations based on metabolic changes, assessing and forecasting food quality, and assessing food shelf life. Food science has demonstrated the immense value of GC/MS-based analysis of non-volatile substances, which may also offer up new opportunities for instrument development or process improvement in the food sector.

One of the main obstacles to stopping illegal rice trafficking, which involves adulterating low-quality rice and mislabeling it as premium rice, is rice traceability. Although current safeguards against illicit rice trade have been put in place, more precise and useful procedures are still required to identify rice traceability in order to guarantee the rice's quality and authenticity. Over the past 20 years, metabolomics methods have been useful for assessing rice quality and classifying its geographical origin. More than half of the world's population relies on rice as a main diet. Being a relatively cheap source of nourishment and energy, rice is in high demand worldwide. It offers carbohydrates with lots of calories, while a large range of rice variations offer varying qualities of appearance, flavor, texture, and taste suited for various cuisines around the world, certain rice types with special and desirable attributes are termed premium rice with greater market value due to increased customer demands. These rice varieties' distinctive characteristics depend not only on their genetic make-up but also on the growth zones and agricultural methods. Because of this, rice traceability is a crucial issue for international rice commerce. Human safety and the world economy are seriously threatened by adulteration and mislabeling of premium rice (high quality and price). For premium items to be safe and of high quality, a quality assurance process must be developed. To solve these issues, metabolomics methods demonstrate the viability of improving regional discrimination. Principal analytical techniques, such as chromatography, vibrational spectroscopy, nuclear magnetic resonance, stable isotope analysis, and multi-element fingerprints.