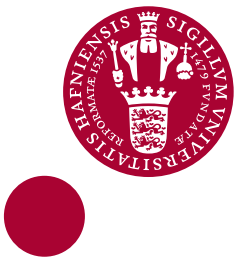

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DIVERSITY, KNOWLEDGE AND USE OF LEAFY VEGETABLES IN NORTHERN THAILAND—MAINTENANCE AND TRANSMISSION OF ETHNOBOTANICAL KNOWLEDGE DURING URBANISATION

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ABSTRACT

More than half of the world's population is now living in urban areas, yet little is known on the transmission of traditional plant knowledge during urbanisation. This study assesses the diversity of leafy vegetables in urban markets and the current level of knowledge and use in Chiang Mai Province, Thailand. The leafy vegetables collected from fresh food markets included 55 species, six of them with a total of 13 cultivars, belonging to 32 families. Structured interviews were made with 49 vegetable sellers. Semi-structured interviews were made with three Thai medicine practitioners and 100 residents of Chiang Mai city. The residents participated in a knowledge test using photographs of six species widely used in dishes and six species specific to traditional homemade dishes. The diversity of leafy vegetables in urban areas of Chiang Mai Province has remained the same in the past decade. Leafy vegetable knowledge and use was mainly maintained and transmitted by middle-aged and older residents. Knowledge and use of leafy vegetables was determined by age and level of education; gender, income and ownership of agricultural land were unrelated. The availability and use of exotic leafy vegetables in markets and dishes was prominent and the knowledge on exotic leafy vegetables was well-integrated in the local knowledge. Leafy vegetables were considered as healthy, quick to prepare and a praised source of food and medicine. However, differences in knowledge between younger and older generations could indicate some knowledge loss about leafy vegetables.

Keywords: acculturation, edible plants, ethnobotany, food plants, knowledge loss, local ethnobotanical knowledge (LEK), medicinal plants, traditional ecological knowledge (TEK)

INTRODUCTION

"Sweet taste brings disease, bitter taste brings health"
—Thai folklore

More than half of the global population is now living in urban areas (UNITED NATIONS, 2014), yet little is known about the transmission of traditional knowledge during urbanisation. Urbanisation is typically linked to other changes such as shifts towards more sedentary lifestyle and processed foods (HAWKES, 2006) which are drivers for obesity, diabetes and cardiovascular diseases (CHOPRA *ET AL.*, 2002; LIM *ET AL.*, 2009). In Asia traditional diets are

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changing to contain higher amounts of wheat, fat and meat. Dairy and temperate fruit and vegetable consumption are growing (KOSULWAT, 2002; PINGALI, 2007). In Thailand, fast food is replacing homemade meals (KOSULWAT, 2002) and vitamin and mineral deficiencies have been reported in spite of economic growth (MATSUDA-INOGUCHI *ET AL.*, 2000; JOHNSON *ET AL.*, 2008). Consumption of leafy vegetables can be a cost-effective way to improve nutrition among low income groups (BARMINAS *ET AL.*, 1998) and lower the risk of many diet related diseases (JOHNSON *ET AL.,* 2008) as they contain high amounts of antioxidants, retinol, beta-carotene and other micronutrients (SUNGPUAG *ET AL.*, 1999; THALANG *ET AL.*, 2001). In addition, many studies have reported the medicinal properties of wild food plants (OGLE *ET AL.*, 2003; CRUZ-GARCIA & PRICE, 2011; MAROYI, 2011; TURREIRA-GARCÍA *ET AL.*, 2015). While urban fresh food markets do provide a wide variety of leafy vegetables, there is a discrepancy between the variety of vegetables available in markets compared to the diversity and amount included in people's daily diet (AWOBAJO *ET AL.*, 2010), and it is assumed that knowledge loss may lead to under utilisation of valuable species.

Several studies have documented the knowledge and use of wild and semi-wild leafy vegetables with a focus on rural areas around the world (DOGAN *ET AL.*, 2004; JANSEN VAN RENSBURG *ET AL.*, 2007; ACHIGAN-DAKO *ET AL.*, 2011; KIDANE *ET AL.*, 2014; POWELL *ET AL.*, 2014; AHMAD & PIERONI, 2016; AMBROSIO & PURI, 2016). Less attention has been paid to leafy vegetables found and used in urban areas with a few exceptions (e.g. KIMIYWE *ET AL.* [2007] and AYODELE [2005]).

This pattern is also found in Thailand where most ethnobotanical research has focused on rural areas and has documented the knowledge, use and availability of wild foods and medicinal plants (ANDERSON, 1993; WESTER, 1997; SOMNASANC *ET AL.*, 2000; SETALAPHRUK & PRICE, 2007; SRITHI *ET AL.*, 2009; CRUZ-GARCIA & PRICE, 2011). For example, ANDERSON (1993) recorded more than 1,000 plant species used by the hill tribes of northern Thailand. In one of the few urban ethnobotanical studies available, JACQUAT (1990) described 241 species from the markets of Thailand including ornamentals, algae, mushrooms, palms and bamboos. The rich diversity of plant species in fresh food markets reflects the bio-cultural diversity of Thailand. The majority of the studies point to the loss of plant knowledge among younger generations. Similar concerns have been reported from other parts of the world (SIGNORINI *ET AL.*, 2009; AKBAR *ET AL.*, 2011; DWEBA & MEARNS, 2011; CHEN & QIU, 2012). Loss of knowledge is often linked to many of the same processes characterising urbanisation, such as changes in lifestyle and dietary preferences. However, little is known about changes in knowledge and use of plants amongst urban residents.

This study aims to help fill the knowledge gap regarding plant use and knowledge in urban areas. The focus is on knowledge and use of leafy vegetables available at markets in the city of Chiang Mai, northern Thailand. We 1) document the number of leafy vegetables found in urban markets and their edible and medicinal uses; 2) identify socio-economic factors that determine knowledge and use of leafy vegetables; 3) investigate changes in how use and knowledge is transmitted; and 4) explore people's perception of leafy vegetables. Perceptions include social status associated with consumption of leafy vegetables, barriers to use and perceived health benefits and risks associated with their use.

We hypothesise that knowledge and use of leafy vegetables will be determined by wealth, land ownership, gender, education, ethnicity and age. Both income and land ownership are often used as indicators of wealth that have been related to people's use, reliance and knowl-

edge on environmental resources (e.g. Reyes-García *et al.*, 2006). We expected that people who owned land and had the opportunity to grow their own vegetables would know more. Higher income and education is often related to less reliance on natural resources (Ohmagari & Berkes, 1997). In addition, ethnicity and cultural values have been shown to play a role in urban areas (Kimiywe *et al.*, 2007). Evidence on the effect of gender is mixed as women are often expected to have better practical skills than men identifying edible plants linked to gendered division of household labor, but this is not always the case (Ghorbani *et al.*, 2012; Turreira-García *et al.*, 2015). Several studies have shown that higher age is usually related to greater knowledge of natural resources (Zarger & Stepp, 2004; Reyes-García *et al.*, 2006; Araújo & Lopes, 2011), including edible plants (Turreira-García *et al.*, 2015).

METHODS

Thailand has a population of 67 million of which 50% live in cities (World Population Review, 2017). The field study took place in Chiang Mai city (= Mueang Chiang Mai District) and Mae Rim District which both are in Chiang Mai Province, northern Thailand. Chiang Mai city, the largest city in northern Thailand, is influenced by hill-tribe peoples and is known for the variety of leafy vegetables in fresh food markets. Both tropical and temperate leafy vegetables are produced around Chiang Mai city.

Data collection took place from September to December 2012 and included collection and identification of leafy vegetables in six fresh food markets (Fig. 1), interviews with vegetable stall keepers (n = 49), Thai traditional medicine practitioners (n = 3) and residents of Chiang Mai city (n = 100). Leafy vegetables were defined as plants having edible leaves or leaves used in the cooking process.

Interviews at Local Markets and Specimen Collections

Six fresh food markets were surveyed, five of them located within Chiang Mai city and one in Mae Rim District 10 km outside Chiang Mai city. The biggest vegetable markets were selected to provide a high variety of raw leafy vegetables and number of sellers. In the largest market (Mueang Mai) almost all permanent stalls were visited. Vegetable stalls in other markets were included if they sold vegetable species that were not collected before. The completeness of the inventory was evaluated using a species accumulation curve. After the 47th stall, no new species were found. In total, 49 vegetables stalls were examined.

Stall keepers were interviewed using a structured questionnaire, and leafy vegetables new to the study were collected. The structured questionnaire included the local plant name(s), origin, habitat, growth habit, plant parts used, preparation, medicinal qualities, other uses and price.

Specimens of collected leafy vegetables were identified by J. F. Maxwell at the herbarium of Department of Biology, Faculty of Science, Chiang Mai University (CMUB). *Flora of Thailand* (Forest Herbarium, Royal Forest Department, 1984), CMUB herbarium list, species in generic order (Maxwell, 2011) and the book *Plants from the Markets of Thailand* (Jacquat, 1990) were used for identification and determination of origin as native or exotic. The specimens were deposited at the University of Copenhagen (KU).

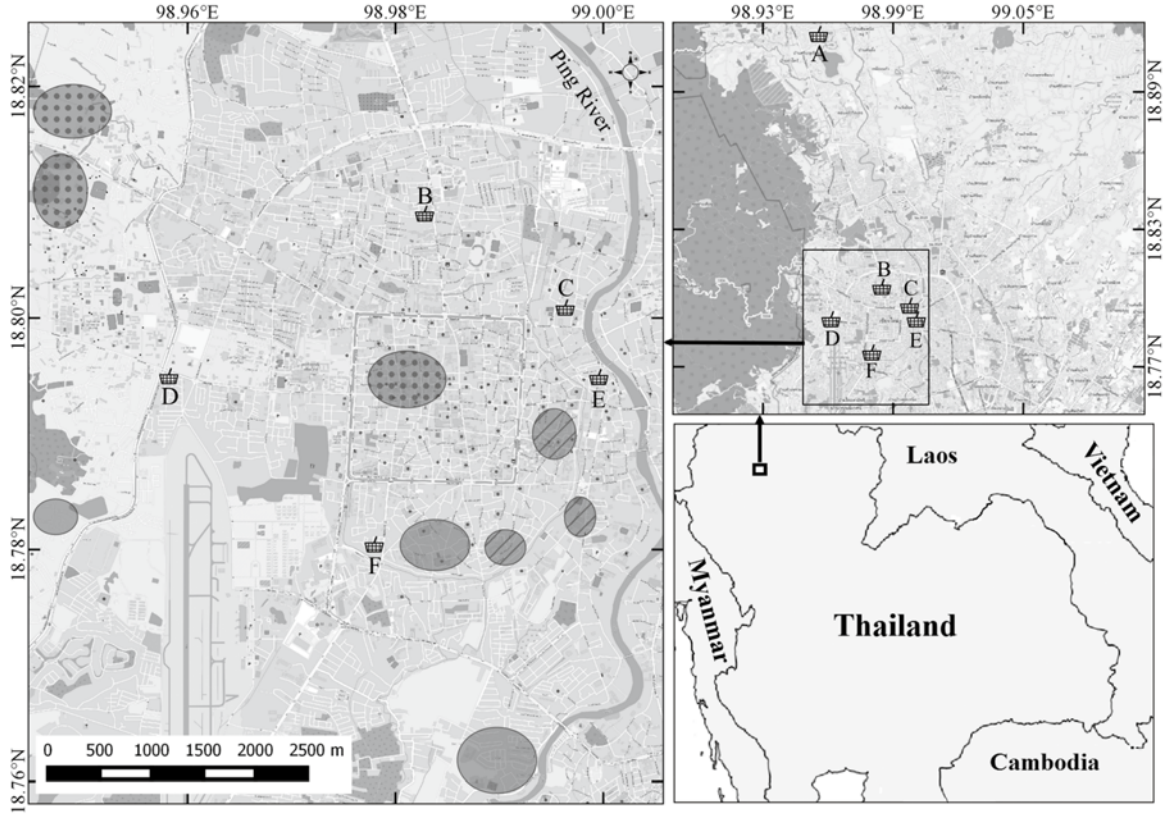

Figure 1. Maps showing locations of rich (dotted gray ellipses), medium (lined gray ellipses), and poor (plain gray ellipses) neighborhoods visited in Chiang Mai city (left map) and markets surveyed (🧺) within Chiang Mai Province, northern Thailand (A, Mae Rim; B, Siri Watana; C, Mueang Mai; D, Suthep [Ton Phayom]; E, Warorot; F, Thipnet [Thipphanet]).

Key Informant Interviews

Food and health are intimately linked in traditional Thai cuisine. Thus, three Thai traditional medicine practitioners were interviewed to obtain in-depth knowledge about the medicinal uses of the leafy vegetables. The medicinal uses were considered to explore the additional benefits that the consumption of leafy vegetables can provide. The key informants were shown photographs of leafy vegetables collected in the fresh food markets and were asked to select the plants they knew; then their knowledge on medicinal uses of those plants was recorded. Literature providing a categorization of the uses of leafy vegetables is lacking. Hence an emic food classification was developed according to the answers received (Table 1).

The medicinal qualities were categorized using the disease classification in HEINRICH *ET AL.* (1998) (Table 2). This classification is widely used in ethnobotanical studies and compared well to the emic disease classifications by the three key-informants. Finally, the key informants were asked whether they perceived a change in diet in Northern Thailand.

Table 1. Emic food categories of plant uses in the study.

Category of use	Specifications	Acronym
Main dish	Plants are eaten fresh, boiled, fried, curried, pickled or in salad	(M)
Seasoning/flavouring/ food colouring	Plants are used to give flavour or colour to food	(S)
Dessert/sweetener	Plants are used to give flavour or sweetness to desserts and drinks	(D)
Juice/shake	Plants are juiced or blended with water into drinks	(J)
Tea	Dry plants are boiled in water to make infusions	(T)
Container/wrap	Plants are used to wrap sweet or salty foods	(C)
Beauty-spa product	Plants are used to make cosmetic or spa products	(B)
Pesticide/insecticide	Plant are used to make pesticides or insecticides	(P)
Animal food or veterinary medicine	Plants are given to animals as fodder or as medicine	(A)
Ornamental/decoration	Plants are used as pot plants or as decorative objects	(O)
Utensil	Plants are made into toys or cooking equipment	(U)

Table 2. Categories of the medicinal qualities (Heinrich *et al.*, 1998).

Medicinal quality category	Acronym
Gastrointestinal	(GAS)
Dermatological	(DER)
Respiratory	(RES)
Gynaecological/andrological	(GYN)
Culture bound syndromes	(CUL)
Pain/febrile diseases	(PAI)
Fever (incl. malaria)	(FEV)
Skeleton-muscular	(SKE)
Ophthalmological	(OPH)
Urological	(URO)
Poisonous animal bites	(POI)
Cardiovascular	(CAR)
Other (detoxification, cancer, diabetes, releases saliva or mucus, creates appetite, tonic)	(OTH)

Household Interviews

A stratified random sampling was used to sample households in different neighborhoods of Chiang Mai city according to wealth, i.e., rich, medium and poor (Fig. 1). The wealth of the neighborhoods was determined by house types: cement houses with fences were considered rich, modest cement houses as medium, and wooden houses were considered poor. A total of three rich, three medium, and three poor neighborhoods were visited. Within each neighborhood, every other household was visited along randomly selected streets. If nobody was at home, the next house on the same side of the street was selected, and the person from the

household who agreed to participate was interviewed. A total of 100 household interviews were conducted with residents. The interview consisted of four parts. Firstly, demographic data were collected. Secondly, a knowledge test was conducted using photographs of six species commonly found in dishes available at Chiang Mai city's food stalls and six species specific to homemade traditional dishes (Table 3). The six species widely used in street food were used as a proxy for general knowledge on leafy vegetables, while the six species specific to homemade traditional dishes were used as a proxy for traditional knowledge. The species were selected with the help of the translator, a local Thai who at the time was an M.Sc. student in Botany at Chiang Mai University. Respondents were asked if they knew the name of the plant, growth habit, plant part(s) used, preparation, medicinal qualities, last time of consumption and taste. Thirdly, respondents were asked how they learned about the leafy vegetable, and finally, about their perception of leafy vegetables, frequency of use, place purchased, and changes in their consumption of leafy vegetables over the last ten years.

Table 3. Species used in the knowledge test. Species were classified as widely used in dishes sold at the market or specific to homemade traditional dishes.

Scientific name	Family	Origin
Widely used in dishes sold at market		
Acacia pennata subsp. *insuavis* (Lace) I. C. Nielsen	Fabaceae	Native
Coriandrum sativum L.	Apiaceae	Exotic
Eleutherococcus trifoliatus (L.) Hu	Araliaceae	Exotic
Houttuynia cordata Thunb.	Saururaceae	Native
Mangifera indica L.	Anacardiaceae	Exotic
Tamarindus indica L.	Caesalpiniaceae	Exotic
Specific to homemade traditional dishes		
Azadirachta indica A. Juss.	Meliaceae	Native
Diplazium esculentum (Retz.) Sw	Athyriaceae	Native
Marsilea crenata Presl	Marsileaceae	Native
Neptunia oleracea Lour.	Fabaceae	Native
Polyscias fruticosa (L.) Harms.	Araliaceae	Exotic
Spilanthes paniculata Wall. ex DC.	Asteraceae	Native

Data Analysis

The results of the knowledge test were analysed with the Kruskal-Wallis test as well as with the Mann-Whitney U test using SPSS 21.0.0 to test if income, gender, land ownership, education or age affected knowledge of leafy vegetables. As most (97%) of the respondents belonged to the Thai ethnic groups, it was not possible to test the relation of ethnicity with knowledge. The respondents were grouped according to age, income level, education, gender, and whether their household owned agricultural land or not. Each individual obtained a knowledge score based on the answers in the plant recognition test. One point was given for each valid answer regarding the following five areas: recognition as edible, knowledge of use

in dishes, knowledge of preparation, recognised as medicinal and knowledge on medicinal use. Thus, each individual could obtain a maximum of 60 points (5 points per species, $n = 12$ species). The answers were validated with the information provided by vegetable sellers and Thai traditional medicine practitioners, and the books by ANDERSON (1993), JACQUAT (1990) and THIANGBURANATHAM (2005).

RESULTS

Market Supply

The leafy vegetables collected from fresh food markets included 55 species, six of them with a total of 13 cultivars, belonging to 32 families (Table 4). The largest number of species and cultivars belonged to Apiaceae (five species, each with three cultivars), and Brassicaceae (three species, each with two cultivars). Cultivars were considered as separate taxa in the calculations below.

Seven categories were used to classify the growth habits of the species; these were listed by the vegetable sellers and later confirmed by J. F. Maxwell. The majority of the species were terrestrial herbs (60%), followed by trees (13%), vines (9.5%), climbers (6%), aquatic herbs (5%), shrubs (5%) and aquatic or terrestrial herbs (1.5%). A total of 41% of all species grew in homegardens, 22% in fields, 13% in homegardens and fields, 8% in wetlands, 5% in homegardens and forests, 5% in forests, 3% in homegardens and disturbed areas, and 3% only in disturbed areas. According to the vegetable sellers, some species were difficult to get, mostly due to seasonal availability or high prices.

The vegetable sellers identified the plant parts used for each species. These identifications were confirmed by the key informants, i.e., the Thai traditional medicine practitioners, who added some additional useful plant parts. The leaves were used in all of the plants, as this was the selection criteria. In 19% of the plants only the leaves were consumed. In the rest, other parts of the plants were also consumed i.e., stems and young shoots (51%), fruits (8%), flowers or inflorescences (5%), flowers and seeds (5%), seeds (4%), stems and roots (3), bark or wood (3%) and pods (2%). Native leafy vegetables accounted for 45% of the species while 55% were exotic species (determined by J. F. Maxwell) based on *Flora of Thailand*.

According to the vegetable sellers, 76% of the plants were available throughout the year and 24% were available only during certain times of the year, either during the warm-rainy season (May–October) and/or cool-dry season (November–February). A few respondents mentioned that many seasonal vegetables had become available throughout the year thanks to modern agriculture. An example of a native and only seasonally available plant was the *Acacia pennata* subsp. *insuavis*. Some species, such as *Anethum graveolens* and *Coriandrum sativum* might be available throughout the year but the price increases during the rainy season. Species native to Europe were also available in the fresh food markets such as *Apium graveolens* L. cultivar group Leaf Celery, *Mentha* ×*cordifolia* and *Brassica oleracea* (Chinese Kale).

Multiple Uses of Leafy Vegetables

Most leafy vegetables had multiple uses. For example, a species may be used as seasoning as well as medicine and as an ornamental. Based on the reports of the vegetable sellers, the three key informants and the respondents of Chiang Mai city, the most common use of

Table 4. List of leafy vegetables collected from the fresh food markets in Chiang Mai city and Mae Rim District, Chiang Mai Province.

Family name	Scientific name	Thai / local name	Habit Annual / Perennial	Habitat	Plant parts used	Native (N)/ Exotic (E) According to Floras Local perception in bracket	Food uses†	Medicinal uses‡	Other uses	No. uses by no. informants and literature (L) §
Alliaceae (Liliaceae)	*Allium fistulosum* L.	Kra thiam yi pun	Herb Perennial	Fields	Young shoots, leaves, stems	Exotic (E)	M	Unknown		1 use 1 informant NL
Alliaceae (Liliaceae)	*Allium sativum* L.	Hua chu	Herb Annual	Fields	Leaves, stems, roots	Exotic (N)	M	CAR		2 uses 1 informant 2 uses (L)
Alliaceae (Liliaceae)	*Allium tuberosum* Rottler *ex* Sprengel	Kui chai, Hom baen	Herb Perennial	Homegardens	Inflorescences, leaves, stems, seeds	Exotic (E)	M, S, D	GAS, GYN, URO		9 uses 4 informants 19 uses (L)
Amaranthaceae	*Amaranthus viridis* L.	Phak khom	Herb Annual	Fields	Young shoots, leaves, stems	Native (N)	M	GAS, GYN, OTH		5 uses 3 informants NL
Anacardiaceae	*Mangifera indica* L.	Mamuang	Tree	Homegardens	Young shoots, leaves, fruits, wood	Exotic (N)	M, D	OTH, RES, CAR,	U	7 uses 4 informants 34 uses (L)
Anacardiaceae	*Schinus terebinthifolius* Raddi	Phak sa u	Tree	Homegardens	Leaves	Exotic (E)	M	Unknown		3 uses 1 informant NL
Apiaceae (Umbelliferae)	*Anethum graveolens* L.	Phak chi lao	Herb Annual	Fields	Young shoots, leaves, stems	Exotic (E)	M, S	GAS, RES		6 uses 3 informants NL
Apiaceae (Umbelliferae)	*Apium graveolens* L. cultivar Celeriac	Ton som	Herb Biennial	Upland fields	Leaves, stems, roots	Exotic (N)	M	CAR		3 uses 1 informant NL
Apiaceae (Umbelliferae)	*Apium graveolens* L. cultivar Celery 1	Khuen chai/ Kam beun	Herb Biennial	Fields	Young shoots, leaves, stems	Exotic (E)	M, S	Unknown		2 uses 2 informants 10 uses (L)
Apiaceae (Umbelliferae)	*Apium graveolens* L. cultivar Celery 2	Jing ju chai	Herb Biennial	Homegardens Fields	Leaves, stems	Exotic (E)	M, J	RES, OTH	O	5 uses 1 informant NL
Apiaceae (Umbelliferae)	*Centella asiatica* (L.) Urb.	Bua bok, Phak nok	Herb Perennial	Homegardens Rice fields	Leaves, stems, young shoots	Native (N)	M, J, T	DER, CAR, OTH	B	14 uses 5 informants 28 uses (L)

Table 4 (continued).

Family name	Scientific name	Thai / local name	Habit Annual / Perennial	Habitat	Plant parts used	Native (N)/ Exotic (E) According to Floras Local perception in bracket	Food uses†	Medicinal uses‡	Other uses	No. uses by no. informants and literature (L) §
Apiaceae (Umbelliferae)	*Coriandrum sativum* L. cultivar 1	Phak chi	Herb Annual	Fields	Young shoots, leaves, stems, roots, seeds	Exotic (N)	M, S	GAS, FEW, OTH		9 uses 5 informants 10 uses (L)
Apiaceae (Umbelliferae)	*Coriandrum sativum* L. cultivar 2	Phak chi	Herb Annual	Fields	Young shoots, leaves, stems, roots, seeds	Exotic (N)	M, S	GAS, FEW, OTH		9 uses 5 informants 10 uses (L)
Apiaceae (Umbelliferae)	*Eryngium foetidum* L.	Phak chi farang	Herb Biennial	Homegardens	Leaves	Exotic (E)	M, S	GAS, OTH		4 uses 3 informants 5 uses (L)
Araceae	*Colocasia esculenta* (L.) Schott	Bon	Aquatic herb Perennial	Lakes, ponds, streams	Leaves, stems	Native (N)	M	Unknown		2 uses 2 informants 12 uses (L)
Araceae	*Lasia spinosa* Thwaites	Phak nam	Herb Perennial	Wet places	Leaves, young shoots, stems	Native (N)	M	CAR, RES		3 uses 2 informants 5 uses (L)
Araliaceae	*Eleutherococcus trifoliatus* (L.) Hu	Phak paem	Shrub Perennial	Homegardens	Leaves, young shoots	Exotic (N)	M	FEV, OTH		3 uses 3 informants NL
Araliaceae	*Polyscias fruticosa* (L.) Harms.	Lep khrut	Shrub Perennial	Homegardens	Young shoots, leaves	Exotic (N)	M	URO, PAI	O	6 uses 3 informants 5 uses (L)
Asclepiadaceae	*Gymnema inodorum* (Lour.) Decne.	Phak chiang da	Vine	Forest	Leaves	Native (N)	M, T	OTH		4 uses 2 informants 1 use (L)
Asteraceae (Compositae)	*Spilanthes paniculata* Wall. ex DC.	Phak phet	Herb Perennial	Homegardens Fields	Leaves, flowers, stems	Native (N)	M	SKE, OTH		4 uses 2 informants 26 uses (L)
Asteraceae (Compositae)	*Stevia rebaudiana* Bert.	Ya wan	Herb Perennial	Upland fields	Leaves	Exotic (E)	T	CAR, OTH		3 uses 1 informant NL
Athyriaceae	*Diplazium esculentum* (Retz.) Sw.	Phak kut	Herb Perennial	Open wet places	Young shoots, leaves (fronds)	Native (N)	M	GAS, CAR, OPH		4 uses 3 informants 3 uses (L)

Table 4 (continued).

Family name	Scientific name	Thai / local name	Habit Annual / Perennial	Habitat	Plant parts used	Native (N)/ Exotic (E) According to Floras Local perception in bracket	Food uses†	Medicinal uses‡	Other uses	No. uses by no. informants and literature (L) §
Basellaceae	*Basella alba* L. and *Basella alba* (*B. rubra*) L.	Phak bang	Vine Perennial	Homegardens	Young shoots, leaves	Native (N)	M	GAS, DER		3 uses 2 informants 20 uses (L)
Brassicaceae (Cruciferaceae)	*Brassica juncea* (L.) Czern. cultivar group Broad -Leaf Mustard	Phak kat	Herb Annual	Homegardens Fields	Young shoots, leaves, flowers	Exotic (N)	M	URO		2 uses 2 informants 1 use (L)
Brassicaceae (Cruciferaceae)	*Brassica juncea* (L.) Czern. cultivar group Head-Leaf Mustard	Salat kayo	Herb Annual	Homegardens Fields	Leaves	Exotic (E)	M	Unknown		1 use 1 informant NL
Brassicaceae (Cruciferaceae)	*Brassica oleracea* L. cultivar group Chinese Kale	Phak khana	Herb Annual	Fields	Leaves, stems	Exotic (N)	M	CAR, OPH	A	5 uses 2 informants 1 use (L)
Brassicaceae (Cruciferaceae)	*Brassica oleracea* L. cultivar group White Headed Cabbage	Ka lam pli	Herb Annual	Fields	Young shoots, leaves	Exotic (N)	M	Unknown		1 use 1 informant 1 use (L)
Brassicaceae (Cruciferaceae)	*Brassica rapa* L. cultivar group Chinese Cabbage	Phak kat khao	Herb Annual	Fields	Leaves	Exotic (E)	M	Unknown		1 use 1 informant NL
Brassicaceae (Cruciferaceae)	*Brassica rapa* L. cultivar group Pak Choi	Hong dae	Herb Annual	Fields	Young shoots, leaves	Exotic (N)	M	Unknown		1 use 1 informant NL
Caesalpiniaceae (Leguminosae, Caesalpinioideae)	*Tamarindus indica* L.	Makham	Tree	Homegardens Village land	Young shoots, leaves, bark flowers, pods, seeds	Exotic (N)	M, S, D	DER, GAS, OTH		10 uses 5 informants 23 uses (L)
Commelinaceae	*Tradescantia cerinthoides* Kunth	Phai nam	Herb Perennial	Homegardens	Leaves	Exotic (E)		DER, URO		2 uses 1 informant NL
Convulvulaceae	*Ipomoea aquatica* Forssk.	Phak bung	Terrestrial or aquatic herb Perennial	Homegardens Wet places	Young shoots, leaves, stems	Native (N)	M, J	OPH, GAS, DER, URO	A	13 uses 4 informants 5 uses (L)

Table 4 (continued).

Family name	Scientific name	Thai / local name	Habit Annual / Perennial	Habitat	Plant parts used	Native (N)/ Exotic (E) According to Floras Local perception in bracket	Food uses†	Medicinal uses‡	Other uses	No. uses by no. informants and literature (L) §
Cucurbitaceae	*Coccinia grandis* (L.) Voigt	Tam lueng/ Phak khaep	Vine Annual	Homegardens Roadsides, Disturbed areas	Young shoots, leaves	Native (N)	M	OPH, CAR, DER		7 uses 4 informants 13 uses (L)
Cucurbitaceae	*Momordica charantia* L.	Ma ra, Ma hoi	Vine Annual	Homegardens	Young shoots, leaves, stems, fruits	Native (N)	M	Unknown		2 uses 2 informants NL
Cucurbitaceae	*Cucurbita moschata* Duchesne	Fak thong	Vine Annual	Homegardens	Young shoots, leaves	Exotic (N)	M	Unknown		2 uses 2 informants 3 uses (L)
Cucurbitaceae	*Sechium edule* (Jacq.) Sw.	Sa yo dai, Ma ra wan	Vine Annual	Homegardens	Young shoots, leaves, fruits	Exotic (N)	M	URO, CAR		6 uses 3 informants 1 use (L)
Euphorbiaceae	*Sauropus androgynus* (L.) Merr.	Phak wan	Shrub Perennial	Homegardens Fields	Young leaves and branches	Native (N)	M	GAS, CAR, FEV		6 uses 3 informants 6 uses (L)
Fabaceae (Mimosoideae, Leguminosae)	*Acacia concinna* (Willd.) DC	Som poi	Climber Perennial	Homegardens	Leaves, young shoots	Native (N)	M	OTH, CAR		6 uses 3 informants 6 uses (L)
Fabaceae (Mimosoideae, Leguminosae)	*Acacia pennata* subsp. *insuavis* (Lace) I.C. Nielsen	Cha om, Phak ra	Climber Perennial	Forests Disturbed areas	Leaves, young branches	Native (N)	M	GAS, RES, SKE	P	8 uses 3 informants 3 uses (L)
Fabaceae (Mimosoideae, Leguminosae)	*Leucaena leucocephala* (Lmk.) De Wit	Kra thin	Tree	Homegardens Disturbed areas	Young shoots, leaves	Exotic (N)	M	Unknown		4 uses 2 informants 15 uses (L)
Fabaceae (Mimosoideae, Leguminosae)	*Neptunia oleracea* Lour.	Phak kra chet	Aquatic herb Perennial	Rice fields, ponds, lakes	Leaves, stems	Native (N)	M	CAR, GAS, OPH		5 uses 3 informants 3 uses (L)
Lamiaceae (Labiatae)	*Elsholtzia kachinensis* Prain	Phak luean	Herb Perennial	Forests	Leaves, young shoots, stems	Exotic (N)	M	GAS, GYN		1 use 1 informant NL
Lamiaceae (Labiatae)	*Mentha* x *cordifolia* Opiz *ex* Fres.	Sa ra nae	Herb Perennial	Homegardens	Young shoots, leaves, stems	Exotic (N)	M, S	GAS	O	7 uses 4 informants NL

Table 4 (continued).

Family name	Scientific name	Thai / local name	Habit Annual / Perennial	Habitat	Plant parts used	Native (N)/ Exotic (E) According to Floras Local perception in bracket	Food uses†	Medicinal uses‡	Other uses	No. uses by no. informants and literature (L) §
Lamiaceae (Labiatae)	*Ocimum americanum* L. cultivar 1	Ho ra pha	Herb Perennial	Homegardens	Leaves, young shoots	Exotic (N)	M, S, T	GAS, CAR, OTH		8 uses 4 informants 29 uses (L)
Lamiaceae (Labiatae)	*Ocimum americanum* L. cultivar 2	Maeng lak	Herb Perennial	Homegardens	Leaves, young shoots, seeds	Exotic (E)	M, S, D	GAS		4 uses 3 informants 21 uses (L)
Lamiaceae (Labiatae)	*Ocimum gratissimum* L.	Yira	Herb Perennial	Homegardens	Leaves, seeds	Exotic (E)	M, S	GAS		5 uses 4 informants 7 uses (L)
Lamiaceae (Labiatae)	*Ocimum tenuiflorum* L.	Kra phrao	Herb Perennial	Homegardens	Leaves, young shoots	Exotic (N)	M, S, T	RES, GAS		9 uses 4 informants 14 uses (L)
Malvaceae	*Hibiscus sabdariffa* L.	Kra jiap	Herb Annual/ Perennial	Homegardens	Leaves, fruits	Exotic (N)	M, J, T	CAR, URO, OTH		7 uses 4 informants 34 uses (L)
Marsileaceae	*Marsilea crenata* Presl	Phak waen	Aquatic fern	Ponds, slow streams	Leaves, stems, young shoots	Native (N)	M, J	GAS, FEV, OTH, OPH, CAR		7 uses 4 informants 3 uses (L)
Meliaceae	*Azadirachta indica* A. Juss.	Sa dao, Sa liam	Tree	Homegardens	Young leaves, young inflores-cences, seeds	Native (N)	M	GAS, OTH, FEV	P, A	15 uses 5 informants 20 uses (L)
Menispermaceae	*Tiliacora triandra* (Colebr.) Diels	Ya nang	Climber	Homegardens forests	Leaves	Native (N)	S, J, T	FEV, OTH		12 uses 7 informants 12 uses (L)
Molluginaceae	*Mollugo pentaphylla* L.	Phak man khom, Phak siang	Herb Annual	Open fields, Disturbed areas Forests	Leaves	Native (N)	M	Unknown		1 use 1 informant NL
Moraceae	*Broussonetia kurzii* (Hook. f.) Corner	Sa lae	Climber	Disturbed areas Thickets	Female inflores-cences, young leaves	Native (N)	M	Unknown		1 use 1 informant 1 use (L)
Moraceae	*Ficus virens* Ait. var. *virens*	Phak hueat	Tree	Homegardens Forests	Young leaves	Native (N)	M	Unknown		1 use 1 informant NL

Table 4 (continued).

Family name	Scientific name	Thai / local name	Habit Annual / Perennial	Habitat	Plant parts used	Native (N)/ Exotic (E) According to Floras Local perception in bracket	Food uses†	Medicinal uses‡	Other uses	No. uses by no. informants and literature (L) §
Pandanaceae	*Pandanus amaryllifolius* Roxb.	Toei	Screwpine	Homegardens	Leaves	Exotic (N)	D, T, J, S	CAR	O, C	9 uses 4 informants 13 uses (L)
Piperaceae	*Piper sarmentosum* Roxb. *ex* Hunt.	Cha phlu	Herb Perennial	Homegardens Forests	Young shoots, leaves	Native (N)	M, T, S	DER, POI, OTH, GAS, RES	C, B	12 uses 4 informants 11 uses (L)
Poaceaea	*Cymbopogon citratus* (DC.) Stapf	Ta khrai	Grass Perennial	Fields	Leaf stalks	Native (N)	S, J, T	OTH		4 uses 1 informant 5 uses (L)
Polygonaceae	*Polygonum odoratum* Lour.	Phak phai	Herb Perennial	HomegardensRice fields, Wet places	Leaves, stems, young shoots	Native (N)	M	Unknown		1 use 1 informant 6 uses (L)
Rubiaceae	*Morinda citrifolia* L.	Yo	Tree	Homegardens	Leaves, fruits	Native (N)	J	GAS, SKE, OTH, URO	C	13 uses 6 informants 17 uses (L)
Rutaceae	*Citrus hystrix* DC.	Ma krut	Tree	Homegardens	Leaves, fruits, roots	Native (N)	S	DER, GAS	B, P	7 uses 3 informants 6 uses (L)
Saururaceae	*Houttuynia cordata* Thunb.	Khao thong, Khao tong, Phlu khae	Herb Perennial	Homegardens	Leaves, stems	Native (N)	M, J	OTH, PAI, GAS, URO, CAR, RES		15 uses 4 informants 12 uses (L)
Zingiberaceae	*Zingiber officinale* Roscoe	Khing	Herb Perennial	Homegardens	Leaves, rhizome	Exotic (N)	M, T	GAS, URO, SKE, RES, FEV, OTH		14 uses 4 informants 45 uses (L)

Native (N)/Exotic (E) in brackets is categorized according to local people's perceptions; †: Use categories: Main dish (M), Seasoning/flavouring/food colour (S), Dessert/sweetener (D), Juice/shake (J), Tea (T), Container/wrap (C), Beauty-spa product (B), Pesticide/insecticide (P), Animal food or veterinary medicine (A), Ornamental/decoration (O), Utensil (U); ‡: Medicinal use categories: Gastrointestinal (GAS), Dermatological (DER), Respiratory (RES), Gynecological/andrological (GYN), Culture bound syndromes (CUL), Pain/febrile diseases (PAI), Fever (incl. malaria) (FEV), Skeleto-muscular (SKE), Ophthalmological (OPH), Urological (URO), Poisonous animal bites (POI), Cardiovascular (CAR), Other/unclassified (detoxification, immune system, infection, inflammation, appetizer, insomnia, cancer, diabetes, antibacterial, supports liver, tonic) (OTH); §: Literature (L): Anderson (1993), Jacquat (1990), Thiangburanatham (2005); NL: Not found in the aforementioned Literature.

leafy vegetables was in main dishes (89%) followed by medicinal uses (75%); more than half of those leafy vegetables were exotic (Fig. 2). There was no apparent pattern in the uses of the medicinal species except that all the species in the Lamiaceae family were used for gastrointestinal ailments. Among the most frequently used leafy vegetables, 51% of the respondents mentioned *Brassica juncea* (broadleaf mustard), 40% *Ipomoea aquatica* and 33% *B. oleracea* (Chinese Kale).

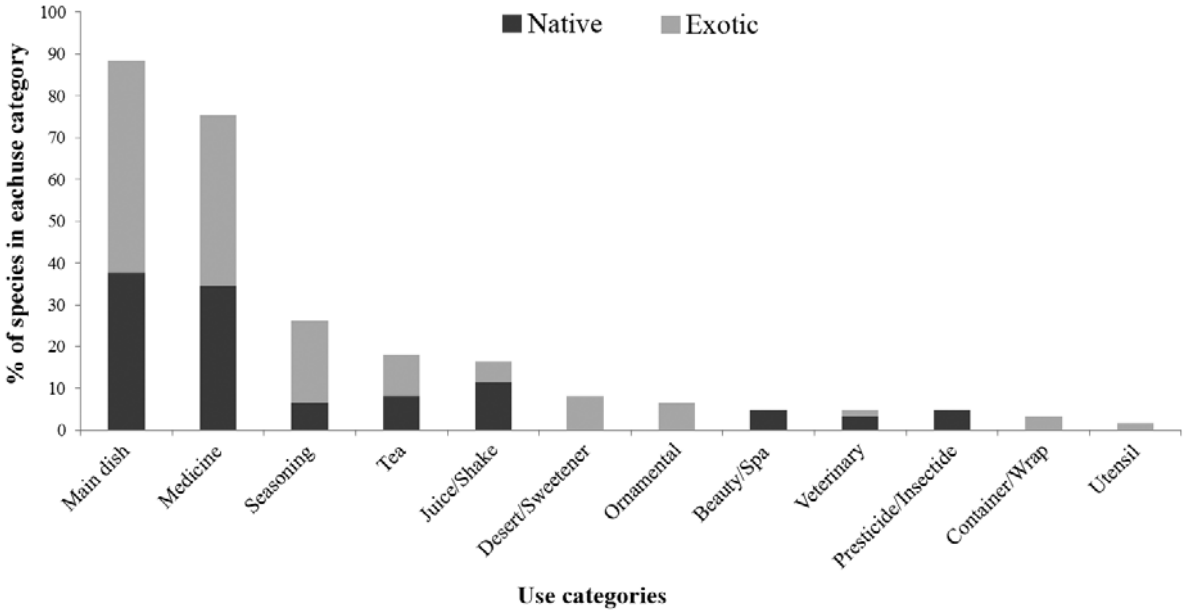

Figure 2. Percentages of native and exotic species and cultivars per use category.

Distribution of Knowledge of Leafy Vegetables

Of the100 respondents living in Chiang Mai city, 97 were Thai and three were Akha, Mon and Thai Yai. Mean knowledge scores increased with age (Fig. 3). None of the respondents reached the maximum possible score (60).

Results of pairwise comparisons show that knowledge scores were significantly different between age groups 18–30 and 31–45 ($p<0.001$), and among 18–30 and 46–60 ($p<0.001$). No significant difference was found between males (mean±SD: 34.69±14.67; $n=39$) and females (36.80±13.50; $n=61$; $p=0.445$). Knowledge about leafy vegetables differed significantly among education levels ($p<0.001$) and decreases with formal higher education (Fig. 4). Pairwise comparisons showed that knowledge is significantly different between high school and polytechnic or university students ($p<0.001$).

There was no significant difference in knowledge scores between different income levels ($p=0.520$). Likewise, knowledge scores did not differ significantly between respondents whose household owned agricultural land (mean±SD: 36.55±14.44; $n=48$) and those who did not (37.24±13.56; $n=52$; $p=0.636$). Recognition of studied plants as vegetable and medicine by the respondents is shown in Figure 5.

There was little consensus on the medicinal uses except that *Tamarindus indica* was often mentioned to be used for gastrointestinal ailments and *Houttuynia cordata* for cancer.

On average, more respondents recognized species used in dishes sold at markets as edible than they did for species specific to homemade traditional dishes (mean±SEM: 81±9 and 69±5 respectively; n=100) with medicinal properties (mean±SEM: 32±4 and 24±4 respectively; n=100).

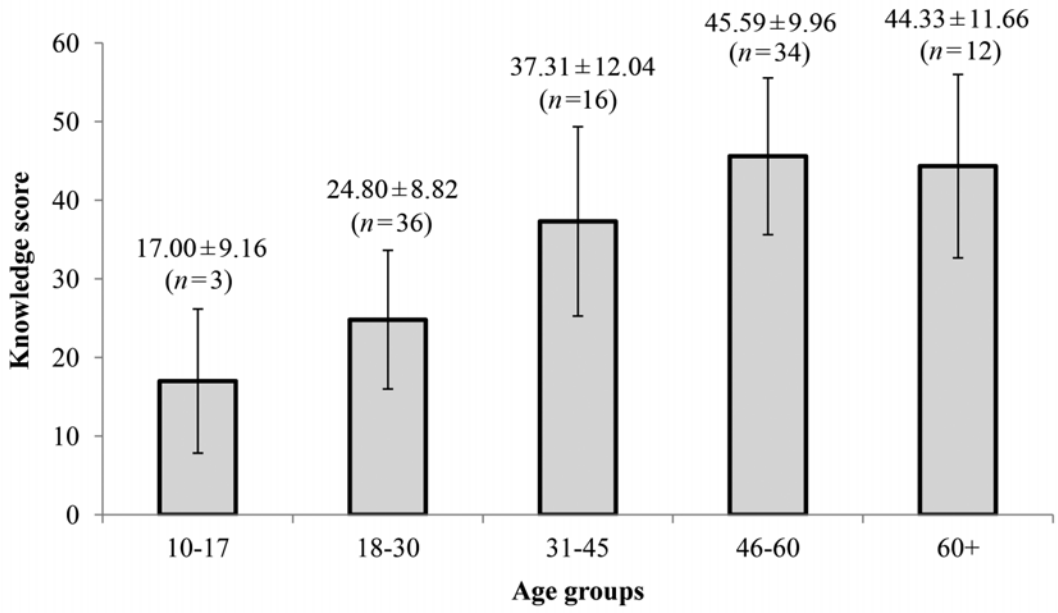

Figure 3. Means and standard deviations of knowledge scores for each age group.

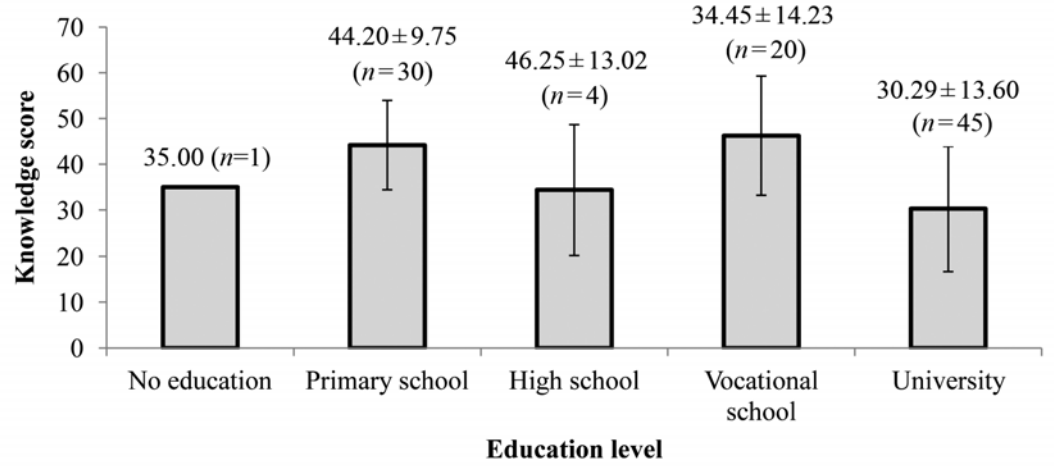

Figure 4. Means and standard deviations of knowledge scores for each education level.

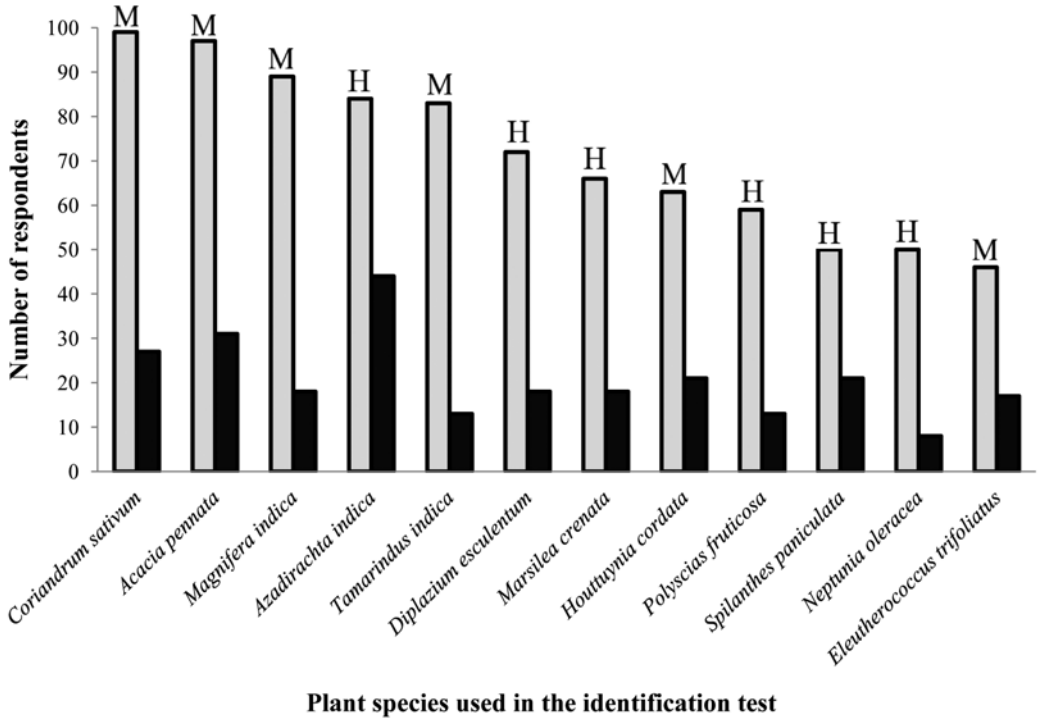

Figure 5. Number of respondents who recognised the species used in the knowledge test as being edible (grey) and as medicinal (black). Species widely used in dishes sold at markets (M). Species used in homemade, traditional dishes (H).

Consumption and Perceptions of Leafy Vegetables

Ninety percent of the respondents bought leafy vegetables in fresh food markets, while 8% shopped both in the fresh food market and supermarket. One respondent (1%) shopped exclusively in supermarkets and one respondent (1%) collected leafy vegetables from her own homegarden. The main determinants for purchase of leafy vegetables were freshness (65%), appearance (26%), price (23%) and taste (22%). Furthermore, 5% mentioned farm cleanness and safety and 4% bought organic leafy vegetables or produce with irregularities and bugs indicating low pesticide content.

Compared to 10 years ago, 35% of the respondents reported to consume more leafy vegetables, 32% less and 33% consumed the same as before (Fig. 6). People above 30 years consumed more vegetables than 10 years ago reportedly due to health reasons.

The main constraint for consumption of leafy vegetables was seasonal availability (51%). Other reasons were little time for cooking (13%), difficulties in preparation (11%), taste (7%), price (7%) and pesticides (3%). In general, mid- and older generations perceived leafy vegetables as healthy whereas younger people mentioned this less often. High vitamin content and medicinal qualities were mentioned often. The majority of respondents would serve leafy vegetables for guests or at special occasions and celebrations indicating that leafy vegetables are still revered in the culture.

According to the Thai traditional doctors the traditional food culture is changing as people have less time for home-cooking and food stalls offer less traditional foods than before. Hence, the traditional doctors reported that traditional vegetables are used less frequently and especially young people prefer to eat introduced vegetables such as carrots and broccoli instead of traditional leafy vegetables.

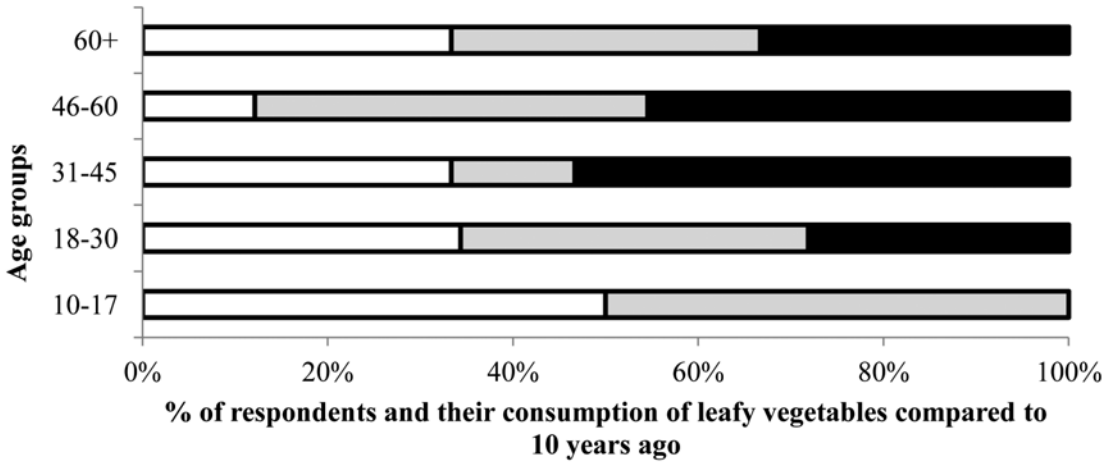

Figure 6. Self-reports on changes in leafy vegetable consumption in the last 10 years by age group, consumed less (white), same (grey) and more (black).

Transmission of Traditional Knowledge

Knowledge transmission took place within the family in most cases (81%). Rarely, knowledge was transmitted from neighbours or friends (8%), from vegetable sellers (8%), from school (7%), from books or magazines (7%), from internet or television (6%) and from the temple (1%). Some respondents indicated more than one source of knowledge. Most of the respondents (83%) commented that the knowledge was passed orally while preparing dishes and during family meals.

DISCUSSION

Diversity of Leafy Vegetables in Urban Markets

A total of 62 taxa including 55 species and 13 cultivars in six of the species were found to be sold in the fresh food markets. This is similar to the species richness reported in earlier studies (Wester, 1997; Shirai & Rambo, 2008). This study found 45% native and 55% exotic species. The number of exotic species reflects that Thailand has been part of the international crop exchange for a long time (Wester, 1997). Despite their popularity and nutritional value many of the leafy vegetables are considered under-utilised (FAO, 1999). Examples of under-utilised species included in the list provided by FAO and found in the fresh food markets were *Coccinia grandis*, *Morinda citrifolia*, *Neptunia oleracea* and *Centella asiatica*. According to FAO (1999), improved varieties and cultivation techniques could increase yields and consumption of many under-utilised vegetables in Thailand.

Use and Knowledge of Leafy Vegetables

Food plants often have multiple uses (Maroyi, 2011; Uprety *et al.*, 2012). Leafy vegetables not only provide nourishment but the majority of them also possess multiple medicinal qualities (Ogle *et al.*, 2003; Turreira-García *et al.*, 2015). The majority (75%) of the leafy vegetables found in urban markets in Chiang Mai city had medicinal uses. Similar

percentages of medicinal edibles were found in in Zimbabwe (69%) (MAROYI, 2011) and in Northeast Thailand (60%) (CRUZ-GARCIA & PRICE, 2011). Perceptions of the healthiness of leafy vegetables seemed to play a role in maintaining their use. However, health concerns in relation to for example pesticide contents may act as a deterrent for some. Perceptions of leafy vegetables as healthy was linked to general notions of their healthiness rather than to knowledge of specific medicinal uses, despite the fact that many of leafy vegetables had specific medicinal uses according to the Thai traditional medicine practitioners.

We hypothesised that people who had access to land may grow their own vegetables, and hence would have a higher knowledge following REYES-GARCÍA *ET AL.* (2006) and ARAÚJO & LOPES (2011) who showed that being in contact with natural resources help maintain ethnobotanical knowledge. However, we found no relationship between these two aspects in the urban setting of Chiang Mai city. We did not find a significant relationship between income and knowledge. Values such as healthiness might have been a more influential determinant of knowledge level. KIMIYWE *ET AL.* (2007) found ethnicity to be the main determinant for vegetable consumption. As 97% of the respondents in our study belonged to the Thai ethnic group, we were not able to test the influence of ethnicity on knowledge. Women are commonly expected to have more knowledge of edible plants than men because they are responsible for preparing household meals in many cultures (NESHEIM *ET AL.*, 2006; ARAÚJO & LOPES, 2011), but we did not find a significant difference between the knowledge of women and men which corresponds with the findings of GONZÁLEZ *ET AL.* (2010), GHORBANI *ET AL.* (2012), and TURREIRA-GARCÍA *ET AL.* (2015). The knowledge test showed that older people were more knowledgeable on leafy vegetables. This has also been shown in other studies (e.g. ZARGER & STEPP, 2004; REYES-GARCÍA *ET AL.*, 2006; ARAÚJO & LOPES, 2011; TURREIRA-GARCÍA *ET AL.*, 2015), and has been explained by elder people having had more time to use and accumulate knowledge in a setting where the resources were still available.

Transmission of Traditional Knowledge

Knowledge transmission has mainly been studied in rural communities where the number of factors that affect knowledge transmission is limited. To study knowledge transmission in an urban area is difficult as the exposure of an individual to external sources of information is greater than for persons living in a remote village. At the same time, urbanisation itself is regarded as one of the factors potentially disrupting knowledge transmission. Regardless the external influences, most respondents claimed to have learned about the use of leafy vegetables from their family. Few people mentioned other local people or friends similar to the rural studies by YATES & RAMÍREZ-SOSA (2004) and TURREIRA-GARCÍA *ET AL.* (2015). The knowledge was transmitted orally which is similar to knowledge transmission in rural areas (LADIO & LOZADA, 2001; ZARGER & STEPP, 2004; TURREIRA-GARCÍA *ET AL.*, 2015). Preparing and sharing meals with the family seems to be crucial for knowledge transmission of traditional leafy vegetables. Despite the perceptions of the traditional practitioners (and some household respondents) and the observed lower knowledge levels amongst younger generations, the self-reported changes in leafy vegetable consumption did not indicate a clear trend of declining use of leafy vegetables at the level of individuals. The observed knowledge distribution may thus either be due to generational differences in relation to knowledge and consumption (i.e., younger generations use less than older, but within each generation consumption remains stable), or may indicate increased consumption levels with age.

Perceptions of Leafy Vegetables in Urban Areas

Several studies from Africa have shown that leafy vegetables were considered as poor peoples' food and avoided by more wealthy and urban populations due to the negative stigma (Jansen *et al.*, 2007; Dweba & Mearns, 2011). The residents of Chiang Mai city generally favored leafy vegetables as easy to prepare and healthy as also shown in Guissou *et al.* (2015). Leafy vegetables were widely served for guests also at special occasions showing that the residents of Chiang Mai city still revered leafy vegetables as part of the food culture.

CONCLUSIONS

The comparison of our results to those of Wester (1997) and Shirai & Rambo (2008) indicates that the availability (measured as presence/absence) and variety (measured as species richness) of leafy vegetables in fresh food markets of Chiang Mai city has been maintained over the last two decades. Hence the possible changes in consumption are not due to lack of availability or variety of leafy vegetables. Knowledge of leafy vegetables was mainly determined by age and level of education; whereas gender, income and ownership of agricultural land did not affect knowledge. Knowledge on leafy vegetables and their use was maintained mainly by older residents who are considered to be the main transmitters of knowledge within the family. The younger generation had less knowledge about traditional leafy vegetables, but self-reported changes in consumption did not show clear evidence of declining consumption and many respondents were conscious of health issues and saw vegetable consumption as part of maintaining their health in a modern city. While changes in lifestyle associated with urbanisation may indeed have led to some loss of knowledge, our study shows that traditional channels of knowledge transmission and interest in the traditional use of leafy vegetables can be maintained in an urban setting.

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