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A new definition of functional food by FFC: what makes a new definition unique?

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ABSTRACT

Functional food science has gained momentum recently in response to the changing health status of developed countries. As healthcare costs and average life expectancy rise, the public has sought ways to become healthier and develop higher qualities of life. The concept of "functional food" developed as a convenient and inexpensive solution to chronic health problems, and is becoming influential in numerous branches of science and policy. Since its conception in 1984, "functional food" changed its meaning per country and culture. The term migrated from Japan to the EU and the United States where it generated profit but bred confusion among experts and non-experts. In this chapter, we review how "functional food" has been defined and redefined over the past 30 years, as well as the benefits of our current definition. The goal of this new definition is to strengthen communication between nutrition scientists, the public, and other groups as well as legitimize functional food science around the world.

Keywords: Functional foods definition; bioactive compounds; biomarkers

INTRODUCTION

Nutrition science first emerged in the 1800s, later than even the idea of "diet" [1]. This new branch of science combined food knowledge with health and human physiology. As the field of nutrition advanced, scientists could isolate and identify nutrients needed for human survival and growth. Beginning in the 1970s, scientists went so far as to recommend daily amounts of nutrients in order to support human health. These came in the form of recommended daily allowances (RDAs) and reference nutrition intakes (RNIs), dietary guidelines, and food guides. Overall, nutrition scientists constructed a model of food intake for healthy living, particularly in terms of growth, body weight, malnourishment prevention, and over-nourishment treatment [1-2].

Two thousand years ago, Hippocrates was on the right path when he said "Let food be thy medicine and medicine be thy food". However, now we might change that to "Let functional

food be thy medicine." Since 2006, the Functional Food Center (FFC) has been using the above statement in our functional food-related books.

Functional food science originated from the collaboration of sciences and the public need. It is the melding on food science, nutrition, and medicine as it produces sustenance that crosses between food and pharmaceuticals. Specifically, researchers study food components and their beneficial health effects. They measure changes in health and homeostatic behavior through the use of biomarkers or "indicators" in the body. From this research, functional food scientists determine the health effects and proper/safe dosages of functional foods [3].

While the steps to developing functional food is somewhat consistent across the world, the meaning of "functional food" is not 1. Countries, such as Japan, Europe, and the United States, for example, do not have a single legislative definition for functional food, leading to numerous global consequences. The lack of a consistent definition between countries has led to unregulated publishing of health claims in some, limiting of functional food production in others, and an overall mistrust or unclear sense of what "functional food" is among government officials, public health professionals, and the public. While "functional food" has generated billions of dollars in sales worldwide, the lack of a standard definition has prevented functional food scientists from delivering functional food to chronically ill populations.

In this review paper, we describe how "functional food" has been defined in the past, why a standard definition is necessary, and the rationale behind the FFC's new definition for "functional food."

ORIGINS OF THE "FUNCTIONAL FOOD" CONCEPT: HUMANITY SOUGHT FOOD THAT COULD HEAL

Japan

The term "functional food" was first coined in Japan. In 1984, The Japanese government allocated research funds for studying functional food or Foods for Specific Health Uses (FOSHU):—[1, 4].

"Food products fortified with special constituents that possess advantageous physiological effects." [5-8]

In Japan, "functional food" has been given a formal legislative food category called FOSHU. In order to qualify, food must satisfy three nutritional requirements: (1) Effectiveness in clinical studies, (2) Safety in clinical and non-clinical studies, and (3) Determination of active/effective components[9,10]. Moreover, In order to obtain a FOSHU designation, manufacturers must complete an application containing scientific evidence supporting the proposed medical or nutritional link, the suggested dose of the functional food, safety of the food, and descriptions of the food's physical/chemical qualities, experimental methods, and composition [11].

This application typically requires a year to obtain and is reviewed by the Ministry of Health and Welfare (MHW) and local authorities. The completed FOSHU label contains: "the approved health claim; recommended daily intake of the food; nutrition information; guidance on healthy eating; a warning against excessive intake, if necessary; any other special precautions relating to

intake, preparation or storage; and other information" [11, 12]. Once FOSHU labels are obtained, they do not expire.

Europe

When functional food science migrated to Europe, researchers defined "functional food" using the following statement:

"Food products can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases"

[7, 13].

Currently, the European government categorizes food into: "conventional foods, modified foods, foods for special dietary use and medical foods" [14]. Unlike Japan, however, the EU government does not have a formal legislative definition for "functional foods."

According to the European Commission Concerted Action on Functional Food Science in Europe (FUFOSE) and PASSCLAIM, food developers are permitted to make two types of claims: nutritional and/or health claims. "Nutrition claims" refer to a food's basic nutrient content and ability to provide energy. "Health claims" refer to a food's ability to prevent, manage, or treat illness. These titles, particularly "health," must be backed by significant scientific evidence, similar to Japan's FOSHU application process. The steps are: (1) the active food or component must be identified, (2) clinical studies and meta-analysis must be performed, (3) health endpoints must be measured either directly or through effective biomarkers, (4) health benefits must be statistically significant [9, 15, 16]. As a part of the EU's initiative to regulate food "labelling, presentation, and advertising," the requirements for health claims are stringent. As a result, they bar many food developers from printing health claims on their proposed "functional foods"9. Moreover, functional food developers find extensive testing costly. In other words, the lack of a clear, cohesive definition may be leading to over-regulation of health claims in the EU, impeding functional food development there.

United States

While the U.S. Food and Drug Administration (FDA) recognizes dietary supplements and medical foods, the United States Department of Agriculture (USDA) does not have a formal definition for "functional food" 1. This gap in U.S. federal legislation creates a challenge for researchers and developers who want to sell or educate the public about functional food.

In spite of this, the FDA recently released guidelines for assessing health claims, entitled the "evidence-based review system for the scientific evaluation of health claims" [17]. Like Japan and Europe, the U.S. would like to systematically review health claims so that the meanings of health claims are clearer [17-19]. Under the evidence-based review system, food manufacturers may issue "nutrient content" claims, "health" claims, or "structure/function" claims. The former two are similar to the EU's "nutritional" and "health" claims respectively [17-20].

A "nutrient content claim" describes the actual components of a food product without any reference to health 1. An example of a nutrient content claim would be, "This product contains 1 gram of sugar." A "health claim" explicitly or implicitly ties the food product to health or disease. However, a health claim may only signify risk reduction of a disease and not "diagnosis, cure, mitigation, or treatment of disease." An example of a health claim would be, "This product promotes cardiovascular health." Finally, a "structure/function" claim simply relates a nutrient to the structure or function of the human body based on accepted scientific research. An example of a structure-function claim would be, "This product contains Vitamin A. Vitamin A is important for maintaining healthy eyes" 17.

Finally, the FDA allows "qualified health claims" on food products whose effects have been suggested but not verified. Nevertheless, food manufacturers must include a disclaimer on the indicate product indicating that the scientific evidence behind the health claim is weak [17, 18, 21].

In order to verify food claims, the FDA pays special attention to research involving the administration of food compounds (at specific dosages) to animals and humans [17, 19]. Claims must then be approved under ''Significant Scientific Agreement" after which FDA officials rank claims based on the strength of the scientific evidence behind them 17.

National & International Organizations

In addition to government agencies, national and international organizations developed their own definitions for functional food 9.

1. The National Academy of Sciences Food and Nutrition Board in the US believes that a "functional food" is:

"*Any modified food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains"* [9, 22].

2. Similarly, the Institute of Food Technologists (IFT) defines "functional foods" as:

"[S]ubstances [that] provide essential nutrients often beyond quantities necessary for normal maintenance, growth, and development, and/or other biologically active components that impart health benefits or desirable physiological effects" [23].

These two definitions are comparable to the EU definition in that they highlight the idea that functional food improves health in addition to providing basic nutrition.

3. Finally, the American Dietetic Association (ADA), a prominent organization of nutrition and dietetics experts, calls "functional foods:"

"*whole, fortified, enriched or enhanced"* that should be consumed regularly and at effective amounts in order to derive health benefits [24-27].

While the ADA's definition contains the same theme as the rest, it does not emphasize how functional food promotes health and reduces disease.

In the U.S. alone, scientific organizations interpret the term "functional food" differently. Although IFT, The National Academy of Sciences, and the ADA concur on the essence of what

functional food is, their definitions vary in detail, specificity, and focus. This fact demonstrates the need for a unifying definition in the United States and abroad. After a formal definition is established, scientific organizations will more easily be able discuss about the future of functional food.

Comparable terms to "Functional Food"

As functional food science developed, so did a litany of food vocabulary. For example, in 1989, Dr. Stephen DeFelice introduced the term, "nutraceuticals": [28]

"[A] substance that is a food or part of a food that provides medical and/or health benefits, including the prevention and treatment of disease' or 'a product produced from foods but sold in powders, pills and other medicinal forms not generally associated with food and demonstrated to have physiological benefits or provide protection against chronic disease" [1, 14, 29-31].

Interestingly, "nutraceutical" is often interchanged with "functional food" in scientific literature. Also, "medical foods" are used to treat metabolic problems and diseases. Finally "dietary supplements" are meant to provide extra health benefits outside of basic nutrition 14.

As evidenced by the number of existing nutritional terms, nutritional science is expanding. However, the similarity of its terms can obstruct the implementation of meaningful regulatory policies. Put simply, without a formal definition, functional food is lost in the mix of U.S. food vocabulary. As a result, the FDA cannot differentiate functional food from other food products and therefore, cannot create a separate regulatory category for functional food.

ESTABLISHING A FORMAL DEFINITION FOR "FUNCTIONAL FOOD"

Functional foods have been developing for over 30 years and are quickly becoming staples in international markets [7, 32-39]. Moreover, as stated above, since functional food emerged in nutrition research, other terms such as: "nutraceuticals, designer foods, f(ph)armafoods, medifoods, vitafoods, dietary supplements, and fortified foods" have appeared. This complicates nutrition vocabulary and confuses consumers1. In other words, a formal definition of functional food is required. In the field of functional food, economic growth and public information cannot sustain itself without establishing what functional food is.

Challenges Due to the Absence of a Proper Definition

A standard definition for functional food is needed to facilitate greater communication between food experts and non-experts, scientists, government officials and the public. This will enable freer exchange of functional food products between countries.

There are several consequences of leaving the definition for functional food open-ended. For instance: scientific groups distorting the meaning of functional foods, public confusion created by ambiguous food labels, and the subsequent loss of functional food's scientific legitimacy among consumers and government officials. As professionals in this field, it is imperative that we clarify what we mean by "functional foods," "bioactive compounds," "nutraceuticals," and other terms. Because these compounds have the potential to help prevent, manage, and treat

illness on a global scale, functional food scientists must unite and agree upon a new formal definition for functional food. A new definition will have several benefits:

First, formalizing a definition for functional food will clarify and improve communication between food/nutrition scientists, policymakers, medical researchers and the public worldwide 7. Better communication will enable the implementation of better policies and food education among non-experts. This will also lead to greater funding and support for nutrition research and policy initiatives. Next, a definition with legislative and research consensus will legitimize functional food science globally, and therefore allow for more progress in food, medical, and policy innovation. Finally, a formal definition will help dispel misconceptions held by the public about functional food. Due to the prevalence of functional food in the world today, alongside the unclear definition of these products, many people harbor pre-existing notions about the legitimacy of functional food products. Moreover, due to their lack of knowledge and experience with functional food, media and non-expert scientists spread false or misleading information about functional food, which plants seeds of doubt in the minds of consumers. Above all, functional food scientists have a responsibility to properly educate the public about functional food because their products are relevant to the future of chronic disease care and prevention. Therefore, this new definition will ensure greater use of functional food by consumers who need it most. As a result of their dedicated research, collaboration with fellow scientists and modern understanding of functional food, the FFC has developed a new definition for functional food.

"FUNCTIONAL FOOD": THE CURRENT DEFINITION-OUR CONCEPT(S)

The FFC, located in Dallas, TX, has been studying functional food since 1998, publishing over 18 books and 2 textbooks. The Academic Society for Functional Foods and Bioactive Compounds (ASFFBC) with more than 2000 participants and 5 volumes of their journal, "Functional Foods in Health and Disease (FFHD)," has hosted 17 international conferences. Their 17th conference was co-hosted by the U.S. Department of Agriculture (USDA) and the Agricultural Research Service (ARS). The FFC is built upon the belief that food can heal particularly when micro- or macronutrients are present in clinically-studied amounts. Via our books, journal articles, and conferences, the FFC and ASFFBC has educated scientists, medical professionals, dietitians, nutritionists, food industry representatives, and students about the interdisciplinary field of functional foods.

The FFC is committed to leading functional food research as well as bringing functional food to mainstream food markets around the world. Between 1998 and 2012, the FFC has hosted conferences, where we attempted to discuss all possible aspects of functional food, including chronic disease management, biomarkers, and bioactive compounds.

In 2012 at the FFC's 10th International Conference in Santa Barbara, CA, we announced a new proposed definition for "functional food": [40]

"Natural or processed foods that contains known or unknown biologically-active compounds; which in defined amounts provide a clinically proven and documented health benefit for the prevention, management, or treatment of chronic disease."

Medical, research, student, and public participants accepted this definition at the conference, which has guided the FFC's research and conversation at our conferences since 2012. Recently, at our 17th international conference in 2014, which was jointly organized by USDA and ARS, we organized a Panel Discussion entitled, "The Definition of Functional Foods and Bioactive Compounds." Here, our new definition for "functional foods" was revised to:

"Natural or processed foods that contains known or unknown biologically-active compounds; which, in defined, effective non-toxic amounts, provide a clinically proven and documented health benefit for the prevention, management, or treatment of chronic disease."

In this latest version of our definition, we added the phrase "***in effective non-toxic amounts"*** to highlight the importance of bioactive compound dosage in the consumption of functional food. Below, we review the meaning and rationale of each part of the definition.

We believe that our current definition of functional food coalesces and improves upon previous definitions in a way that may be used by both experts and non-experts.

In the current definition, we first highlight the fact that functional foods can be *natural* or *processed*. By this, we mean that foods in their pure unchanged or changed forms can be functional. A natural unchanged food has not undergone human interference. A changed food has undergone some chemical modification, whether it be the addition, removal, alteration, or increased bioavailability of a chemical compound within the food1. For example, a natural food may be a pure orange or avocado, while a processed food may be folate-fortified cereal or milk infused with Vitamin C. As for the meaning of *food*, scientists and governing bodies disagree. Japan includes pills and capsules under functional foods while the EU does not. The FFC defines *food* as components of a normal diet for optimized nutrition. This includes conventional foods and not pills or capsules.

Second, functional foods contain *known* or *unknown biologically-active (bioactive) compounds*. *Biologically-active compounds* or secondary metabolites are molecules in food, usually in small amounts, that act synergistically to benefit health. As stated above, the active components of functional foods may be "an essential macronutrient, if it has specific physiological effects, or an essential micronutrient, if its intake is over and above the daily recommendations"3. A micronutrient (e.g. vitamins or minerals) is required and must be ingested in certain trace amounts. A macronutrient (e.g. carbohydrates, proteins, and fats) must be consumed in large amounts as they make up most of human diet [41]. specifically, bioactive compounds may "exert antioxidant, cardio-protective, and chemo-preventive effects," which slow disease development or progression[42, 43]. Bioactive compounds are considered the source of functional food effectiveness, which makes them the central point of this definition.

Bioactive compounds can be categorized as "phenolic compounds, lipids, proteins and peptides, and carbohydrates." The bioactive compounds contain mixtures of "flavonoids, capsaicinoids, lignin, trepenoids, carotenoids, chlorophylls, vitamins, stilbene, phenolic acids, fibers, sterols, lipids, fatty acid, polysaccharides, and some plant-derived proteins and peptides." Finally, humans may need to obtain certain nutrients by ingesting bioactive compounds because

humans cannot synthesize these nutrients naturally, such as chlorophyll from lettuce and linoleic acid from pecans42.

Bioactive compounds *may* or *may not be known*. By this, we mean that researchers may or may not have identified these compounds or discovered these compounds' exact function(s) and/or mechanism(s) within human or animal physiology.

Third, functional foods containing bioactive compounds must be consumed in certain *effective non-toxic* amounts. This fact is paramount to functional foods working therapeutically and not toxically. For example, Vitamin C is a known bioactive compound that should be consumed at 90 mg. in order to maintain normal health. A food containing more than 200-300 mg. of Vitamin C per day may act therapeutically in terms of reducing one's risk of contracting a cold, thereby acting as a functional food. However, there comes a point at which consuming Vitamin C becomes toxic, which is at approximately 2000 mg. or more daily [44]. If a food serving contained 2000 mg. or more of Vitamin C, the food, instead of acting "functionally" or therapeutically would become toxic to the consumer. In other words, functional foods are meant to protect against chronic illness, and therefore, must contain the correct dosage of the bioactive compound in question, neither too little nor too much. Correct dosages of bioactive compounds in a particular functional food depends on the bioactive compound at hand, the illness it is meant to treat, and/or the "food vehicle," or food in which the bioactive compound in contained. For instance, if a bioactive compound is found to prevent type II diabetes and prostate cancer, different amounts of the compound may be required for each. Researchers must consider, in their clinical trials, the effects of the bioactive compound in certain dosages over the long-term, which requires more extensive research and meta-analysis. The "food vehicle" may also affect the amount of bioactive compound needed to exert an effect; some foods are better carriers of bioactive compounds or are better absorbed by the body than others. In light of these observations, determining functional food dosage should be made a priority in research.

Next, functional foods must provide *a clinically proven* and *documented health benefit*. Demonstrating success in clinical studies or tests involving humans are imperative to functional food acceptance among health experts, policy makers, and the public. In order to demonstrate causal relationships between functional foods and the *prevention, management, or treatment of chronic disease*, extensive pre-clinical and clinical trials must be performed. Pre-clinical trials use mice or rats, whose physiologies is similar to humans, to show that specified dosages of bioactive compounds benefit the animals while a placebo does not. After pre-clinical trials, researchers must be successful among human patients. Researchers should conduct epidemiological analyses of the population of interest, identifying patients who are representative of the group. Then, researchers should administer appropriate amounts of the bioactive compound to large samples of patients, preferably over a long period of time. If patients exhibit therapeutic changes related to prevention, management, or treatment of their disease without exhibiting toxic effects, then the food has potential to be labelled as functional.

WHAT MAKES THE FFC DEFINITION UNIQUE?

The current definition of functional food highlights the importance of "bioactive compounds" within functional foods. Bioactive compounds are considered the backbone of functional food

effectiveness. Due to greater chemical and biological technology, food scientists can now separate food substances into fine chemical components and test food extracts for biological behavior. As a result, researchers can draw causal relationships between specific bioactive compounds and health outcomes.

According to Dr. Martirosyan, two important concepts relating to bioactive compounds are: the amount of bioactive compounds and ratio of bioactive compounds to convert an ordinary food into a functional food. Different amounts of bioactive compounds are effective in different situations and sometimes too much of a bioactive compound in a food can be toxic. In general, consuming physiologic levels of bioactive compounds is considered safe. Consuming higher levels of bioactive compounds (e.g. supra-physiological or therapeutic doses) must be tested for safety and health benefits. Therefore, it is crucial to have a thorough discussion on the use and control of bioactive compounds in functional foods. In the 17th International conference report on our website: www.functionalfoodscenter.net, we consider food safety to be of the utmost importance. Functional food safety will be discussed further at our upcoming 18th and 19th International conferences on functional foods. They will be held at Harvard Medical School on September 15-16, 2015 and Kobe University, Japan on November 17-18, 2015 respectively.

For almost 20 years, FFC has collaborated with scientists that have studied the benefits of functional foods. We have been able to tie these benefits to chemical compounds. By making bioactive compounds the focus of the definition, the new definition of functional foods, has provided an explanation for the effectiveness of functional foods' ability to improve health and prevent, manage, and treat illness. The new definition simplifies and explains how functional foods operate at biochemical and empirical levels. This directs food scientists toward specific goals (e.g. identifying a bioactive compound) and indicates directions for future functional food research (e.g. elucidating bioactive compounds in a product and the mechanism by which they produce an effect).

A second feature of our definition is the use of biomarkers, or a class of indicators within the body that give signals of properly or improperly functioning organs or systems. Functional food scientists frequently use biomarkers in their research to determine the rate or effectiveness of a biological process in its natural state as well as after functional food administration. When a bioactive compound is proposed to exhibit certain benefits, changes in biomarker activity confirms or denies these benefits. Biomarkers can manifest in the form of protein, blood sugar, cholesterol, triglyceride levels, or more subtly, the levels of hormone stimulating a particular tissue. Like bioactive compounds, biomarkers are a diverse group of compounds and/or reactions. As each and every bodily process triggers countless biological pathways, reactions, and responses, there are nearly infinite ways to measure the rate or effectiveness of a process.

First, biomarkers can indicate the mechanism by which bioactive compounds prevent or treat illness. Biological pathways are often long and convoluted reactions, so, researchers often must undergo years of research in order to determine details about pathway. Biomarkers are often part of biological pathways. By measuring and analyzing them, researchers can determine reaction mechanisms, particularly the order of each process and the roles that each enzyme, protein, and molecule play. Second, observing biomarkers in a specific process can clarify or confirm the role of a bioactive compound in the body. For instance, scientists may measure biomarkers involved in disparate processes in order to observe how a particular bioactive

compound affects both their activity levels. Examples include: water filtration in the kidneys or production of bile in the liver. Functional food scientists will choose the most efficient, accurate, and easily measured biomarkers in their studies of health and chronic disease development. In summary, with the addition of "bioactive compounds" (and the unstated biomarkers), the new functional food definition is in its most complete form. Previous definitions simply state that functional foods improve health and mitigate disease. However, the current definition provides a cause: activity by bioactive compounds. The definition also implicates the use of biomarkers, an essential means of gauging the effectiveness of functional food in preventing, managing, and treating disease. Below (Figure 1.1) shows the development of the functional food definition from its conception to its latest proposed form.

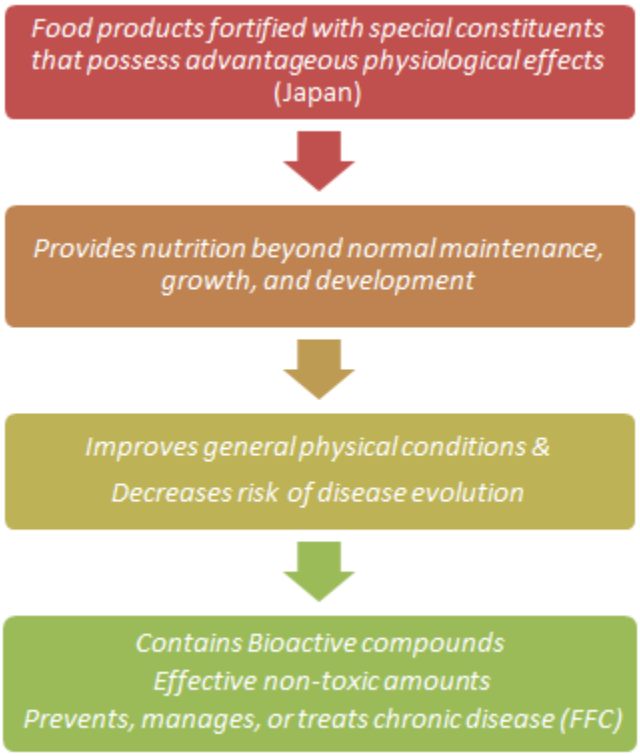

Figure 1.1 Development of "functional food definition"

HOW NEW DEFINITION WILL HELP CREATE NEW FUNCTIONAL FOOD PRODUCTS

Establishing a definitive meaning for functional food not only brings about consensus in scientific and governmental communities. A new improved definition will pave the way for functional foods to be formally and legitimately introduced to food markets.

By 1997, Japan, the United States, and Europe each generated $3 billion in sales with a projected global sale record of $130 billion by 2015 [9, 45, 46]. However, food industrialists make claims based on differing definitions, and so, are not making scientific research, food safety, and health claim legitimacy top priorities.

Functional food scientists would like to revise this process by establishing a new definition for functional food. This will allow food industrialists to base their health claims on supported

research. With support from the scientific and governmental communities, bringing functional foods to markets will help billions suffering from chronic illnesses and general health problems. Below (Figure 1.2) is a cycle of steps that the FFC believes will help bring functional foods to market [47].

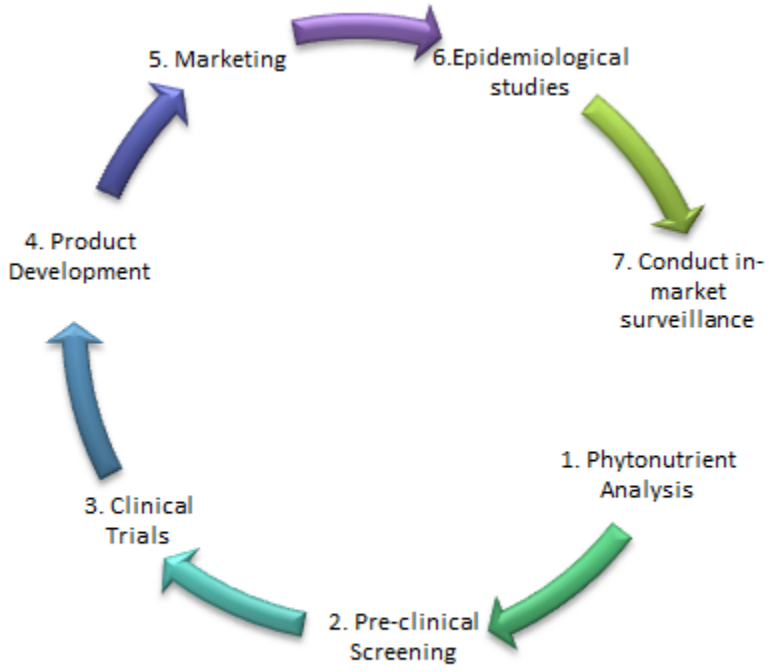

Figure 1.2 Steps for bringing functional foods to markets (FFC)

In Step 1, we examine the link between a particular food and health benefits. In Step 2, we run *in vitro* and *in vivo* studies with non-living and animal specimens respectively. In Step 3, we run human studies. This involves administering human-appropriate dosages of bioactive compounds and testing for adverse side effects. In Step 4, we develop an appropriate food vehicle for our bioactive compounds (e.g. figs, celery, or apple with a special yoghurt coating). In Step 5, we market to the public and educate them about the health benefits of functional food. In Step 6, we run studies on populations in order to test for long-term effects and overall product effectiveness. Finally, in Step 7, we measure public attitudes toward functional food.

CONCLUSIONS:

1. Functional food originated in Japan in the 1980s. Food scientists submitted evidence that their foods had "*advantageous physiological effects*." Approved foods then acquired special FOSHU or Food for Specific Health Uses labels. Subsequent countries and scientific organizations attempted to create their own definitions of functional food. This bred high sales but confusion among the public as to the meaning of functional food.
2. The Functional Food Center (FFC) defines "functional food" as *natural or processed foods that contains known or unknown biologically-active compounds; the foods, in defined, effective, and non-toxic amounts, provide a clinically proven and documented*

health benefit for the prevention, management, or treatment of chronic disease. This definition is unique because of its acknowledgement of "bioactive compounds," or biochemical molecules that improve health through physiological mechanisms. Also, this definition notes that bioactive compounds must be taken in non-toxic amounts because, bioactive compounds have upper limits before they become dangerous.

3. The FFC seeks to standardize the functional food definition in order to legitimize functional food science. We also want to formally bring functional foods to markets, improve international communication, and better population health.

List of Abbreviations: American Dietetic Association, ADA; Agricultural Research Service, ARS; Academic Society for Functional Foods and Bioactive Compounds, ASFFBC; U.S. Food and Drug Administration, FDA; Functional Food Center, FFC; Functional Foods in Health and Disease, FFHD; Foods for Specific Health Uses, FOSHU; Functional Food Science in Europe, FUFOSE**;** Recommended daily allowance, RDA; Reference nutrition intake, RNI; United States Department of Agriculture, USDA

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