Original Article

Vegetable, fruit, and phytonutrient consumption patterns in Taiwan

Wen-Harn Pan [a],[*], Nai-Hua Yeh [a], Ray-Yu Yang [b], Wei-Hsuan Lin [a],[c], Wan-Chen Wu [b], Wen-Ting Yeh [a], Mi-Kyung Sung [d], Haeng-Shin Lee [e], Sue-Joan Chang [f], Ching-Jang Huang [g], Bi-Fong Lin [g], Meng-Tsan Chiang [c]

[a] *Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan*
[b] *Nutrition, The World Vegetable Center, Tainan, Taiwan*
[c] *Department of Food Science, National Taiwan Ocean University, Keelung, Taiwan*
[d] *Department of Food and Nutrition, Sookmyung Women's University, Seoul, South Korea*
[e] *Department of Health Industry and Policy, Korea Health Industry Development Institute, Chungcheongbuk-do, South Korea*
[f] *Department of Life Sciences, National Cheng Kung University, Tainan, Taiwan*
[g] *Department of Biochemical Science and Technology, National Taiwan University, Taipei, Taiwan*

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ABSTRACT

Phytonutrients may play important roles in human health and yet only recently a few studies have described phytonutrient consumption patterns, using data obtained from daily consumption methods. We aimed to estimate the phytonutrient content in Taiwanese diets and analyzed main food sources of 10 major phytonutrients. In this study, food items and dietary data gathered with the 24-hour dietary recall from 2908 participants in the 2005–2008 Nutrition and Health Survey in Taiwan were used to create a food phytonutrient database with 933 plant-based foods through integrating database, literature search, and chemical analysis and to appraise phytonutrient consumption status of participants. SUDAAN (Survey Data Analysis) was used for generating weighted phytonutrient intake estimates and for statistical testing. In Taiwanese adults, ~20% met the recommended number of servings for fruits and 30% met that for vegetables from the Taiwan Food-Guide recommendations. However, only 7.4% consumed the recommended numbers for both fruits and vegetables. Those meeting the recommendations tended to be older and with more females compared with those who did not. Phytonutrient intake levels were higher in meeters than nonmeeters. More than 60% of α-carotene, lycopene, hesperetin, epigallocatechin 3-gallate, and isoflavones came from a single phytonutrient-specific food source. In addition, sweet potato leaf, spinach, and water spinach were among the top three sources of multiple phytonutrients. Cross-comparison between this study and two previous studies with similar methodology showed higher mean levels of lycopene and quercetin in

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* *Corresponding author.* Institute of Biomedical Sciences, Academia Sinica, Number 128, Section 2, Academia Road, Nankang, Taipei 11529, Taiwan.
E-mail address: pan@ibms.sinica.edu.tw (W.-H. Pan).

the United States, anthocyanidins in Korea, and lutein and zeaxanthin in Taiwan. The Taiwanese phytonutrient pattern is different from that of the Korean and American. It would be interesting to relate phytonutrient patterns to health profiles in the future.

1. Introduction

Encouraging increase in vegetable and fruit consumption is among the top ranking health promotion policies. Vegetables and fruits contain a large number of phytonutrients in addition to their rich contents of vitamins, minerals, and dietary fiber. A large body of research has demonstrated that increased intake of fruits and vegetables lowers the risk of noncommunicable diseases such as cardiovascular disease, stroke, and cancer [1—3].

Among a large numbers of phytonutrients; carotenoids (α-carotene, β-carotene, β-cryptoxanthin, lutein/zeaxanthin, lycopene), flavonoids (anthocyanidins, epigallocatechin 3-gallate, hesperetin, quercetin), and isoflavones are more extensively studied and profiled for plant foods. Laboratory studies showed that almost all phytonutrients have anti-oxidative and anti-inflammatory effects. Their functions also include immune function modulation [4], hormonal regulation [5], antibacterial and antiviral effects [6,7], signal transduction [8], and nerve conduction [9]. Epidemiologic evidences point to their potential roles in reducing risk of various chronic diseases. For example, low blood concentrations of carotenoids have been associated with cardiovascular disease and cancer [10,11]; lutein and zeaxanthin with bone health [12], polyarthritis [13] and age related muscular degenerative diseases [14—16]; lycopene with prostate cancer [17,18]. Anthocyanidins and epigallocatechin 3-gallate (EGCG) has been associated with cognitive impairment [19,20], Alzheimer's disease [21], and lung cancer [22]. Greater intake of hesperetin has been associated with decreased incidence of cerebrovascular disease and asthma [23]. Providing quercetin has helped reduce low density lipoprotein (LDL)-cholesterol and blood pressure levels [24] and prevent bone loss [5]. Isoflavones have estrogen-like and antioxidant effects, which have been associated with reduced risk of lung cancer [25,26] and breast cancer.

Vegetables, fruits, and some other plant foods are major food sources of phytonutrients. These phytonutrients contributing to the different colors of various vegetables and fruits are often grouped into five-colored groups such as: green, red, white, purple/blue, and yellow/orange. According to the Taiwan Food-Guide recommendations, people are advised to consume three to five servings of vegetables and two to four servings of fruit per day depending on their total caloric intake levels from 1200 Kcal to 2700 Kcal. Although general understanding is that intake of vegetables and fruits often fall short of the Food-Guide recommendations, data is lacking on phytonutrient intakes in Taiwan as well as in many parts of the world at the present time. Therefore, we used data from the 2005—2008 Nutrition and Health Survey in Taiwan to estimate the proportion of people with lower than Food-Guide recommendations for vegetables and fruits and intake levels of the 10 above-mentioned phytonutrients and to rank the main food sources of each phytonutrient. Finally, a comparison of phytonutrient intake patterns was made between estimates of Taiwanese and those previously reported for Korea [27] and for the United States (US) [28].

2. Methods

2.1. Nutrition and health survey in Taiwan 2005—2008

Dietary data for this study was taken from the Nutrition and Health Survey in Taiwan (NAHSIT) 2005—2008 for which the first author is the principle investigator. The survey adopted a multi-staged sampling scheme. The 358 counties and city districts in Taiwan were divided into five strata based on geographical location. In each stratum, probability—proportional-to-size method was used to select townships or city districts. Within each township or district, cluster sampling in two locations was carried out to generate sample lists. Information on socio-demographics, lifestyle, 24-hour dietary recall, and health-related questionnaires were gathered within households along with health examination in the temporarily established clinics. The survey details have been published elsewhere [29]. The Institutional Review Board from Academia Sinica, Taipei, Taiwan approved the study protocol, informed consent forms, and the questionnaires and every participant provided signed informed consent. We specifically analyzed the 24-hour dietary recall data from 2908 participants aged 19 years and older who had completed the dietary assessment.

2.2. Dietary data collected by 24-hour recall

Interviewers collected information through face-to-face interviews regarding foods consumed by participants in the past 24 hours. Interviewers used specifically designed food-piece models (for dishes containing chopped, sliced, or shredded foods), multiple hollow hemisphere models (for round-shaped foods) for Taiwanese, and other standard cooking measures to assist participants in providing information regarding the quantity of foods consumed [30]. Mixed dishes, e.g., the stir-fries were composed by interviewees with food piece models which were then disaggregated and weighed separately. The real weights of foods were estimated from the food model data using established polynomial equations between model measures and real food weights as described elsewhere [30]. The Nutrient Composition Database for Foods in Taiwan was used to estimate participants' calorie and nutrient intakes.