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Review Article

Global perspective of health related edible plants from the agricultural point of view

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In knowledge-based economies, nutrition concepts evolve with advances in agriculture. As people around the world become more health conscious, national health becomes one of the main directives for agricultural policies, including that of functional foods and their global markets. This article evaluates the development of the functional food industry in Taiwan and other countries through analysis of R&D capacity and bibliometrics. It attempts to identify future trends in nutrition with technology foresight research. Taiwan has a wide variety of indigenous herbal plants, although its functional food related literature is not large compared with some other Asian countries. However, there are quality papers on the immunologic functions of edible plants Globally there is much interest in edible plants with antioxidant activity and those phyto-nutrients which might help reduce the burden of chronic illness as well as in the nutrigenomics that will lead to the design of foods with these properties. To make the most of available agricultural resources, countries like Taiwan should relate agricultural development to the nutritional status of their populations. This strategy will add significant value to global agriculture

Key Words: edible plants, functional food, global trend, R&D capacity, research front

INTRODUCTION

In knowledge-based economies, nutrition concepts evolve with advances in agricultural technologies and industrial transformation (Fig. 1). In the time of traditional agriculture, crop production aimed to prevent hunger. With the progress in medicine and sanitation as well as the enhancement in the quality of life of populations, science-based agriculture led to plenitude and refinement of foods, while nutritional imbalance became an increasingly prevalent problem. In the 21st century, an great body of evidence points to the close association between diet and chronic illnesses, including cancer, allergy, obesity and diabetes.[1] As people around the world become more health conscious, the maintenance of national health had become one of the main directives for agricultural policies.[3] The focus of nutrition research is also moving towards "preventive medicine", and the study of health related edible plant are gaining momentum.[2]

In the age of globalize competition, the technology-driven strategies employed by industries will be driven by customer demand. Every country has its own distinct dietary patterns and culture, and nutritional demands.[4] Thus, the directions for the R&D of functional food adopted by each country differs. This article evaluates the current development of the health food industry in Taiwan and other countries through R&D capacity analysis and bibliometric analysis, and attempts to identify future trends in nutrition with technology foresight research.

Review of functional food R&D capacities and global directions

Bibliometric analysis has mainly been used to evaluate the output of technological R&D. Nowadays, it is further used in the analysis of the global trends with regard to technological developments, as well as the assessment of the competitiveness of technological R&D strategies during formulation. An analysis of the ISI (Institute for Scientific Information) database shows rapid growth in the publication of functional food related literature between 1997 and 2006. The U.S. produced the highest number of papers, accounting for 40% of global literature on functional food, followed by Japan and the UK. With regard to the topics discussed in the papers, Western countries (U.S., UK, Germany and Netherlands) pay greater attention to research on the circulatory system and cancer prevention. Eastern countries (Japan, Korea, China and Taiwan) on the other hand, focus on gastrointestinal health and anti-aging. Thus it can be surmised that the focus of functional food R&D is associated with the local culinary culture and dietary patterns.

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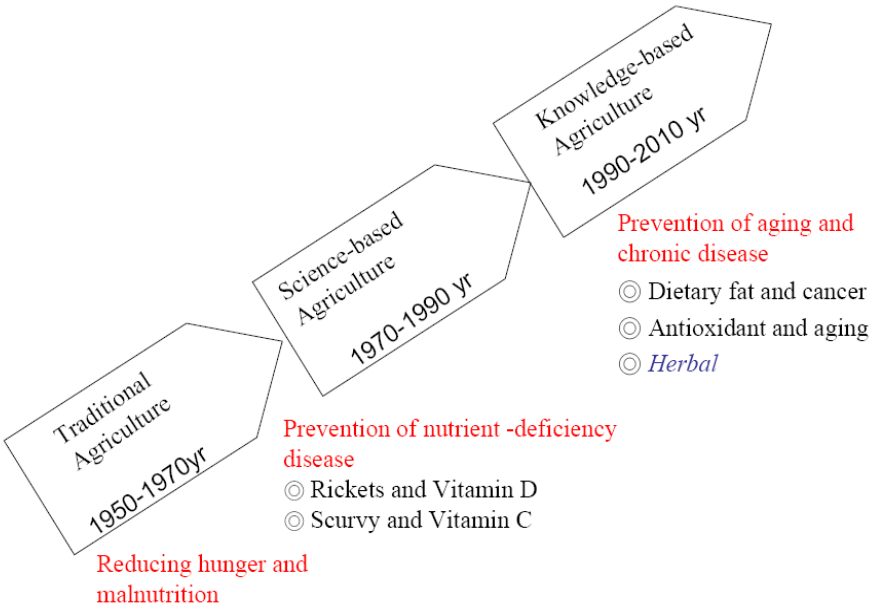

Figure1. Transformation of Nutrition Concepts

Table 1. Top 10 Functional Edible Plants in literature Worldwide, 2001-2007

No	Scientific name	English name	Paper volume
1.	*Glycine max*	Soybean	7095
2.	*Vitis vinifera*	Wine grape	3392
3.	*Salvia officinalis*	Sage	2370
4	*Allium sativum*	Garlic	2035
5.	*Fragaria x ananassa*	Strawberry	2011
6.	*Linum usitatissimum*	Common flax, flax-seed, linseed	1770
7.	*Gracilaria arcuata*	Red seaweed, red alga	1539
8.	*Brassica oleracea*	Purple cabbage	1510
9.	*Ipomoea batatas*	Sweet potato	1303
10.	*Sesamum indicum*	Sesame	1066

Data from Thomson ISI database

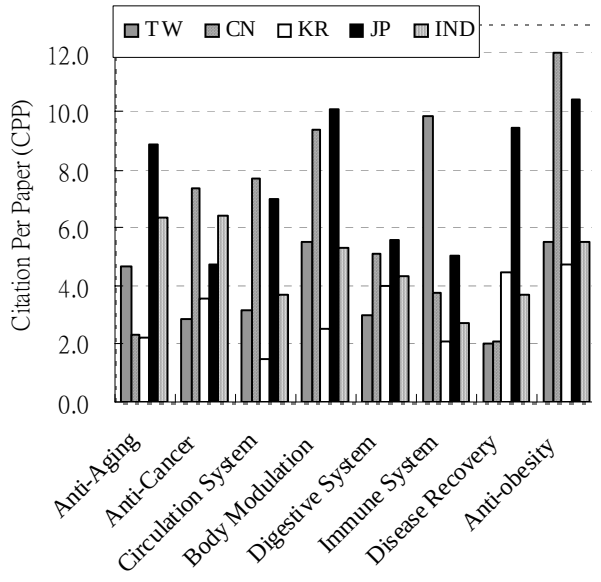

Figure 2. Literature Quality Analysis of Functional Food in Eastern Countries from the ISI database, 2001-2007. (TW: Taiwan, CN: China, KR: Korea, JP: Japan, IND: India)

In the age of knowledge-based agriculture, health related edible plants have become the principal sources of functional food materials.[5] An analysis of global literature finds that rice and soybean are the most studied food. The top 10 most studied health related edible plants worldwide are listed in Table1, of which, wine grape, garlic, strawberry and purple cabbage are found to be associated with immunity or antioxidant activity.[6]

The sheer volume of publication is not indicative of the quality of the papers. Citation per paper is often included in the evaluation of the quality of the papers. Taiwan, as compared to other Eastern countries, does not produce high volumes of papers on functional food, but the citation of its studies on immune system is markedly higher than that of other Eastern countries (Fig. 2), suggesting that immunological research of functional food presents an opportunity in the international market for Taiwan.

With respect to the current status of functional food development in Taiwan, the government (including the National Science Council, Council of Agriculture, Ministry of Economic Affairs, and Department of Health) has been pushing primarily for the R&D of medicinal herbal plants in recent years (Fig. 3). An example of which would be Anoectochilus for liver protection, Hibiscus sabdariffa for lowering blood lipid, and Chinese yam for its anti-cancer and anti-aging properties. As consumers show more interest in foods for health reasons, the health effects of more agricultural products are being studied, discovered, and proven.[7] Taiwan has a wide variety of indigenous plants. If Taiwan is able to grasp the key technology for the extraction of active ingredients,[8] it will give the country a competitive edge in the gloal functional food market.

The future of global functional food development

Technology evolvement is continuous and dynamic. The functional food industry has become an emerging demand-driven industry. If the government can formulate a strategy for the prioritization of R&D programs and

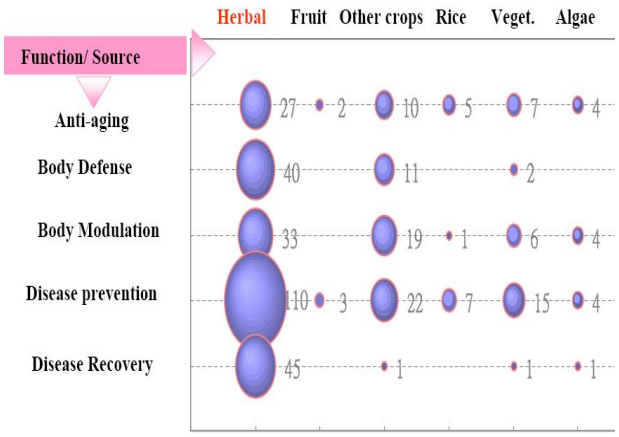

Figure 3. Agricultural resource ratio of functional food in Taiwan

Table2. Nutrition-related Topics in Japan's Technology Foresight Program and accomplished Year.

Nutrition related topics (Japan's 5th ~ 8th technology foresight reports)	Year of realization
Actual application of enzyme to splice specific sites of protein to increase nutritional ingredients.	2005-2009
Actual application of artificial sugar substitute in diet food products.	2007-2011
Design of functional foods based on individual constitution for the prevention of disease.	2011-2015
Development of health food for the enhancment of antioxidant activites and the prevention functional degeneration of the elderly, such as brain activity and mastication.	2012-2014
Development of genetically modified food containing functional ingredients for the prevention of hypercholesteremia, hypertension and hay fever.	2013-2015
Enhancing the positive understanding and awareness of the citizens to genetically modified organisms (GMO).	2009-2015
Reviewing the safety of genetically modified products from pragmatic and environmental aspects and developing evaluation methods and systems comprehensible to consumers.	2011-2025

Data from the NISTEP technology foresight report, 1993-2007 year

allocate resources, it will give the functional food industry in Taiwan a head start in the international market. To attain the benefits of technological resources integration, many countries devote considerable efforts on the development of new methods to keep in line with the latest technological trends,[9] of which, the technology foresight approach can serve as a planning tool for the formulation of technology policies and strategies that guide the initiatives and directions for technological development in the future.[10-11]

The technology foresight programs of Japan, in recent years, indicate the increasing weight of nutrition issues in agriculture research. The major trend of the country's R&D undertakings is to design custom-made functional foods from the perspective of disease prevention. Japan expects to apply and popularize these technological developments around 2010-2015 (Table2). As shown by a trend analysis of Japan's foresight programs, the Japanese believe that health is under the cross influences of: life style, diet, exercise and genetic factors, and diet structure is known to be closely related to diseases, in addition to being the biggest influencing factor in many diseases. Thus, nutrigenomics is expected to make a breakthrough contribution in the "selection and design of the most appropriate individualized diet".[12-13] Other topics, including how health issues enrich the functions of agriculture, food safety and genetically modified organism (GMO) are also of great interest to the Japanese people.

Finally, on the basis of past literature, we develop the methodology to identify the trend of cross-domain knowledge flow and explore the research front in the global agricultural industry using the ESI (Essential Science Indicator) database. We find that nutrition for health accounts for 30% of agricultural topics. We also use co-word analysis to identify the focus and progress of nutrition for health research. This study finds that popular nutrition for health topics, of global interest, are divided into two major directions (Fig. 4), one of which is the extraction of cyaniding, bioflavonoids, resveratrol and other substances present in fruits (e.g. grape and blueberry). Those substances are found to have antioxidant activities 50 times that of vitamin E. The other direction is the development of nutrients in food to reduce the onset of chronic illness. For example, the study of conjugated linoleic acid (CLA), a fatty acid found naturally in meat and dairy food. One study found that conjugated linoleic Acid may help decrease body fat by increasing energy expenditure. Furthermore, DHA-rich diets (include omega-3 fatty acid) may help prevent Alzheimer's disease.[14] A new study on coffee and diabetes has shown that men who drank 6 cups of coffee a day may reduced their chances of developing type-2 diabetes by half, and women who drank the same amount may reduce their risk by 30 percent.[15]

In the age of knowledge-based agriculture, the development of agriculture is no longer for the sole purpose of solving the food shortage problem or addressing malnutrition issues. Its main purpose nowadays is to prevent chronic illness and fight aging. In the move towards internationalization, Taiwan's health food industry can make the most of available agricultural resources, and step up current research to discover new active functional ingredients in order to gain a competitive edge in the world market. Taiwan can also embark on the research regarding diet and nutrition in East Asia (China, Southeast Asian countries and Japan) based on the nutritional status of the Taiwanese population and strategically develop functional foods that are more acceptable in the East Asian markets. As such, brands created targeting East Asian consumers may differentiate from products in the Western markets.

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AUTHOR DISCLOSURES

Yi-Yang Lee, Chih-Sheng Tsou, Hai-Chen Lin, Cheng-Hua Ien and Ya-Tien Wu, no conflicts of interest.

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