A Perspective of the Research on Food Factors in Human Health: A Return to the Mechanistic Approach

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Summary Food is a mixture of several nutrients and non-nutrients. The functions of food in human health can be categorized as its primary function in nutrition, its secondary function in palatability and its tertiary function in bioregulation. Nutrients contribute mainly to the primary function, while many non-nutrients in foods and foodstuffs are strongly associated with the secondary and/or tertiary functions. Individual food ingredients and ingredients as a whole are the so-called food factors. Much interest has arisen in the tertiary function of food factors related to the prevention of lifestyle-related diseases and promoting health in an aging society. This is why many studies evaluating the tertiary functions of food factors are now in progress all over the world. This symposium aims to present cutting-edge knowledge from celebrated Asian professors on the molecular mechanisms for the tertiary functions of food factors, in particular, polyphenols in soybeans and green tea, and n-6 polyunsaturated fatty acids in fish. In this context, this article will briefly review recent trends in research on the tertiary function of food factors.

Key Words food factors, mechanistic approach, functional foods

Development of Functional Food Legislation in Japan and the World

In 1984, Japanese researchers started a systematic, large-scale national project under the sponsorship of the Ministry of Education, Science, and Culture (MESC) exploring the interface between the medical and food sciences (1). This project terminated successfully in 1995, when the Ministry of Health and Welfare (MHW) initiated the world’s first policy for legal approval of the commercialization of selected functional foods using the term “Food for Specified Health Uses” (FOSHU). In 1991, health foods with an “enhanced function claim,” which were legally permitted when backed up by scientific evidence, were first launched and distributed on the Japanese market. In 2001, the Japanese government established a new system for regulating functional foods, i.e. those with a “nutrient function claim.” These are included in a new category—“foods with a health claim.”

In the United States, the Nutritional Labeling and Education Act (NLEA 1990) was launched in 1994. This law approved the labeling of health claims for all processed foods with manufacturers taking responsibility. Twelve items are now permitted that highlight the relationship between whole foods or food ingredients and diseases such as cancer, coronary heart disease and hypertension, with a “reduction of disease risk claim.” In addition, the Dietary Supplement Health and Education Acts (DSHEA) were put into effect in 1999. This law approved the labeling of general health foods with a “structure, function claim” for sale on the market only after notifying the Food and Drug Administration of the United States Department of Health and Human Service (FDA). Although no system similar to FOSHU has been established in the European Union, specified foods with a health claim are being distributed in the European market. Since 2007, the Regulation on Nutrition and Health Claims made on Foods has allowed the approval of “Claims referring to children’s development and health” such as xylitol-containing chewing gum, α-linolenic acid, and docosahexaenoic acid, together with a “reduction of disease risk claim.” In Asia, China established a system in 1999, so now a wide variety of health foods is available in the market labeled as “Foods for Maintaining Health.” In Korea, the enforcement of the Health Functional Food Act of 2003 promotes the popularity of functional foods. In Taiwan, the Health Food Control Act of 1999 allowed the government to approve various health foods. In a sense, the Japanese research project which started in 1984 can be considered as having triggered the establishment of legislation on functional foods in the rest of the world. Nowadays, questions are being raised on the scientific evidence on the health claims for functional foods. The Joint FAO/WHO codex declared in 2009 that health claims must be defined by scientific evidence based on a well-designed human intervention study and a comprehensive inspection of that scientific evidence.

Insight into the Methodology Underlying Evaluation of the Tertiary Function of Food Factors

Initially, targets for research on the tertiary function of food factors have been mostly related to methods to control the biomarkers indicating the risk of lifestyle-related diseases, the levels of blood sugar, blood pressure and blood lipid, and the promotion of intestinal health

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including prebiotics and probiotics (2). The discovery of ingredients that can modulate these biomarkers or prebiotics/probiotics is often connected to the development of a new FOSHU and other products labeled with an “enhanced function claim.” Many items have been produced on a commercial basis through basic research, applied studies and finally, human intervention trials. At present, a wide range of research studies on these targets is underway to create new health foods using novel food ingredients.

However, immunomodulation, antioxidant action, anti-inflammation and other biological defense systems have also been targeted for investigating the tertiary function of food factors. The role of food factors in the higher brain function has also been investigated by targeting the modulation of the central nervous system. However, it is very difficult to link the physiological effects of food factors on the biological defense or central nervous systems to preventing and/or reducing the risk of diseases such as cancer and mental disorders. Furthermore, very few biomarkers have been shown to be reliable indices for this type of prevention or risk reduction. This is why research areas in biological defense and central nervous systems are hardly expected to lead to the innovation of new health foods backed up with scientific evidence. This has prompted us to search for new biomarkers linking food factors to disease prevention/risk reduction by introducing indices of disease prediction and progression from the medical field.

Research on food factors has been heavily stimulated by rapid progress in the basic life sciences, in particular, the completion of sequencing the human genome at the beginning of the 21st century. In this post-genome age, researchers are searching for novel physiological functions of food ingredients through the use of comprehensive gene expression analysis. This is the basis of “nutrigenomics” (3). Many approaches in nutrigenomics are now well advanced and new strategies in molecular biology, such as proteomics and metabolomics, are now being introduced into the field of food factor research. A contrasting approach is also now becoming popular among food scientists who recognize the tertiary function of food factors as the physicochemical reaction of mutual chemical substances, or “food chemical biology.” A fruitful outcome of this approach is the discovery of several molecular targets in food ingredients, such as cellular and subcellular receptors, transcription factors and functional proteins that regulate signal transduction pathways through the activation of transcription factors and the resulting gene expression (4). Now we are confronted with an unexplored research field—the role of food factors in epigenetics. Therefore new ideas and new supportive methodologies are required to explore the tertiary function of food factors in the epigenome.

Overall, it is still true that elucidating the molecular mechanism for understanding physiological activity is essential for applying the tertiary functions of food factors to commercial health foods labeled with health claims. We should therefore return to a mechanistic approach towards food factors.

REFERENCES