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# Trends in Research and Development of Functional Foods

AKIHIRO HASEGAWA AND SHIN-ICHI MOGI
*Life Science and Medical Research Unit*

## 3.1 Introduction

Concerning the research and development of functional foods, it is clearly stated in the Comprehensive Strategy to Promote Science and Technology, planned in 2001 by the Council for Science and Technology Policy of the Cabinet Office, that "It is necessary to conduct scientific research on human health and food functions from the viewpoint of disease prevention to develop functional foods and new diagnostic techniques," and the research on functional foods has been referred to as one of the research fields on which more and more emphasis should be placed within the next 5 years or so.

In addition, in 1991, a system for the approval of "foods for specified health uses (FOSHU)" (foods that are intended to contribute toward attaining specific health purposes and for which license or approval for the claims to be listed on their labels that they help or are suited to maintain or improve health has been obtained from the Minister of Health, Labour and Welfare) was established under the Nutrition Improvement Law. Moreover, as of December 2001, the number of food items that have gained approval, etc., for FOSHU labeling climbed to 289, and the sales of FOSHU foods in fiscal 2001 was estimated to exceed 400 billion yen. In this way, FOSHU foods have rapidly penetrated into the life of the Japanese.

On the other hand, many challenges should be tackled in the research and development of functional foods including risk-associated, indiscriminate consumption by general consumers of so-called "health foods" due to the release of new information exaggerating the functionality of foods by the media, as well as limited scientific evidence showing the functionality of foods against the backdrop of the fact that very few research papers about food functionality have been published in major scientific journals on a worldwide basis.

This article outlines the present state of research and development of functional foods, and discusses subjects such as: i) how evaluation of food functionality should be conducted; ii) measures to be taken by the Japanese government to promote research and development of functional foods; and iii) how information on functional foods, which has been sorted out based on scientific evidence, should be provided to the Japanese people.

## 3.2 Definition, etc., of functional foods

### *3.2.1 General definition of functional foods*

It has been known that foods have not only the i) primary function (function to supply nutrients) and ii) secondary function (function to gratify the five senses) but also the iii) tertiary function (function to beneficially affect human health, physical ability and mental state), for instance, a function to exert beneficial effects in terms of the maintenance of health or recovery to health by regulating physiological systems including the gastrointestinal system, circulatory system, endocrine system, immune system and nervous system. Against the backdrop of the fact that scientific evidences showing such tertiary functions of foods have been obtained, foods designed and processed so that they can exercise such body-regulating functions are generally called functional foods.

However, there have been no regulations in which the definition of "functional food" is clearly provided in Japan. Definitions relating to functional foods include the one in Article 8, Item 5 of the Enforcement Regulations of the Nutrition

Improvement Law, in which "foods that are to be taken by the people in daily diet for specific health-keeping purposes and for which license for claims to be listed on their labels that they may help to achieve such purposes has been obtained from the Minister of Health, Labour and Welfare" are defined as "foods for specified health uses (FOSHU)," and target processed foods in consideration of the need to assure the truthfulness of claims on labels relating to functional ingredients.

### *3.2.2 Difference in the definition between Japan and other countries*

While there have been no clear definition of functional foods in other countries as well, the following scientific definitions given in Table 1 have been formulated by authoritative researchers, etc.

As can be seen from Table 1, no essential difference exists between the definition of functional food in the United States and that in EU, while the United States has legally defined "nutraceuticals" as a regulatory category separate from the functional food category. Nutraceuticals are defined as "foods derived from such naturally-occurring, physiologically active substances as those contained in dietary supplements, herb products, etc., and provide medical or health benefits, including prevention and treatment of diseases." Nutraceuticals are deemed to fall under the category of functional food in Japan and EU countries, but, in the United States, they are regarded as a separate category not covered by the functional food category, which characterizes the regulatory system for food products in the United States.

### *3.2.3 regulatory systems for foods with health claims*

The regulatory system for foods with health claims was established in Japan in April 2001 as an extension of the labeling system for FOSHU foods (established in 1991) in order to cope with the growing complicated and diversified functions expected from foods against the backdrop of growing consumer awareness of nutrition and interest in promoting health. Under the system, a category for foods with nutrient function claims has been newly set up separately from that for traditional functional foods (Table 2). Foods with nutrient function claims are foods that correspond to such dietary supplements as those having penetrated deeply into the marketplace in the United States, etc., and for which the government has created specifications and labeling standards so that they can meet the recommended amounts of nutritional intake and can support health-related policies in Japan.

The range of foods falling under the FOSHU foods has been enlarged since April 2001 to cover FOSHU products in the forms of tablets or capsules.

## 3.3 Research and development of various functional food components

To date, many functional components of foods having beneficial effects on the gastrointestinal system, circulatory system, endocrine system, immune system, nervous system, etc., have been found based on scientific evidences obtained in epidemiologic studies, in vitro studies, studies

**Table 1:** Definitions of functional foods in the United States and the European Union (EU)

| Country (name of the relevant researcher or research institution) | Definition |
|---|---|
| US (US Institute of Medicine) | Any processed food or ingredient for processed food that may provide a health benefit beyond the traditional nutrients it contains. |
| EU (Bellisle et al.) | Food products containing ingredients (including nutrients) that may exert a beneficial effect on one or more physiological functions of the body. |

Source: Materials prepared by Dr. Morio Saito at the National Institute of Health and Nutrition, an independent administrative institution (IAI).

**Table 2:** Categories of Supplement Foods

| Category | Definition | Sample Claim |
|---|---|---|
| Foods for specified health uses *(need to be licensed individually)* | Foods that are intended to contribute to a specific health purpose and for which license or approval for claims to be listed on their labels that they help or are suited to maintain or improve health has been obtained from the Minister of Health, Labour and Welfare. | ・ This product may help maintain normal blood pressure.<br>・ This food product may help improve bowel movement. |
| Foods with nutrient function claims *(need to meet certain standards)* | Foods intended to contribute to the supplementation or supply of nutrients, which tend to be insufficiently taken by the elderly, people with unhealthy dietary habits, etc.<br>When daily intake of the relevant nutrient from the food product meets a specific standard, the product can bear a specific claim about the functions of the nutrient | ・ Vitamin D is a nutrient that promotes calcium absorption in the bowel and helps with bone formation.<br>・ Calcium is a nutrient necessary for the formation of bones and teeth.<br>(Warning, etc.)<br>・ This product is not intended as a treatment for disease or to promote health by the intake of large amounts.<br>product has not been individually evaluated by the Ministry of Health, Labour and Welfare. |

Source: Authors' compilation by making reference to the materials prepared by the Ministry of Health, Labour and Welfare

using animal models, and clinical studies involving human subjects. The following sections detail the representative food-derived functional ingredients.

### *3.3.1 Lactic acid bacteria*

Lactic acid bacteria, a group of bacteria that powerfully degrades carbohydrates into lactic acid, is mainly used in the processing of cheese, lactic acid bacteria drinks, etc. The physical form of their cultures may be added to such fermented food products to be taken by humans, and their cultures themselves are often ingested as a drug for controlling intestinal functions.

Known functions of lactic acid bacteria include: (1) promotion of intestinal peristaltic movement; (2) regulation of the intestinal bacterial flora; (3) inhibition of the proliferation of noxious bacteria; and (4) boosting of the immune functions.

In recent years, a novel term "probiotics" (a concept that intake of live microorganisms in adequate amounts may provide benefits to hosts by improving the intestinal bacterial flora) has become familiar to us.

In European countries, probiotics has become a field that is ripe for scientific studies on its clinical effects on various diseases, its action mechanism, etc. For example, the group led by E. Isolauri of the University of Turku, Finland has shown that the intake of Lactobacillus rhamnosus is associated with decreased incidence of atopic dermatitis in children.

In addition, in Japan, under the initiative of the Japan Bifidus Foundation, etc., universities and food manufacturers have started to actively conduct research and development of probiotic products and it is expected that future evolution of such research will lead to the elucidation of the molecular mechanism underlying the regulation of immune responses by probiotic cultures.

### *3.3.2 Oligosaccharide*

The prefix "oligo" comes from the Greek word meaning "few." While carbohydrates such as starch and cellulose are called polysaccharides, complexes of 2-10 molecules of such monosaccharides as glucose and fructose are called oligosaccharide. The representative examples of oligosaccharides are fructo-oligosaccharide, soybean oligosaccharide, galacto-oligosaccharide and xylo-oligosaccharide.

Oligosaccharide is known to have, for example, the following functional features: (1) to have lower calorific value because it is not absorbed at the wall of the small intestine and reaches the large intestine; (2) to promote the activities of Lactobacillus bifidus by inhibiting the proliferation of noxious bacteria in the large intestine; and (3) to have a weaker sweet taste and is less prone to cause dental caries. Many FOSHU foods containing oligosaccharides have been put on the market with such nutrient function claims as "beneficial for the intestines" and "improves gastrointestinal health."

Since the development of manufacturing techniques (techniques for synthesis or extraction) is a significant challenge to be dealt

with in order to commercialize functional oligosaccharides, sugar alcohols, the Japanese government has given higher priority to research and development activities aiming to develop such techniques when allocating research funds.

### 3.3.3 Polyphenols

Polyphenols are pigments contained in many foods and may function as antioxidants. Some polyphenols are known to exert physiological effects by inhibiting the overproduction of reactive oxygen species that may cause arteriosclerosis and aging. In France, the incidence rate of death due to coronary artery disease is lower than those in other European countries despite frequent intake of diets high in animal and dairy fats, which is called the "French paradox." As the clue to this paradox, Renaud reported the correlation between higher wine consumption and the lower incidence of death due to coronary artery disease in an English medical journal "The Lancet" in 1992. Furthermore, in 1993, Frankel et al. published a report in "The Lancet" that polyphenols, antioxidants contained in red wine, exhibit inhibitory effects in vitro on the oxidation of LDL-cholesterol, which is a crucial step to the development of arteriosclerosis, and polyphenols gained the spotlight overnight. The representative examples of known polyphenols include catechins contained in green tea, red wine, etc., tannins, rutins found in onions, etc., as well as isoflavones contained in soybeans.

The catechin, a representative polyphenol, is an ingredient in green tea giving the astringent taste and is known to have physiological effects including, for example, (1) antioxidant effects, (2) antibacterial action, (3) anticariogenic effect, (4) deodorant effect, (5) reactive oxygen scavenging effect, (6) inhibitory effect on serum cholesterol increase, (7) inhibitory effect on blood glucose increase, (8) inhibitory effect on blood pressure increase, (9) antitumor action, (10) antiallergic action, (11) antithrombotic effect, and (12) ultraviolet-absorbing effect.

### 3.3.4 Lipids

Since triacylglycerol represents about 95% of dietary lipids, the functionality of lipids has been studied with regard to triacylglycerol as having a typical fatty acid composition. There are two types of fatty acids making up lipids, including saturated fatty acids, which have all the hydrogen the carbon atoms can hold, as well as unsaturated

**Table 3:** Types of food items, etc., within each category of FOSHU health claims

| Category of health claims | Types of foods | Relevant food components |
|---|---|---|
| Food suited for those who want to improve gastrointestinal health | Fermented milk, lactic acid and bacteria drinks, carbonated beverages, soft drinks, powdered soft drinks, table sugar, cookies, instant noodles, fried instant noodles, cereal, etc. | Lactic acid bacteria, fructo-oligosaccharides, xylo-oligosaccharide, soybean oligosaccharide, actosucrose, galacto-oligosaccharides, isomalto-oligosaccharides, psyllium seed husk, indigestible dextrin, etc. |
| Food suited for those who take insufficient amounts of calcium | Soft drinks, tofu (soybean curd) | CMC (Citric Acid, Malic Acid and Calcium), CPP (Casein Phospho Peptide) |
| Food suited for those who care about cholesterol levels | Soft drinks, biscuits, sausage, cooking oils, etc. | Soy protein, chitosan, depolymerized sodium alginate, diacylglycerol |
| Food suited for those who have higher blood pressure | Soft drinks, lactic acid and bacteria drinks, powdered soup | Glycoside from Eucommia leaves, gasein dodeca peptide, lactotripeptide, katsuobushi (dried bonito) oligopeptide |
| Food suited for those who care about anemia | Soft drinks | Heme iron |
| Food suited for those who worry about dental caries | Chocolate, gum, candy | Maltitol, palatinose, erythritol, green tea polyphenols |
| Food suited for those who care about blood glucose | Soft drinks, powdered soft drinks | Indigestible dextrin |

Source: Authors' compilation by making reference to the materials prepared at the National Institution of Health and Nutrition

fatty acids, which contain one or more double bonds between carbon atoms. Among unsaturated fatty acids, the ones in which the first double bond occurs three carbons from the methyl ($CH_3$) end of the molecule, are called n-3 (omega-3) series. Omega-3 fatty acids have long been thought to have a LDL-cholesterol-lowering effect, and various functions of those fatty acids, particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), are already on their way to becoming elucidated.

Among the effects of DHA, not only the LDL-cholesterol-lowering effect but also beneficial effects on the susceptibility to allergy, vision-improving effect, anti-cancer effect, etc., have recently received attention.

Moreover, the intake of diacylglycerol, which is processed from plant oil, has been proven to be associated with a lower rate of postprandial increase in blood triglycerides, and cooking oils containing diacylglycerol have gained licenses for FOSHU labeling and have rapidly penetrated into the Japanese marketplace in recent years, attracting people's attention.

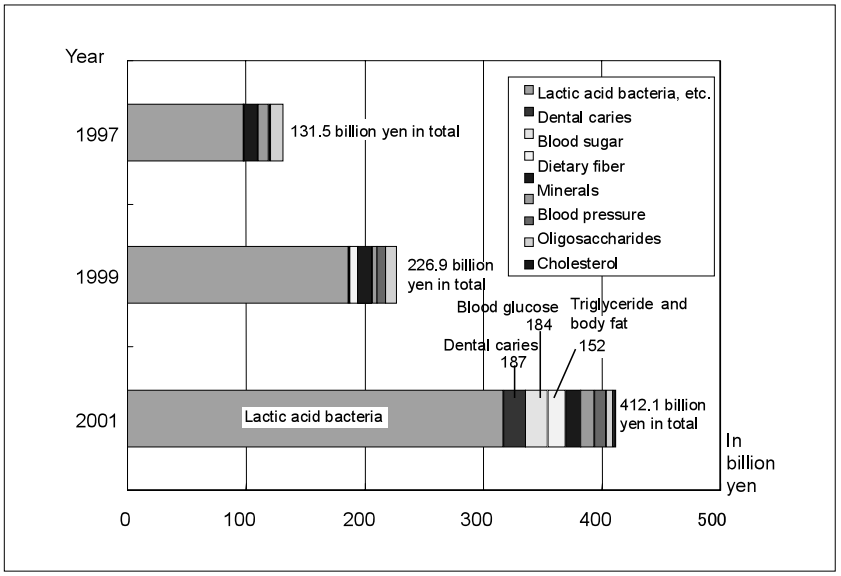
## 3.4 Trends in research and development of foods with health claims

As mentioned at the outset of this article, the total number of food product items that have gained approval, etc., for FOSHU labeling, for which a regulatory system was established in 1991, climbed to 289 as of December 2001. In addition, the number of product items that gained approval for FOSHU labeling reached an all-time high in 2001. The current categories of health claims, types of food items falling under each category, as well as the relevant functional food components are summarized in Table 3.

The "types of foods" and the "relevant food components" within the category of "food suited for those who want to improve gastrointestinal health" cover a fairly broad spectrum, and a survey conducted by the Japan Health Food and Nutrition Food Association showed that product items falling under this category represent as high as 57.8% of product items that have gained approval for FOSHU labeling.

Moreover, according to a questionnaire survey targeting food manufacturers conducted by the Japan Health Food and Nutrition Food Association, the sales of FOSHU products in fiscal 2001 was 412.1 billion yen (based on manufacturers' suggested retail prices), having increased by 182% from 226.9 billion yen in fiscal 1999. Among the FOSHU foods, marked increase in the sales of FOSHU products intended for those who care about "dental caries," "blood glucose" and "serum triglyceride and body fat" is worthy of special remark. Based on these data and in light of trends in application for FOSHU approval by food

**Figure 1:** Sales of FOSHU products by functional component or targeted health-related condition




Source: Materials prepared at the Japan Health Food and Nutrition Food Association (a legally incorporated foundation)

manufacturers, the Japan Health Food and Nutrition Food Association expects that the ratio of FOSHU food products (including foods in the above-mentioned three groups) other than those using lactic acid bacteria to all FOSHU products will increase.

In the process for putting FOSHU products on the market, in vitro studies, studies using experimental animals and clinical studies involving human subjects are conducted by food manufacturers to evaluate the efficacy and safety of the relevant food components, and evaluations of candidate FOSHU foods are officially performed based on scientific data obtained in such studies before the approval for FOSHU labeling. However, problems exist in the process, including the fact that studies for efficacy and safety assessment are conducted in as few as about several tens of subjects, as well as the fact that ingestion periods in such studies are relatively short (about 1 month in ordinary cases; about 3 months at the longest).

## 3.5 Trends in policies on functional foods in countries other than Japan

### *3.5.1 Trends in the United States*

In the United States, under the Nutrition Labeling and Education Act (NLEA), the Food and Drug Administration (FDA) has authorized 12 health claims (reduction-of-disease-risk claims) for nutrients or other substances in conventional foods or dietary supplements that have been shown to be related to a disease or health-related condition based on sufficient scientific evidence (Table 4). Food manufacturers may make these FDA-authorized health claims on the labels of the processed food products, etc., they manufacture and market without individual petition to FDA.

On the other hand, among functional foods, a characteristic trend observed in the United States is toward high market penetration of dietary supplements marketed in the forms of tablets, capsules, liquid or powder. Under the Dietary Supplement Health and Education Act (DSHEA), dietary supplement products may bear structure/function claims on their labels, which describe the effect a particular food or nutrient has on the structure or function of the body. When a food manufacturer intends to put a dietary supplement product on the market, the manufacturer must notify the FDA about the ingredients of the relevant product, and details of the structure/function claims to be made.

Nevertheless, it has been pointed out that functional foods and dietary supplements still have safety problems, and the US government, as its national nutritional policy, would rather control and regulate them to promote proper intake by consumers than try to get them into widespread use. In 1993, the Office of Special Nutritionals was established in the FDA and constructed a database on the adverse events associated with the intake of dietary supplements (The Special Nutritionals Adverse Event Monitoring System) to provide convincing information that enables consumers, etc., to take dietary supplements safely through candid disclosure of such information to consumers, etc., on the Internet. In this database, data on 2,621 cases of health hazards and an associated 3,451 items of dietary supplements have been stored during the period from 1993 to October 20, 1998 (the database has not been updated since October 20, 1998). Based on the information entered into the database, the most commonly reported symptoms include vomiting,

**Table 4:** Health claims authorized by FDA

| | Type of health claim by food components |
|---|---|
| 1 | Calcium and Osteoporosis |
| 2 | Dietary Lipids (Fat) and Cancer. |
| 3 | Dietary Saturated Fat and Cholesterol and Risk of Coronary Heart Disease |
| 4 | Dietary Sugar Alcohol and Dental Caries |
| 5 | Fiber-containing Grain Products, Fruits and Vegetables and Cancer |
| 6 | Folic Acid and Neural Tube Defects |
| 7 | Fruits and Vegetables and Cancer |
| 8 | Fruits, Vegetables and Grain Products that contain Fiber, particularly Soluble fiber, and Risk of Coronary Heart Disease |
| 9 | Sodium and Hypertension |
| 10 | Soluble Fiber from Certain Foods and Risk of Coronary Heart Disease |
| 11 | Soy Protein and Risk of Coronary Heart Disease |
| 12 | Stanols / Sterols and Risk of Coronary Heart Disease |

Source: Authors' compilation by making reference to the material titled "Food Labeling and Nutrition" published on FDA's home page

diarrhea, headache, etc., while it should be noted that 184 cases of "death" have also been reported.

### *3.5.2 Trends in countries other than Japan and the United States*

When turning our eyes away from the United States toward EU countries, there have been no directives concerning health claims, and discussions are under way on the concept of and labeling for dietary supplements in EU member countries.

In the Codex Alimentarius Commission (in the FAO/WHO food standards program), adoption of health claims was decided in the 24th Workshop on Food Labeling held in May 1996 and discussions have been continued about health claims since the 25th Working Party was held in April 1997, but agreement has been reached only at Steps 1-3 (the stage for final approval is Step 8).

Among the achievements in research and development activities in EU countries, world attention has focused, for example, on xylitol, which has an anticariogenic effect and on which studies advanced considerably in the 1970s, as well as a margarine product named "Benecol" developed in 1995, which contains "plant stanol esters" and helps maintain normal serum cholesterol levels. Both of them were developed in Finland. In Finland, the National Technology Agency of Finland (TEKES) takes charge of the financial support for the research and development of functional foods. In the TEKES's research and development program entitled "Innovation in foods" to be implemented from 2001 to 2004, high priority was assigned to research and development activities in the field of food and health, and research funds invested into this field totaled up to 50 million Euros (approx. 6 billion yen). In this program, special emphasis is placed on the efficient commercialization of the results of research and development activities under the program as well as on the promotion of collaboration between people in the field of food science and people in other fields (including medicine and biotechnology).

## 3.6 Circumstances surrounding the promotion of research and development of functional foods in Japan

Concerning the circumstances surrounding the promotion of research and development of functional foods by the Japanese government, as shown in Table 5, research project funds provided by the Ministry of Agriculture, Forestry and Fisheries make up a sizable proportion of all funds allocated by the government.

During three years from 1997 to 1999, the Ministry of Education, Culture, Sports, Science and Technology funded the Funds for the Coordination of Advancement of Technology to i) research for the evaluation and elucidation of the antioxidative properties of foods, ii) research for the evaluation and elucidation of the inhibitory effects of foods on the aging-related change in brain functions, and iii) research for the elucidation of the physical properties of foods related to mastication (chewing) as "research aiming at the comprehensive analysis of food functions with the graying of Japan in view as well as at the application of the results of the analysis," in which many researchers from the Ministry of Agriculture, Forestry and Fisheries, Ministry of Education, Science, Sports and Culture, Ministry of Health, Labour and Welfare, the Environment Agency, and private companies participated.

In the past, the Ministry of Agriculture, Forestry and Fisheries provided research funds mainly for research on the isolation and identification of functional components in foods as well as research on the development of methods for evaluating the functional components in foods. Recently, research institutions under the Ministry have launched new challenges such as research on the interaction between functional components and one aiming at the utilization of combinations of functional components for better dietary habits. In addition, the Ministry has given financial support to private companies, etc., for, as example, their research on the methods for synthesizing functional components, particularly carbohydrates, as well as research aiming at the development of methods for manufacturing

**Table 5.:** Amounts of budget for main research programs on functional foods in fiscal 2002
(Unit: million yen, figures in parentheses are amounts in fiscal 2001.)

**(Ministry of Agriculture, Forestry and Fisheries)**

| | |
|---|---|
| Research at public research institutions | Comprehensive research on the functionality and safety of foods for the establishment of healthy eating habits (planned term: 2000-2005)..... 355 (255)<br>The purpose of this program is to promote comprehensive research on the functionality and safety of foods for the purpose of establishing healthy eating habits that may contribute to the prevention, etc., of lifestyle-related diseases, with the aim of realizing a vigorous society where many people live to an advanced age in good health.<br>(Details of the research)<br>• Elucidation of the mechanism of the action of functional components as well as interaction between such components<br>• Evaluation of the effects of functional components in vivo<br>• Proposal for the establishment of healthy, Japanese-style eating habits by utilizing two or more functional components |
| Publicly funded research at private companies, etc. | Program for the development of techniques for the multipurpose utilization of carbohydrates produced by the application of carbohydrate engineering (term: 1998-2002) ..... 36 (53)<br>The purpose of this program is to develop, for example, techniques for the efficient production of useful carbohydrates created by applying the results of research by independent administrative institutions as well as to promote the development of manufacturing methods for novel foods utilizing such carbohydrates for many purposes. |
| | Program for the development of techniques for the improvement of the functionality of foods (planned term: 1999-2003) ..... 56 (74)<br>The purpose of this program is to design and improve functional components of foods by using leading-edge technologies such as biotechnology as well as to promote the development of new ingredients for foods with improved functionality, reaction at the time of eating, taste, etc. |
| | Program for the development of new techniques for the isolation and extraction of components of foods to be utilized in the food industry (planned term: 2000-2004) ..... 49 (73)<br>The purpose of this project is to promote the development of, for example, supercritical fluid extraction techniques, and isolation or extraction techniques utilizing membranes with the aim of efficiently isolating, extracting and concentrating food components for general-purpose use by applying the results of research conducted at independent administrative institutions. |
| | Program for the development of techniques for the evaluation and manufacturing of health-oriented foods by the application of life sciences (newly adopted program)(term: 2002-2005) ..... 58 (0)<br>The purpose of this program is to scientifically evaluate the effects of foods by utilizing biomarkers (simple biological markers), etc., found at independent administrative institutions as well as to promote the development of methods for manufacturing foods that may help maintain good health. |
| Others | Program for research and development aiming at the creation of new programs by the Institute for the Promotion of Research on Bio-Oriented Technology Research Advancement Institution (BRAIN) (planned term: 2000-)<br>• Development of functional crops with health benefits (rice and vegetables with, for example, preventive effects on lifestyle-related diseases, cedar pollen allergy and infectious diseases) .....(188)<br>• Development of foods with health claims utilizing the functional components of citrus fruits .....(56)<br>• Development of foods utilizing the antiallergic effects of tea.....(54)<br>(The budget for this program is provided as that for contracted research activities by the government-academia-industry consortiums.) |

Budgets for programs listed in the box in the "Others" row are not funds that were directly earmarked in the national budget for those programs in fiscal 2001, and the amount of budgets for those programs in fiscal 2002 have not been determined yet.

**(Ministry of Health, Labour and Welfare)**

| | |
|---|---|
| Programs for research in human genome, regenerative medicine, etc. | • Research for the assurance of the safety of foods produced by the application of biotechnology and development of multifunctional foods ..... (100)<br>(Only a very small amount of funds was provided for the development of multifunctional foods.) |
| Programs for comprehensive research on foods and chemical substances<br>(This program corresponds to the one that had been called "Programs for comprehensive research for Safety in Daily Living" until 2001.) | • Research on the safety and effects of FOSHU ingredients ..... (14)<br>• Research on the safety and effects of the ingredients for FOSHU foods ..... (16)<br>• Research on the safety and effects of FOSHU ingredients ..... (10) |
| Programs for comprehensive research in human sciences including drug discovery<br><br>Programs for research for the evaluation of medical techniques | • Research on the inhibitory effects of transesterificated lipids containing EPA and DHA on body fat deposition ..... (2)<br>• Research for the evaluation and analysis of new functional food ingredients from the standpoint of food science..... (7)<br>• Research for the establishment of methods for certification tests of hypocariogenic, noncariogenic and anticariogenic foods as well as for the application and popularization of such methods ..... (4) |

*Since programs funded by the Ministry of Health, Labour and Welfare are those for which themes of research in various fields including food science were invited from the public, budgets for the programs listed above could not be calculated for 2002.

Source: Authors' own compilation

functional foods.

On the other hand, the Ministry of Health, Labour and Welfare (MHLW) adopts just a few research programs on functional foods every year, as programs to which the MHLW Scientific Research Funds are to be provided by the Ministry, although in small amounts, as part of research funding projects for which themes for research are invited from the public, including the Comprehensive Research Project on the Safety of Foods and Chemical Substances and the Comprehensive Research Project on Human Science such as Drug Discovery. The programs mainly include those for research for the evaluation of safety and efficacy of FOSHU foods, and the researchers at the National Institute of Health and Nutrition, National Institute of Infectious Diseases, etc., are in charge of research for the evaluation of interaction between FOSHU foods and drugs, as well as risks associated with the intake of FOSHU foods by disease-affected people.

## 3.7 Conclusion
### — Challenges to be addressed in future research and development of functional foods —

A broad view of the efforts that are underway in Japan to promote research and development of functional foods revealed the following challenges to be addressed in future research and development activities:

**(1) Promotion of research for the accumulation of substantial scientific evidences**

While in vitro studies, studies using experimental animals, clinical studies involving human subjects, etc., have been conducted in the process of research and development of functional foods, including FOSHU foods as a main subcategory of foods with health claims, problems still exist in the process, including, for example, the functionality of foods is evaluated in studies involving human subjects with limited sample size and with relatively short ingestion periods.

In order to further promote research and development of functional foods, continuous efforts to reinforce research techniques, including the development of biological markers that can be utilized in the exploration of functional components and in the evaluation of such components, are of importance. From now on, it may be necessary to evaluate the efficacy of functional foods on a massive scale and with a long-term perspective by grasping the actual conditions of the consumption of functional foods by consumers and by epidemiologically analyzing the efficacy of such foods in terms of maintenance and improvement of health.

**(2) Risk factors for diseases and ways in which research on functional foods should be conducted**

Studies on food functionality have often been conducted by isolating a single component from the relevant food to examine the presence or absence of beneficial effects of the component, and recent studies have yielded splendid products including the identification of novel functional food components.

The basic methodology of current research on functional foods is that, by targeting a single disease risk factor (e.g., cholesterol levels), a functional food should be designed so that it can reduce the risk of the relevant disease. However, in light of the fact that diseases are actually induced by two or more independent risk factors, it may also be necessary, in the future, to consider new methods for designing functional foods targeting two or more risk factors.

**(3) Establishment of systems for research enabling the application of the results of research and development of functional foods to actual diet**

In order to pursue research on functional foods with a macroscopic purpose to improve the health of the Japanese, it may be essential to establish not only systems for research by people belonging to food manufacturers or agricultural departments at universities, but also systems for research for the utilization and evaluation of functional foods by, for example, investigating whether optimum amounts of functional components are received by the people from daily diet, investigating appropriate methods for preparing functional foods, and assessing the

applicability of functional foods to preventive medicine.

In Japan, comprehensive researches on the metabolism and recommendable amounts of intake of nutrients, kinds and composition of foods, methods for preparing foods, etc., have been conducted exclusively by authoritative research groups at departments oriented toward domestic science (nutritional science and food science) at universities. However, in 1999, 941 and 266 out of about 43,000 postgraduates at the domestic-science-oriented departments decided to take a master's course and doctoral course, respectively, at a graduate school in the course of domestic science, indicating the fact that the number of postgraduates who decide to proceed to a graduate school in the course of domestic science tends to be much smaller than those in other academic courses. In addition, people as human resources who are conversant with analytical methods in organic chemistry have not sufficiently developed in Japan. Currently, there is immense pressure from medical institutions for domestic-science-oriented universities to develop supervising dieticians as human resources having expertise that enables them to play active parts as medical staff, so, being the case, it may be difficult for such universities to put energies only into fostering researchers who are conversant with analytical methods in organic chemistry. Therefore, for the time being, it is desired that the interchange of researchers who are playing leading roles in the field of chemical analysis of functional food components be promoted and that measures be taken to aid such researchers in securing minimum access to facilities, equipment and funds that are required in laboratories for the study in domestic science. In addition, we should recognize the significance of the functions served by "faculties of nutritional science within medical departments of universities," which rarely exist now in the universities in Japan.

### (4) Supply of information on functional foods to consumers

As indicated by the circumstances surrounding dietary supplements in the United States, excessively great reliance on functional foods and intake of such foods in incorrect ways may pose health hazards to consumers. In consideration of such risks associated with the intake of functional foods, the FDA has taken measures, in addition to the measures mentioned in Section 3.5, to protect consumers from such risks in collaboration with scientists, including the supply of information on its home page on the scientific findings from research on functional foods and amounts of intake that are deemed acceptable to secure consumers' safety*. In addition, the FDA, on its home page, has advised that pregnant women as well as patients with such conditions as diabetes mellitus, hypertension and heart disease should consult with a doctor before they start taking such foods, and has called attention to the interaction between functional foods and drugs.

* http://www.cfsan.fda.gov/~dms/ds-savvy.html
(Tips For The Savvy Supplement User:)

In Japan, on the other hand, information on functional foods based on scientific evidence is infrequently provided by the government agencies concerned at present. In recent years, there have been increasing opportunities for consumers in Japan to obtain information on dietary supplement products developed and manufactured in foreign countries, and it has become increasingly easy for Japanese consumers to buy such products by mail order, etc. Under these circumstances and in light of the fact that a lot of complaints (10,688 complaints in fiscal 2000) about so-called "health foods" have actually come into the National Consumer Affairs Center of Japan from consumers who suffered from health hazards associated with the intake of such foods, the government agencies concerned, from now on, should provide not only information concerning the labeling system within the jurisdiction of the competent authorities of the government but also detailed information on risks associated with the intake of functional foods based on scientific evidences. Moreover, it is also important to promote research on functional foods to obtain scientific evidences about the effects of excessive intake and interaction with drugs.

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