
Global Perspective of Health Related Edible Plants from Agricultural Point of View

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Facing knowledge-based economic stage, nutrition concepts evolve with the advancement of agricultural transformation. As people around the world become more health conscious, the maintenance of national health grows into one of the main directives for government's agricultural policies. To explore the niches and opportunities for Taiwan's functional food industry in the global markets, this article evaluates the current development of functional 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 and research front. The result shows that Taiwan has a wide variety of indigenous herbal plants, although Taiwan's publication of functional food related literature is not high in volume as compared to other Eastern countries, the quality of those published papers on the immunologic functions of edible plant is unexcelled by other Eastern countries. In the global functional food development, hot topics of functional edible plant with antioxidant activity and essential nutrients to help reduce the onset of chronic illness as well as the science of nutrigenomics that will lead to the design of functional food for individual constitutions.

Beside make the most of available agricultural resources to discover new functional ingredients, Taiwan can also develop functional foods in East Asia based on the nutritional status of people in Taiwan, and strategically elevate the competition of global market.

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

Introduction

In the advent of knowledge-based economy, nutrition concepts evolve with the advancement of agricultural technologies and industrial transformation (Figure1). In the time of traditional agriculture, crop production aimed to prevent hunger. With the progress in medicine and sanitation as well as the enhancement of quality of life, science-based agriculture led to plenitude and refinement of food, while nutritional imbalance became an increasingly prevalent problem in modern times. In the 21st century, an abundance of evidence points to the close association between diet and chronic illnesses, including cancer, allergy, obesity and diabetes¹. As people around the world become more health conscious, the maintenance of national health grows into one of the main directives for government's agricultural policies³. The focus of nutrition research also moves towards "preventive medicine", and the studies of health related edible plant are gaining momentum².

In the age of globalize competition, the technology push strategy employed by industries will be driven by customer demand. Every country has its own distinct dietary patterns and culture, and nutritional demands⁴. Thus the directions for the R&D of functional food adopted by each country differ. This article evaluates the current development of 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 and research front.

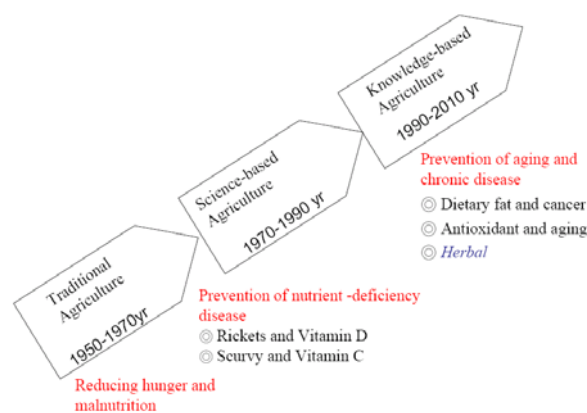


Figure1. Transformation of Nutrition Science Concept

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Review of Functional Food R&D Capacities and Global Directions

Bibliometric analysis used to apply mainly to evaluating the output of technological R&D. Nowadays it is further used in analysing the global trends of technological development and the assessment of competitiveness for the reference of formulating technological R&D strategies. 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 UK. By the topics discussed in the papers, Western countries (U.S., UK, Germany and Netherlands) pay greater attention to the research of circulatory system and cancer prevention. Eastern countries (Japan, Korea, China and Taiwan) on the other hand focus on gastrointestinal health and anti-aging function. Thus it can be surmised that the focus of functional food R&D is associated with the local culinary culture and dietary patterns.

In the age of knowledge-based agriculture, health related edible plants have become the principal sources of functional food material⁵. An analysis of the global literature finds that rice and soybean are the most studied food materials. The top 10 most studied health related edible plants worldwide (Table1), of which, wine grape, garlic, strawberry and purple cabbage are found to be associated with immunity or antioxidant activity⁶.

Table 1. Top 10 Functional Edible Plants Worldwide between 2001-2007

No	Scientific name	English name	Paper volume
1.	<i>Oryza sativa</i>	Rice	24147
2.	<i>Glycine max</i>	Soybean	17095
3.	<i>Arachis hypogaea</i>	Peanut; ground nut	4020
4.	<i>Vitis vinifera</i>	Wine grape	3392
5.	<i>Salvia officinalis</i>	Sage	2370
6.	<i>Allium sativum</i>	Garlic	2035
7.	<i>Fragaria x ananassa</i>	Strawberry	2011
8.	<i>Linum usitatissimum</i>	Common flax, flaxseed, linseed	1770
9.	<i>Gracilaria arcuata</i>	Red seaweed, red alga	1539
10.	<i>Brassica oleracea</i>	Purple cabbage	1510

Data from Thomson ISI database

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

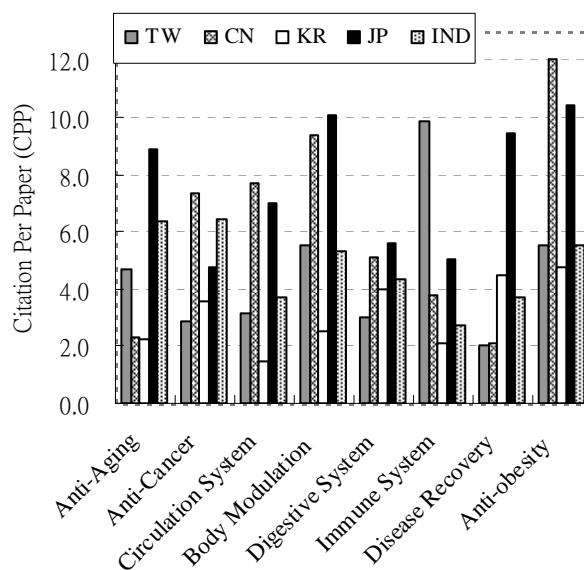


Figure 2. Literature Quality Analysis of Functional Food in the Eastern Countries from ISI database 2001-2007. (TW: Taiwan, CN: China, KR: Korea, JP: Japan, IND: India)

Results With respect to the current status of functional food material 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 (Figure 3), for instance, *Anoectochilus* (liver protection) *Hibiscus sabdariffa* (lowering blood lipid), and Chinese yam (anti-cancer, anti-aging). As consumers show more interest in food for health, the health effects of more agricultural products are being studied, discovered, and proven⁷. Taiwan has a wide variety of indigenous plants. If Taiwan is able to grasp the key technology for the extraction of active ingredients⁸, it will give the country a competitive edge in the global functional food markets.

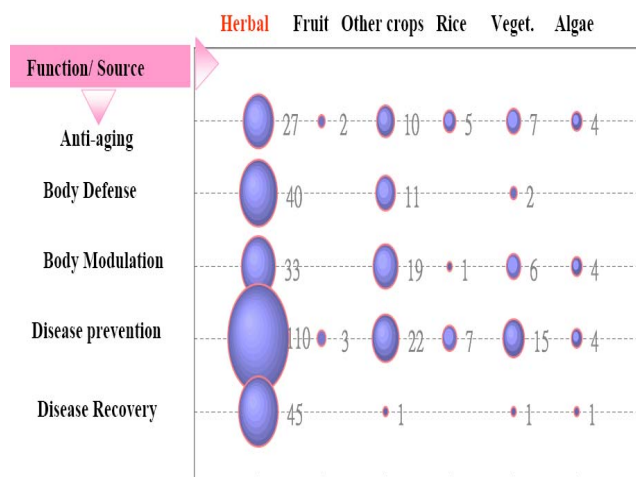


Figure 3. Agricultural products resource ratio of functional food in Taiwan

The Future of Global Functional Food Development

Technology evolution is continuous and dynamic. The functional food industry has become an emerging demand-driven industry. If the government can formulate a strategy of prioritizing R&D programs and develop niche research resources, it will help the functional food industry make a head start in the international markets. 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 trends⁹, 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 future¹⁰⁻¹¹.

The technology foresight programs of Japan in recent years show increasing weight of nutrition for health issues in agriculture research. The major trend of the country's R&D undertakings is to design custom-made functional food from the perspective of nutrition for 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, also the biggest influencing factor in diseases. Thus nutrigenomics is expected to make breakthrough contribution to 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.

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

Nutrition related topics (Japan's 5 th ~ 8 th 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.	2007-2011
Design of functional foods based on individual constitution for prevention of disease.	2011-2015
Development of health food from the standpoint of nutrition for enhancing antioxidant activities and preventing functional degeneration of the elderly, such as brain activity and mastication.	2012-2014
Development of genetically modified food containing functional ingredients for preventing hypercholesterolemia, hypertension and hay fever.	2013-2015
Enhancing the positive understanding and awareness of the citizens to genetically modified organism (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 NISTEP technology foresight report, 1993-2007year

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 agriculture topics. We also use co-word analysis to identify the focus and progress of nutrition for health research. This study finds that hot nutrition for health topics of global interest converge in two major directions (Figure 4), one 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 activity 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, conjugated linoleic acid (CLA) is a fatty acid found naturally in meat and dairy food. One study found that conjugated linoleic acid may help burn and lose fat by increasing energy expenditure. Furthermore, DHA-rich diet (include omega-3 fatty acid) may help prevent Alzheimer's disease¹⁴. On the other hand, a new study of coffee and diabetes has shown that men who drank 6 cups of coffee a day reduced their chances of developing type-2 diabetes by half, and women who drank the same amount cut their risk by 30 percent¹⁵.

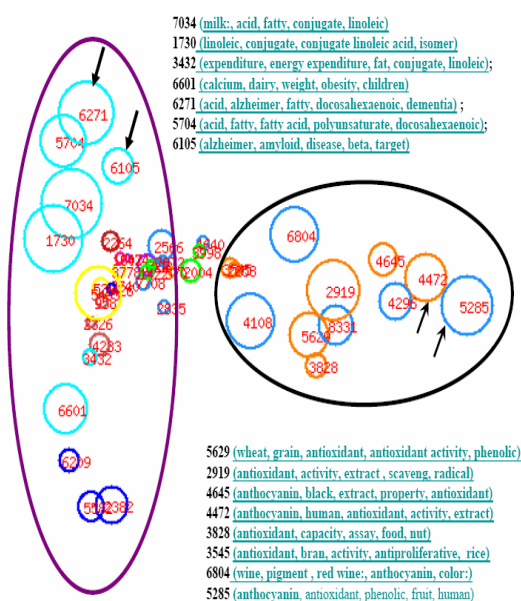


Figure 4. Research front Analysis of Nutrition for Health Topics in Agriculture Research.

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 the malnutrition issue. 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 the research to discover new active functional ingredients to gain a competitive edge. Taiwan can also embark on the research of diet and nutrition in East Asia (China, Southeast Asian countries and Japan) based on the nutritional status of people in Taiwan and strategically develop dietary and nutritional types of functional foods more readily 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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