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Weeds as important vegetables for farmers

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Abstract

The objective of this study was to investigate the multiple uses and cognitive importance of edible weeds in Northeast Thailand. Research methods included focus group discussions and freelistings. A total of 43 weeds consumed as vegetable were reported, including economic, naturalized, agricultural and environmental weeds. The weedy vegetables varied considerably on edible parts, presenting both reproductive (flowers, fruits and seeds) and vegetative organs (shoots, leaves, flower stalks, stems or the whole aerial part). The results of this study show that weedy vegetables are an important resource for rice farmers in this region, not only as a food but also because of the multiple additional uses they have, especially as medicine. The fact that the highest Cognitive Salience Index (*CSI*) scores of all wild vegetables freelisted corresponded to weeds, reinforces the assertion that weeds are culturally cognitively important for local farmers as a vegetable source. This is a key finding, given that these species are targets of common pesticides used in this region.

Keywords: weed, wild food plant, vegetable, salience, use, edible part, Thailand, Southeast Asia

Introduction

A calculation that one out of every ten plants on Earth is a weed means that there are approximately 30000 weed species globally [1]. Although scientists and agricultural extension officers recommend eradicating them, 89% of the most widespread and aggressive weeds in the world are edible [2]. Moreover, many of these species have a high nutritional value and medicinal properties [1].

There is now substantial evidence that farmers all over the globe incorporate selected wild plant species classified as weeds by agricultural scientists into their normal diet. Other edible weed species may be used only in times of scarcity. One way to explain the use of weeds of agriculture in the diet of farmers is that of the botanical dietary paradox [3,4]. The paradox is that as wild edible species of the forest become more distant from the agricultural fields, farmers eat more wild species from the farming areas, and there is a tendency for famers to eat more wild food plants. This paradox in part can be explained by the fact that the weeds of agriculture enter the diet as the amount of time spent gathering in old growth/pristine areas becomes too burdensome.

Price and Ogle [4] identify three sorts of use values for edible weeds. The first is direct use value which refers to the benefit from the actual use as vegetables for food (as well as the overlap with medicine among other direct uses). Indirect use value of the weed vegetables would include the cultural and social value of the diversity of wild vegetables (expressed for example in local culinary recipes or ritual use). The last kind of value is option value which is that of having and managing the species as a form of insurance for the future (such as insurance against times of drought).

The consumption of weeds is a world-wide phenomenon that is noted as having an important role for human nutrition. Their consumption has been widely reported on the African, American and European continents [1,5–15]. The consumption of weeds is also widespread in Asia, with Bicol's weed recipes in the Philippines as one example [16]. Other examples include the tribal people in the Indian states of Jharkhand, Orissa and West Bengal [17], the use of weeds in preparing traditional Korean and Chinese dishes [18], and in Thailand, where 30% of weeds are reported as edible [19]. Weeds from rice fields are especially widely consumed in Asia, for example in West Bengal, India [20], in Laos [21] and Thailand [19,22,23].

Edible weeds also possess multiple additional uses besides food, such being a source of animal fodder and medicine [16]. For instance, the multiplicity of uses of edible weeds has been reported in India [20], Vietnam [24] and Thailand [19]. The overall utility of weeds for farmers in various ASEAN countries is expounded upon in "Utility of weeds and their relatives as resources" [25] edited by Kim, Shin and Lee.

Despite the growing recognition that weeds constitute an important component of farmer's diets around the world,

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detailed studies on the main characteristics of edible weeds and how important farmers think they are for their families and communities are rare. Moreover, weeds are frequently overlooked as a source of food in Thailand by scientists [19], where most weed research is focused on reducing their population [22]. The objective of this study was to investigate the multiple uses and cognitive importance of edible weeds in Northeast Thailand. In this paper an "edible weed" is defined as a wild food plant species (according to the emic conceptualization of farmers in Northeast Thailand) that is classified as a "weed" in the scientific literature [26,27].

Study site

The research on which this paper is based took place in a village in the Northeast region of Thailand. The Northeast is Thailand's largest region and is vulnerable to both drought and floods. The region's rural areas are comprised of poor small-holders who cultivate glutinous rice in paddy fields as the dietary staple and main source of income. There are already substantial indications of the importance of wild foods including plants from the anthropogenic environments of farming areas, to rural households but no specific attention to those species considered weeds.

The earlier research on the region informs us that wild food plants are an important component of the farmer's diet in the Northeast [28–32]. These food plants are gathered from an array of environments related to the farming system and many are commensals to agricultural practices [28,32,33]. These wild vegetables are consumed not only raw but also steamed, in soups and curries [34]. It has been previously proposed [32] that some of these wild food plants were indeed in all probability weeds of agriculture and commensals to farming practices.

Methods

Fieldwork was conducted between 2006 and 2010 in a subsistence oriented rice farming village (Ban Sa-at Tai) in Kalasin Province, Northeast Thailand (Fig. 1). Farming is the main occupation in the village, with lowland cultivation of glutinous rice (or sticky rice) being the main activity. Farmers gather wild food in both the rainy (May through October) and dry season (November to April) [28].

Botanical names of edible weeds were extracted from a previous publication from the authors of this article [28] presenting a thorough list of wild food plants, including weeds, elaborated for the study site. The list of edible weeds consumed as vegetables was compared to the "Global compendium of weeds" [26] and "Weeds reported in South and Southeast Asia" [27].

Focus group discussions provided data on the multiple edible parts and additional uses of edible weeds. The focus groups were comprised of six to nine middle-aged women (34–66 years old) recognized by the villagers to have wide knowledge on wild food plants [35,36]. Women were chosen for the groups given that it has been reported that in Northeast Thailand women are the main wild food plant gatherers and knowledge holders of this resource [37–39].

Freelistings were carried out with a total of 130 female villagers as part of a village census with the objective to assess the cognitive salience of wild food plant species. Informants were asked to name all the wild food plants that they know [40]. Freelistings were analyzed considering both frequency of mention and mean position of a plant in the lists, combining both measurements in a single index [41]. The Cognitive Salience Index (*CSI*) of each plant was calculated as the frequency of mention divided by the weight of the mean position (number of subjects mentioning the species multiplied by the mean position of the term across informants' lists). It is assumed that the items mentioned first in a list are more salient than those mentioned last. The calculation is based on the scoring across informants that can range from 0–1, with 1 representing all informants having mentioned an item first and thus at the top of the list (most salient), and 0 representing no one mentioning an item (least salient).

Fig. 1 Location of Kalasin Province, Northeast Thailand.

Results

Weeds consumed as vegetables in Kalasin, Northeast Thailand

From a total of 87 wild food plants reported for Kalasin, Northeast Thailand [28], 65 plants are consumed as vegetable (51 are consumed only as vegetable and 14 also as fruit). Two thirds of the vegetables (66%) are classified as weeds in the scientific literature [26,27]. These plants include trees, climbers, aquatic and terrestrial herbs, bamboos and shrubs. Out of this total (43 plants), 40 plants were identified to the species level corresponding to 39 different species (two plants are different varieties of the same species), and three plants were identified to the genus level. Given that this study is only focused on weeds consumed as vegetables, the results presented from now onwards are based on the list of 43 weedy vegetables (Tab. 1).

Tab. 1 List of weeds consumed as vegetables in Kalasin, Northeast Thailand, indicating multiple edible parts, multiple uses and weed classification in the scientific literature.

Botanical name	Status according to the Global Compendium of Weeds[1]	Classified as weed in the rice fields of Southeast Asia[2]	Classified as weed in the rice fields of Thailand[2]	Edible part(s)	Additional use(s)
Adenanthera pavonina L.	cultivation escape, environmental weed, naturalised, noxious weed, economic weed			shoot, flower	food
Aegle marmelos Corrêa	naturalised			shoot, fruit	food, medicine, ritual
Amaranthus viridis L.	agricultural weed, casual alien, cultivation escape, environmental weed, garden thug, naturalised, economic weed	✓	✓	shoot, whole aerial parts	food, medicine, fodder
Asparagus racemosus Willd.	quarantine weed			shoot	food
Azadirachta indica A. Juss. var. *indica*	agricultural weed, environmental weed, garden thug, naturalised, noxious weed, sleeper weed, economic weed			shoot, flower	food, medicine, agriculture
Azadirachta indica A. Juss. var. *siamensis* Valeton	agricultural weed, environmental weed, garden thug, naturalised, noxious weed, sleeper weed, economic weed			shoot, flower	food, medicine, timber, agriculture
Bambusa bambos (L.) Voss	economic weed			shoot	food, handicraft, fodder
Basella rubra L.	agricultural weed, casual alien, naturalised, economic weed	✓		shoot	food, medicine
Blumea sp.			✓	shoot	food, medicine, ritual
Cajanus cajan (L.) Millsp.	agricultural weed, casual alien, cultivation escape, environmental weed, naturalised, economic weed			seed	food, medicine
Careya arborea Roxb.	economic weed			shoot, flower	food
Cassia siamea Lam.	environmental weed, garden thug, naturalised, economic weed			shoot	food, medicine, cleaning
Cassytha filiformis L.	agricultural weed, naturalised, economic weed			leaves, flower, stalk of flower, stem	food
Centella asiatica (L.) Urb.	agricultural weed, environmental weed, naturalised, economic weed	✓	✓	whole aerial parts	food, medicine
Cissampelos pareira L.	naturalised, economic weed			shoot, leaves	food, medicine
Coccinia grandis (L.) Voigt	agricultural weed, cultivation escape, environmental weed, garden thug, naturalised, noxious weed, economic weed	✓		shoot, flower, fruit	food, medicine, fodder
Cuscuta chinensis Lam.	agricultural weed, naturalised, economic weed	✓		whole aerial parts	food
Eichhornia crassipes (Mart.) Solms	agricultural weed, casual alien, cultivation escape, environmental weed, garden thug, naturalised, noxious weed, sleeper weed, economic weed	✓	✓	shoot, flower	food, handicraft, fodder
Emilia sonchifolia (L.) DC.	agricultural weed, cultivation escape, environmental weed, naturalised, economic weed	✓	✓	whole aerial parts	food
Glinus oppositifolius (L.) Aug. DC.	agricultural weed, environmental weed, naturalised, economic weed	✓	✓	whole aerial parts	food
Hydrolea zeylanica (L.) J.Vahl	agricultural weed, naturalised, economic weed	✓	✓	shoot, flower	food, medicine
Ipomoea aquatica Forssk.	agricultural weed, cultivation escape, environmental weed, naturalised, noxious weed, economic weed	✓	✓	shoot	food, medicine, fodder
Leucaena leucocephala (Lam.) de Wit	agricultural weed, cultivation escape, environmental weed, garden thug, naturalised, noxious weed, economic weed			shoot, leaves, fruit	food, medicine, fuel, fodder, agriculture
Limnocharis flava Buchenau	agricultural weed, environmental weed, naturalised, noxious weed, economic weed	✓	✓	shoot, flower, stalk of flower, fruit	food
Limnophila aromatica Merr.	agricultural weed, economic weed	✓		whole aerial parts	food, medicine

Tab. 1 *(continued)*

Botanical name	Status according to the Global Compendium of Weeds[1]	Classified as weed in the rice fields of Southeast Asia[2]	Classified as weed in the rice fields of Thailand[2]	Edible part(s)	Additional use(s)
Lobelia begonifolia Wall.	agricultural weed	✓		whole aerial parts	food
Lobelia sp.	naturalised	✓	✓	whole aerial parts	food
Ludwigia adscendens (L.) H. Hara	agricultural weed, environmental weed, economic weed	✓	✓	shoot, leaves, stem	food, medicine, fodder
Marsilea crenata C. Presl	agricultural weed, environmental weed, naturalised, economic weed	✓	✓	whole aerial parts	food, medicine
Momordica charantia L.	agricultural weed, casual alien, cultivation escape, environmental weed, garden thug, naturalised, economic weed			shoot, fruit	food, medicine
Monochoria hastata (L.) Solms	agricultural weed, environmental weed, naturalised, noxious weed, economic weed	✓	✓	shoot, flower, stalk of flower	food, handicraft, fodder
Monochoria vaginalis C. Presl	agricultural weed, cultivation escape, environmental weed, naturalised, noxious weed, economic weed	✓	✓	whole aerial parts	food, medicine
Neptunia oleracea Lour.	naturalised, economic weed	✓		shoot	food
Nymphaea pubescens Willd.	agricultural weed, casual alien, cultivation escape, environmental weed, naturalised, economic weed	✓	✓	stalk of flower	food, medicine
Nymphoides indica (L.) Kuntze	agricultural weed, environmental weed, naturalised, economic weed	✓	✓	shoot	food
Oenanthe javanica DC.	agricultural weed, environmental weed, naturalised, economic weed	✓	✓	shoot	food
Ottelia alismoides (L.) Pers.	agricultural weed, environmental weed, naturalised, noxious weed, economic weed	✓	✓	whole aerial parts	food
Passiflora foetida L.	agricultural weed, cultivation escape, environmental weed, naturalised, economic weed	✓		shoot, fruit	food
Phyllanthus acidus (L.) Skeels	cultivation escape, environmental weed, naturalised, economic weed			shoot, fruit	food, medicine, ritual
Senna sophera (L.) Roxb.	naturalised, economic weed			shoot, flower, fruit	food, medicine
Spirogyra sp.	economic weed	✓		whole aerial parts	food, medicine
Spondias pinnata Kurz	naturalised			leaves, fruit	food, medicine, timber
Tamarindus indica L.	cultivation escape, environmental weed, garden thug, naturalised, economic weed			shoot, fruit	food, medicine, timber, fuel, fodder, dye, cleaning

[1] By HEAR [26], the definition of each category is available at http://www.hear.org/gcw/gcwterms/#status. [2] By Moody [27].

The Global Compendium of Weeds [26] groups species according to different statuses. The reported weedy vegetables include species corresponding altogether to ten different statuses. Eighty eight percent of the plants were classified as "economic weeds" that refers to those with economic impact, 81% of plants were regarded as "naturalized weeds" or plants with self-spreading populations, 65% correspond to "agricultural weeds" that include those present in farming areas, 60% are "environmental weeds" referring to plants that invade native ecosystems, 33% were classified as "cultivation escapes" including plants that escaped from farming areas or gardens, 26% are "noxious weeds" corresponding to species with legal restrictions in some countries, 21% were classified as "garden thugs" or invasive plants that can quickly get out of control in gardens, 14% are "casual aliens" or plants that appear eventually and apparently without direct human intervention, 7% were regarded as "sleeper weeds" including species that pose a future threat, and, finally one species was classified as "quarantine weed" or forbidden to enter a country due to quarantine regulations.

Eighty one percent of the plants showed more than one status. The species classified in more than 50% of the categories were: *Eichhornia crassipes* presenting nine statuses; *Amaranthus viridis*, *Momordica charantia*, *Coccinia grandis*, *Leucaena leucocephala*, *Azadirachta indica* var. *indica* and *A. indica* var. *siamensis* showing seven; *Cajanus cajan*, *Nymphaea pubescens*, *Ipomoea aquatica* and *Monochoria vaginalis* presenting six different statuses.

The weedy vegetables were also categorized according to their classification as weeds in rice fields. These plants included climbers, aquatic and terrestrial herbs only. Trees, shrubs and bamboo species did not appear in the lists of rice weeds. These plants grow in habitats associated to rice cultivation such as shelters and tree rows (but not in rice plots per se), as well as in home gardens, roadsides and secondary woods, which altogether are part of the local farming landscape. More than half of the weedy vegetables (58%), such as the climber *Cuscuta chinensis*, have been classified as weeds in the rice fields of Southeast Asia, and 42%, such as the herb *Ipomoea aquatica*, as rice weeds in Thailand [27].

Multiple edible parts and multiple uses of weeds

The weedy vegetables varied considerably on edible parts, presenting both reproductive (flowers, fruits and seeds) and vegetative organs (shoots, leaves, flower stalks, stems or the whole aerial part). Eight categories were established: young shoots are eaten in 65% of the plants, whole aerial parts in 28%, flowers in 26%, fruits in 23% (however, in most of the cases the fruit is not eaten as a vegetable and for all these species either the shoots or leaves are consumed as vegetable), leaves in 12% of the plants, flower stalks in 9%, stems in 5%, and seeds in one species. Almost half of the plants (49%) had more than one edible part. In this way, for 5% of the plants four parts are eaten, such as *Cassytha filiformis* (leaves, flower, stalk of flower, stem) and *Limnocharis flava* (shoot, flower, stalk of flower, fruit). For 12% of the plants three parts are eaten, for example *Ludwigia adscendens* (shoot, leaves, stem). Finally, 33% of plants have two edible parts, such as *Azadirachta indica* var. *indica* (shoot, flower).

Roughly two thirds of the weedy vegetables (65%) had uses in addition to food, up to a total of nine different uses. Medicine was the most commonly reported additional use for more than half of the plants (58%), followed by fodder (21% of the plants). Timber (which comprised weedy tree species that are not specifically considered as rice weeds), handicraft manufacture, ritual use and auxiliary uses in agriculture were reported for 7% of the weeds. Two species are used as fuel and for cleaning, whereas one plant is utilized as a dye (natural colorant). The species that had the most additional uses were the trees *Tamarindus indica* (medicine, timber, fuel, fodder, dye, cleaning), *Leucaena leucocephala* (medicine, fuel, fodder, agriculture) and *Azadirachta indica* var. *siamensis* (medicine, timber, agriculture). Rice weeds, which exclude tree, bamboo and shrub species, presented a maximum of two additional uses. Thirty per cent of the weedy vegetables presented two additional uses, such as the aquatic herb *Ludwigia adscendens* (medicine, fodder) and, finally, 23% of the plants have only one additional use.

Weed salience as a measurement of importance as food

The list of weedy vegetables was compared to the results of the freelisting of wild vegetables conducted at the study site. More than half of the freelisted plants (53%, 32 species) are weeds, corresponding to 75% of the weedy vegetables identified in this research. Moreover, 15 of the 19 species that had the highest *CSI* score are weeds. The wild vegetables with the highest *CSI* score were *Ipomoea aquatica* (0.359) and *Limnophila aromatica* (0.173), which are aquatic herbs regarded as rice weeds. Both are medicinal annual plants growing in rice fields and home gardens. *I. aquatica* is a common target of herbicides. Other plants that had a high *CSI* score were the climber *Coccinia grandis* (0.122), the aquatic weed *Limnocharis flava* (0.105), the tree *Leucaena leucocephala* (0.096), the aquatic fern *Marsilea crenata* (0.091) and the herb *Centella asiatica* (0.090). *Glinus oppositifolius*, which showed also to have a high *CSI* score (0.086), grows in the non-irrigated fields in the

Tab. 2 List of most salient weeds out of the freelist of wild vegetables, indicating the Sutrop's *CSI* score, frequency of mention ($n = 130$) and percentage of respondents who listed the plant.

Botanical name	Sutrop's *CSI*	Frequency of mention ($n = 130$)	Percentage of respondents (%)
Ipomoea aquatica Forssk.	0.359	110	84
Limnophila aromatica Merr.	0.175	111	85
Coccinia grandis (L.) Voigt	0.123	73	56
Limnocharis flava Buchenau	0.111	88	67
Leucaena leucocephala (Lam.) de Wit	0.095	49	37
Centella asiatica (L.) Urb.	0.091	86	66
Marsilea crenata C. Presl	0.091	67	51
Glinus oppositifolius (L.) Aug. DC.	0.087	78	60
Nymphaea pubescens Willd.	0.072	67	51
Azadirachta indica A. Juss. var. *siamensis* Valeton	0.062	59	45
Amaranthus viridis L.	0.060	60	46
Cassia siamea Lam.	0.059	63	48
Neptunia oleracea Lour.	0.049	33	25
Careya arborea Roxb.	0.039	38	29
Monochoria hastata (L.) Solms	0.032	34	26

hot dry season constituting an important dietary complement in this period of the year. Tab. 2 presents the list of the weedy vegetables that exhibited the highest *CSI* scores.

Discussion and conclusions

The results of this study show that weedy vegetables are an important resource for rice farmers in Kalasin, Northeast Thailand, not only as food but also because of the multiple additional uses they have. This is certainly important in this region that is the poorest in the country [42]. It is particularly remarkable that more than half of the weedy vegetables identified are also regarded as sources of medicine, which is consistent with previous findings in the research area [43]. The overlapping roles of wild plants as food and medicine have been discussed by various authors [12,44–46], and have been reported in different regions in the world such as Palestine [47], China [48] and, certainly, Thailand [19,22]. Additionally, the use of weeds as medicinal plants has also been discussed in the scientific literature, for instance regarding home garden weeds in South Africa [49,50] and rice weeds in Chhattisgarh, Eastern India [50].

Comparing with previous studies conducted in Thailand, the list of weedy vegetables obtained with the present research includes 11 vegetables that have also been reported by Vongsaroj and Nuntasomsaran [22], as well as 16 vegetables also listed by Maneechote [19]. However, most weeds reported in the list have not been registered by these authors. Some of Northeast Thailand's edible weeds are also consumed in other Asian countries, such as *Centella asiatica* in India and China [20,51], *Glinus oppositifolius* in India [20], *Amaranthus viridis* and *Ipomoea aquatica* in the Philippines and China [16,51,52], *Coccinia grandis* in Vietnam [24], as well as *Momordica charantia* in Vietnam [24] and China [51].

The fact that the highest *CSI* scores of all wild vegetables freelisted corresponded to weeds, reinforces the assertion that weeds are culturally cognitively important for local farmers as a vegetable source. Indeed these species are a major part of the diet and culinary tradition in the region. This is a crucial finding, given that these plants are not only regarded as weeds to be eliminated by agronomists and rural extension services, but also are targets of common pesticides used in this area.

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