Preface to Special Issue "Realizing Health for People and the Planet through Food and Sustainable Food and Agriculture Industries"

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1. Introduction

Throughout the world, people's lives have changed tremendously in the past 100 years, and Japan is no exception to this change. During the Showa era and the post-war period, Western food rapidly became a part of the Japanese diet, and with advances in technology, processed food became a widespread mainstay. Today, many people live in urban areas, and their eating habits are mostly supported by extensive food systems that primarily encompass agricultural production, processing, storage, distribution, sale, and disposal. These food systems, which exist on a global scale, have led to the increase of cheap and convenient fast food, as well as the growing consumption of processed food worldwide. While this has made food as a source of energy, readily available to many, it has also led to an increase in lifestyle-related diseases caused by the overconsumption of fat and salt, and the reduced intake of essential nutrients. Over 2 billion people currently live with obesity, despite the fact that many people still face issues such as starvation and malnutrition.

It is also reported that through a long series of conscious choices over a century, just 15 plant varieties now supply 90% of the world's calories, compared to the 50000 varieties once available. The Food and Agriculture Organization of the United Nations (FAO) reports that global agriculture is dominated by just 12 varieties of grain, 23 varieties of vegetables, 35 varieties of fruits and nuts, and 5 species of animals. Farming in the U.S. has increasingly shifted toward a system of large-scale monocropping of corn and soy. This practice, which aims to maximize yield through breeding and intensive selective cultivation, is reported to reduce nutrient levels in the resulting crops. Monocropping also carries significant risks related to the climate, as well as substantial threats to human nutrition.

As outlined above, diet has a profound impact on both human health and the global environment. In 2019, a report by the EAT-Lancet Commission proposed the "planetary health diet" as a guide to which foods are healthy for people and the planet. By 2050, the world's population is expected to reach around 10 billion people, and increasing crop and animal production to meet the food security needs of this population will inevitably accelerate global warming. Accordingly, food systems and dietary habits that are safer for the environment are urgently needed, and the above-mentioned report by the EAT-Lancet Commission proposes that a diet healthy for the planet is also healthy for people. Dietary choices are heavily influenced by local circumstances, individual economic power, attitudes, and preferences, and there are many challenges to overcome before this "planetary health diet" can be adopted universally. Nevertheless, understanding the direct effects of personal dietary choices on the health of the planet helps us to recognize the importance of these choices.

Essential to this understanding is an analysis of the basic nutritional components (proteins, amino acids, vitamins, minerals, fats, sugars) and functional components of food, and the provision of science-based data on the levels of these components in crops and food products. Equally essential to this understanding is the analysis of heavy metals, which affect the health of agricultural land, as well as the microbiological and contaminant testing that form an integral part of food distribution through global food systems. This special issue introduces Shimadzu's latest analytical instruments and presents various solutions for analyzing food samples that are complex and contain a range of various components.

2. Analysis of Agricultural Products and Social Implementation for a Healthy and Long-Lived Society

Shimadzu is collaborating with NARO to create a healthy and long-lived society through diet. This special issue highlights this collaboration, including an analysis of functional food components, identifying which nutrients are deficient in the Japanese diet and utilizing this scien-

tific evidence to promote a system for the certification of "G-Plus foods," and studying the relationship between diet and cognitive function in an aging society. This special issue also presents a workflow for the analysis of functional components in agricultural products, developed through joint research with NARO, and a technique for identifying which high-value-added plant varieties contain functional components.

3. Nutritional Analysis of Emerging Alternative Foods and Qualitative and Quantitative Analysis of High-Value-Added Foods

More and more alternative foods are constantly being developed, with two important examples being plant-based proteins and edible insects. The nutritional content of these foods is an increasingly popular area of study. This special issue presents examples of analyses performed using high-performance liquid chromatography (HPLC) and energy dispersive X-ray fluorescence spectroscopy (EDX). EDX is a particularly promising technique in terms of applications in the food market due to improved sensitivity arising from technological advancements, ease of operation, and speed of analysis. This special issue also presents an example analysis of D-amino acids by UHPLC, where D-amino acids are food components expected to bring new flavors and functional attributes to food. Fatty acids are fundamental components of food and information on fatty acid content is important for all foods. This special issue also describes three different methods of analyzing fatty acids.

A2 milk is a new high-value-added food that offers health benefits to many. This special issue describes a rapid analysis method using matrix assisted laser desorption/ionization (MALDI) to verify levels of a β-casein protein specific to A2 milk. Yogurt is a health food produced by fermentation that improves gut health and is available in a wide variety of products. This special issue also describes an example food metabolomics analysis of metabolites in yogurt, a health food produced by fermentation that improves gut health and is already available in a wide variety of products. This food metabolomics analysis can also be adapted for a range of beverages, foods, and fermented foods, and various software are suggested for this analysis.

4. Microbial, Harmful Element, and Allergen Testing

Foods are universally tested for harmful substances with a high risk of adverse health effects. These harmful substances can enter food through ingredients, manufacturing, or distribution, and testing is performed at each of these steps. This special issue introduces CompactDry CFR, a rapid assay for coliform bacteria, as well as another test kit that uses a sandwich ELISA method to detect walnut allergens. Both these test kits are newly developed by Shimadzu Diagnostics. CompactDry CFR has been awarded MicroVal certification. After the walnut test kit was officially recognized as a notification assay in compliance with applicable guidelines, it was launched to the market under the name FA Test EIA-Walnut.

This special issue also covers the topic of inorganic element analysis describing an analysis of minerals and harmful elements in infant milk formula and table salt by inductively coupled plasma-mass spectrometry (ICP-MS), as well as arsenic speciation analysis in apple juice using LC-ICP-MS.

5. Case Studies on the Use of Genetic Analysis in Food Testing

Some highly sensitive and highly specific food tests analyze specific genes. This special issue explores the use of genetic analysis technology to detect food poisoning microbes and differentiate between varieties of meat and fish. There is a growing need for faster methods of testing for food poisoning microbes, and PCR-based methods of testing are being developed to meet this need. This special issue describes the development of a testing kit for Salmonella spp. that uses real-time PCR and provides simpler sample pretreatment compared to previous methods. This special issue also describes the MultiNA II microchip electrophoresis system, which automates every step of nucleic acid electrophoresis and presents example applications of the MultiNA II system for identifying different types of meat and fish.

6. AI Technology in Food Analysis and Data Processing

Food analysis encompasses a wide range of components. There is a growing need to automate and streamline the process of determining analysis conditions for this analysis and processing the resulting data. Artificial Intelligence (AI) technology, which has advanced significantly in recent years, is now playing an increasingly prominent role in the field of analytical technology. LabSolutions MD is a software product developed by Shimadzu that assists in analytical method development and is equipped with an AI algorithm that automates the optimization of gradient conditions. This special issue describes a case study in which LabSolutions MD is used to analyze functional components (catechins) in tea using HPLC. An analytical method optimized with LabSolutions MD is used to analyze tea leaves and compare them by type and variety. This issue also introduces a peak integration software called Peakintelligence, which eliminates operator dependency and streamlines data interpretation during an analysis by liquid chromatography-mass spectrometry. Peakintelligence was developed using deep learning, a type of AI technology.

7. Conclusions

The food industry is a market that will continue to thrive as long as humans exist on earth. With the global population predicted to grow to approximately 10 billion people by 2050, we are entering a period when food supply will become a key concern for the entire world. Food systems are required that can provide a sustainable supply of safe, reliable, and nutritious food. This special issue highlights analytical solutions essential to the development of such food systems capable of supplying high-quality crops, livestock, marine products, processed foods, beverages, and more.