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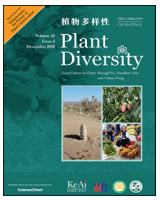

Research paper

Plant diversity in herbal tea and its traditional knowledge in Qingtian County, Zhejiang Province, China

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ABSTRACT

Herbal teas composed of locally occurring plant species have long been used as the primary form of health care in Qingtian County, Zhejiang Province, China. However, large-scale emigration overseas and an aging population threaten the conservation of traditional knowledge of these herbal teas. Traditional knowledge about the plants used for these herbal teas is not well documented in Qingtian, despite their widespread use. The aim of this study was to assess the plant-cultural diversity of plants used as herbal teas, and to point out the prospective value of herbal teas used by Qingtian people. This study was conducted using semi-structured interviews, as well as field and market surveys. Forty-three local informants were interviewed. We recorded plant resources, plant parts used, local names, and medicinal uses. Quantitative ethnobotanical indices, including cognitive salience (CS), frequency of citation (FC), index of informant consensus (F_{ic}) and use value (UV), were calculated to analyze the level of representativeness and relative importance of plants used in herbal teas. One hundred and twenty-nine species belonging to 75 families and 113 genera were reported to be used in herbal tea, with Compositae being the richest family. Whole plants are most commonly used to make herbal teas (66.7%). In this study, informants reported that 92.2% of plant species used in herbal teas are wild. The most utilized herbal preparation form is dry/fresh. Informants reported that herbal teas are used to treat 31 ailments. Our results show that the highest representativeness, based on CS and FC, was recorded for species *Actinidia eriantha*. Based on UV, the top five most used species are *Goodyera schlechtendaliana*, *Plantago asiatica*, *Prunella vulgaris*, *Lophatherum gracile* and *Leonurus japonicus*. The highest F_{ic} was cited for dental medicine. This study helps document the status of current herbal teas in Qingtian. The use value and traditional knowledge of herbal teas have provided basic data for further research focused on bioactivity studies and sustainable utilization of the most important species.

1. Introduction

For hundreds of years, people who have lived in Qingtian, southern China, have responded to extreme heat by drinking herbal teas (Wang, 2013). Qingtian residents collect familiar plants to make herbal teas in an effort to prevent and/or treat physical ailments. Generally, herbal tea, less commonly called tisanes, is a generic term used for any beverage made from the infusion or decoction of steeped flowers, roots, leaves, or other parts from plants other than *Camellia sinensis* (L.) Kuntze. Despite significant improvements in modern health care, current interest in food as medicine has highlighted the medicinal properties of plants. Although many people drink herbal teas for pleasure, elderly people that live in rural areas often use herbal teas as affordable, accessible, and effective alternatives to medicine (Joubert et al., 2008).

Traditional medicine, which is widely used as a complement and alternative to synthetic drugs in health care systems all over the world, relies on knowledge and use of medicinal plants

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(Neelam et al., 2018). Traditional knowledge of these medicinal plants, which has been gained through long-term struggle against disease and harsh natural environments, is of tremendous value (Stepp, 2004; Hu et al., 2020). Furthermore, because traditional medicine is affordable, accessible and lacks the adverse effects of chemical drugs, it has attracted attention from health system stakeholders (Lewu and Afolayan, 2009; Hu et al., 2020). For example, the World Health Organization has promoted the use of traditional medicine, including medicinal plants, in its 2014–2023 strategy, with the aim of keeping populations healthy through providing access to effective and affordable alternatives to medicine, and of providing healthcare choices consistent with people's cultural practices. In addition, researchers in search of novel drugs have attempted to maximize their efforts by using an ethnobotanical approach to investigate regions of high biodiversity and disturbed environments (Frei et al., 2000; Stepp, 2004; Sun et al., 2020). Integrating traditional and complementary medicine (T&CM) into health care services is an important factor in achieving health and well-being (Zhang et al., 2019). Importantly, traditional medicine, including traditional Chinese medicine, is inseparable from its culture (Li et al., 2015). Therefore, it is of vital importance to protect the plant-cultural diversity of medicine food homology plants.

In Qingtian County traditional knowledge of herbal teas is at risk of being lost. Herbal tea traditional knowledge is largely passed on by word-of-mouth in a spoken dialect that is disappearing. In 2000, the elderly in Qingtian outnumbered the young 43:1, well above international standards (i.e., >30:1) (Zhan, 2014). Many working-age Qingtian residents have emigrated to find work, leaving only children and the elderly behind. In addition, increased contact between Qingtian and other countries has facilitated the sharing of traditional knowledge, but also reduced the cultural importance of local herbal teas. Therefore, in Qingtian, particularly in rural areas, traditional medicines that use herbal teas have an uncertain future.

One possible solution to this challenge is documenting the plant resources and traditional knowledge of herbal teas, including local names, medicinal uses, and plant parts used. In addition, quantitative analysis of ethnobotanical indices is important for conserving plant-cultural diversity. In this study, we assessed the current status of traditional knowledge on herbal teas in Qingtian, evaluating the potential value of herbal teas used by Qingtian people. We also compared similarities of plant-cultural diversity of herbal teas between Qingtian and Lingnan.

2. Methods

2.1. Study area

Qingtian is located near China's southeastern coast in Lishui city, Zhejiang province between 27°56′N, 119°47′E and 28°29′N, 120°26′E (Fig. 1). The county covers an area of 2493.34 square kilometers, of which 89.7% are hills, about 5% are rivers, streams, ponds and reservoirs, and only 5.3% are cultivated land. In 2007, Qingtian's agricultural population accounted for 83.95% of the total population, and their per capita cultivated area was 0.4 mu (Zhan, 2014). During summer and autumn, Qingtian's weather is characterized by the Pacific Subtropical High, high temperatures, and abundant rainfall. The geography and climatic conditions of Qingtian support relatively abundant plant resources. There are 1340 species of medicinal plants in Lishui city, accounting for 75.1% of the total species in Zhejiang Province (Zhang et al., 2013). According to incomplete statistics, there are thousands of medicinal plants distributed in Qingtian (Wang, 2013).

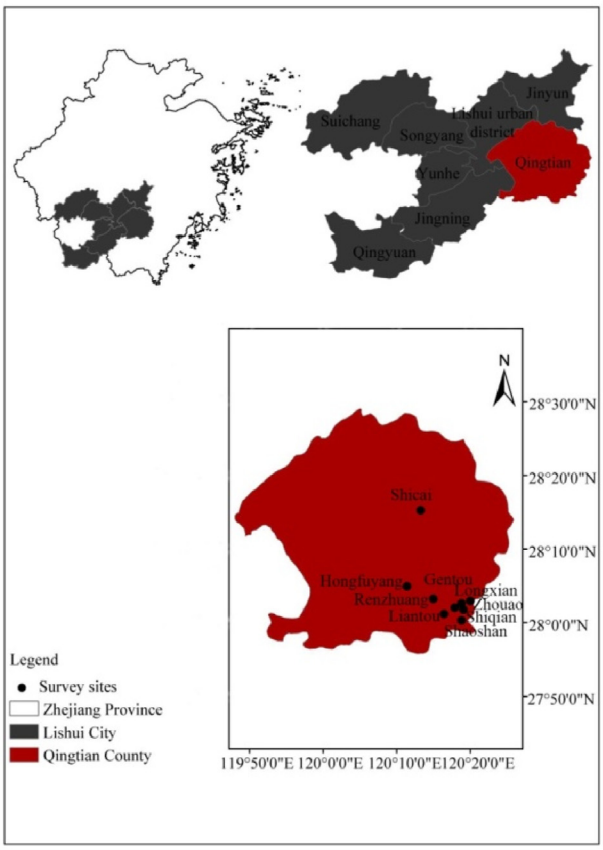

Fig. 1. Study area location.

2.2. Interviews and plant material collection

Ethnobotanical investigations were conducted in nine villages (Longxian, Shiqian, Gentou, Zhouao, Liantou, Renzhuang, Shicai, Shaoshan, Hongfuyang) between July and September 2019 (Fig. 1). Surveys were based on semi-structured interviews and free-lists, with each session attended by a university-educated translator. Key informants were selected systematically after visiting the Qingtian agricultural and rural affairs bureau and the local village head. All informants surveyed were farmers and herbal tea shop owners who have experienced in making herbal teas. In our survey, 41 farmers had the time and confidence to identify plants used to make herbal teas; these individuals are identified as key informants. Five key informants were selected for investigation in each of eight villages. In Hongfuyang, however, only one key informant was recommended and interviewed, a 40-year-old man who acquired traditional knowledge about medicinal plants from his mother. Two herbal tea shops at Dabutou and the Central vegetable market in Qingtian were interviewed. Local herbal tea shop owners were automatically qualified as key informants. In total, we collected data from 43 informants (31 males and 12 females), ranging in age from 40 to 75 (mean age 57.5). During our survey, young people were rarely observed in the villages. The education level of informants varied from illiterate (70% of informants) to tertiary-educated (3% of informants).

Free lists from each respondent were elicited by the prompt: “Name all the plant species you can think of that are used to make herbal teas.” In the semi-structured interview, we recorded the local name, plant parts used, medicinal uses, and other traditional knowledge for each plant species. The species mentioned by each

informant were identified by a professional botanist using live specimens or photographs. The voucher specimens of some species were collected and stored at the Weed Herbarium of Nanjing Agriculture University; other species were only photographed. Official collaboration with the Qingtian Agricultural and Rural Affairs Bureau ensured that the collection of local traditional knowledge was compliant with the ISE Code of Ethics (ISE Code of Ethics, 2006). Verbal permission was granted by all participants of this study.

2.3. Statistical analyses

We analyzed data using several quantitative ethnobotanical indices, including Cognitive salience (CS), Frequency of citation (FC), Index of informant consensus (F_{ic}), Use Value (UV), and Similarity coefficient (S).

(1) We used Frequency of Citation (FC) to assess the importance of a particular species for the treatment of certain illness categories (Tardío et al., 2008). This index varies from 0, when a plant species is identified as an herbal tea by no informants, to 1 in the unlikely case in which all informants identify a species as an herbal tea.

$$FC = \frac{N_p}{N_i}$$

where N_p is the number of informants who mention the particular use of the species and N_i is the number of all informants interviewed in the survey.

Most plants were mentioned for several ailment categories. To assess the relative importance of each species as herbal teas, the total use value (UV) was calculated as follows (Hudaib et al., 2008):

$$UV = \frac{\sqrt{U}}{N_i}$$

where U is the number of uses for each species mentioned by each informant i.

(2) Cognitive salience (CS) (Robbins et al., 2017) was used to represent the typicality and representativeness of each plant in herbal tea culture in Qingtian. This index was derived from free-list, combining list position and list frequency, and was calculated as follows:

$$B = [k - r(i)] / [k - 1]$$

$$CS = \left[\sum B + F - 1\right] \Big/ [2Z - 1]$$

where k is the number of listed items; $r(i)$ is the ith rank of each item's listed position (i = 1, 2, …,k); F is the number of lists in which the term is mentioned to measure the overall sample or group; Z is the number of informants.

(3) Index of informant consensus (F_{ic}):

F_{ic} is an indicative value of how many informants agree a specific plant use to treat a particular category of ailments. F_{ic} is calculated as follows (Hudaib et al., 2008):

$$F_{ic} = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

where N_{ur} is the number of use-reports in each category and N_t is the number of taxa used.

(4) The Similarity coefficient (S) was used to quantify the plant species used for herbal teas in both Qingtian and Lingnan. S was calculated by the following formula (Zheng et al., 2013):

$$S = \frac{2c}{(a + b)}$$

where a and b represent the species used in Qingtian and Lingnan, respectively, and c represents the species in common between two regions.

Chi-square analysis was used to understand whether traditional knowledge of herbal teas (e.g., plant status and plant part used) varied considerably between Qingtian and Lingnan.

3. Results

3.1. Taxonomic diversity of plant used in herbal teas in Qingtian

Our free-list survey of plants used in herbal teas identified 129 plant species distributed among 75 families and 113 genera (Appendix A). The highest number of species belonged to Compositae (17 spp.), followed by Gramineae (8 spp.), and Labiatae (6 spp.) (Fig. 2).

Excluding herbal tea shop owners, the number of species cited per informant varied from 4 to 27. We also noted that informants showed a preference for wild plant species. Of the 129 reported species, most were weeds (92.2%) in rural farmland and surrounding areas.

3.2. Local traditional knowledge of herbal teas in Qingtian

In our survey, informants reported that herbal teas were only prepared one way locally. Specifically, herbal teas are brewed by pouring boiling or almost boiling water over the ingredients and then steeping, without additions or tedious processing. In addition, informants reported that dry materials are more often used in preparation of herbal teas. Of the plant species used to prepare herbal teas, 45% (58) are used dry, whereas 54.3% species (70) are used dry or fresh. Several plant part(s) are used in herbal teas, including whole plant, root, flower, rhizome, fruit, aerial part, leaf, stem, tuber, stigma and stem pith. The most used plant parts are whole plant (66.7%), root (10.9%), and flower (5.4%) (Fig. 3). Compared with Drug Standard Database (http://www.drugfuture.com/standard/), there are 67 plant species used to make herbal teas that are not included in the Chinese Pharmacopoeia. Furthermore, for 21 of the remaining 62 species, the plant parts used in herbal teas in Qingtian are inconsistent with plant parts used for medicinal purposes according to the Chinese Pharmacopoeia (see Appendix A for complete list).

3.3. Diversity of ailment categories treated by herbal teas in Qingtian

Informants reported that herbal teas prevent or alleviate illnesses in 31 ailment categories (Table 1). Herbal teas are most frequently used (N_{ur} >50) to clear away heat and detoxify, diuretics, anti-inflammatories, and ways to improve blood circulation. Three uses were only cited once (anti-inflammatory, induce sweat, and itch relief); thus, we were unable to calculate their F_{ic} values. In six ailment categories (headache, sore-throat, excessive sweat, high

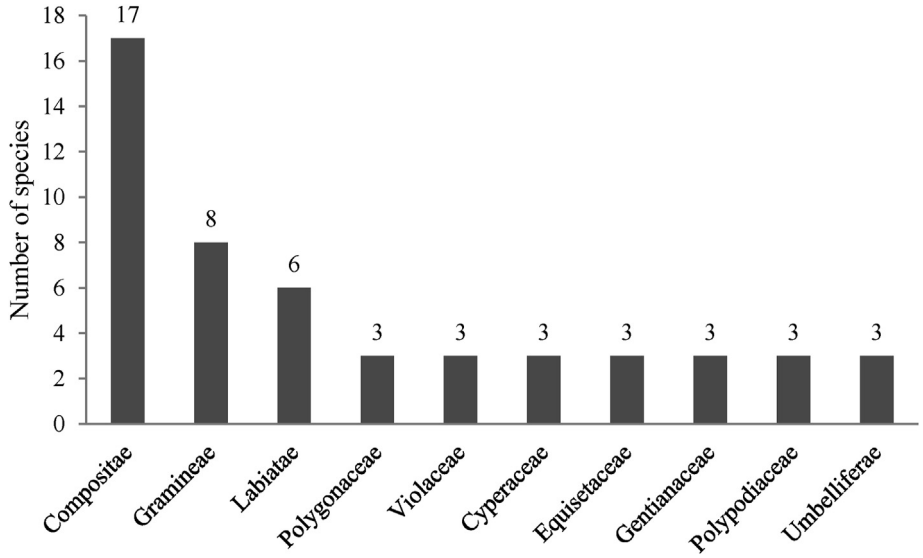

Fig. 2. Family rank of species used in herbal teas in Qingtian.

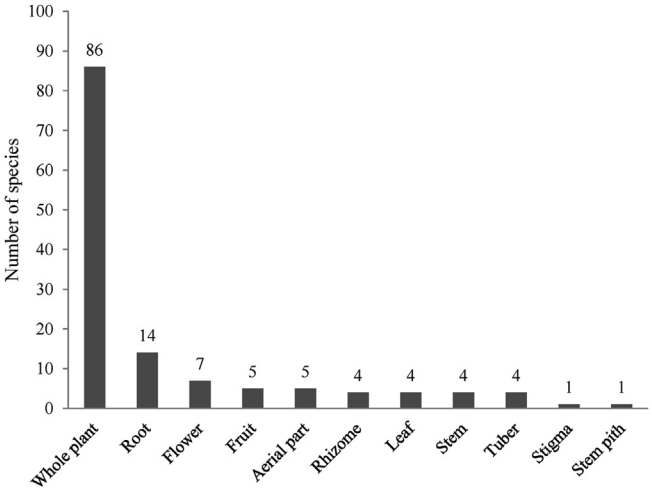

Fig. 3. Plant parts used for herbal teas in Qingtian.

blood pressure, kidney stones, and flatulence), informants reported using only one plant species; therefore, the F_{ic} values for these categories is 1.00 (Table 1). Aside from these six ailment categories, the highest F_{ic} value (0.8) was cited for dental problems and gynecopathy. The plant species that received the highest FC value for treating dental problems was *Conyza canadensis* (L.) Cronq (Table 2). For gynecopathy, *Mirabilis jalapa* L. was the plant with the highest FC value. The third highest F_{ic} value (0.78) was for sedative, for which *Lophatherum gracile* Brongn. received the highest FC value. The fourth highest F_{ic} value (0.75) was cited for anti-malarial, involving two species, i.e. *Artemisia annua* L. and *Torilis scabra* (Thunb.) DC. The fifth highest F_{ic} value (0.74) was cited for promoting digestion and relieving dyspepsia; for stomach problems, *Cyperus rotundus* L. and *Agrimonia pilosa* Ldb. had higher FC values than *Crataegus pinnatifida* Bunge, which is known as a plant used for digestion.

The efficacy and usage of *C. rotundus* for stomach problems is consistent with Chinese Pharmacopoeia; however, promoting digestion and relieve dyspepsia with *A. pilosa* has not been included in Chinese Pharmacopoeia. Similarly, neither *C. canadensis* nor *M. jalapa* have been included in Chinese Pharmacopoeia. Although the pharmacopoeia includes *L. gracile* and *A. pilosa*, informants in our study identified previously unreported uses for these plants. For example, informants mentioned that *L. gracile* has three uses: sedative, diuretic and expectorant. The pharmacopoeia does not include expectorant. Chinese Pharmacopoeia 2015 (The Committee of Pharmacopoeia, 2015) states that *A. pilosa* is used as an anti-hemorrhagic and anti-inflammatory. However, our informants reported that herbal teas of *A. pilosa* have four medicinal uses: promote digestion and relieve dyspepsia, antidysentery, anthelmintic and tonification. The Chinese pharmacopoeia lists "promoting digestion and relieve dyspepsia" as a use of *C. rotundus*. Other uses of *C. rotundus* were similar to Chinese Pharmacopoeia, but did not completely correspond to them (see Appendix A for details).

3.4. The relative importance of plant species used for HTs

According to the ethnobotanical survey, most plant species can cure several ailments. To assess the number of ailments that can be treated by each plant species, we calculated the total use value (UV), which also served as a measure of the relative importance of each species as an herbal tea. The UV of species varied from 0.02 to 0.15 (Appendix A). Species with the highest UV (0.15) were *Plantago asiatica* L. and *Goodyera schlechtendaliana* Rchb. F. *P. asiatica* and *G. schlechtendaliana* are not included in Chinese Pharmacopoeia (Table 3). Informants reported that the main medicinal uses of *P. asiatica* include clearing away heat and detoxifying the body, diuretic, and cooling the blood. The main medicinal uses of *G. schlechtendaliana* are as a diuretic, cough suppressant, and dental medicine, as well as to clear away heat and detoxify the body, and promote blood circulation. The main medicinal uses of *Prunella vulgaris* are as anti-inflammatories that can also cleanse the liver and improve eyesight, and clear away heat and detoxify the body. The species with the second highest UV was *P. vulgaris* (UV = 0.14), which is included in Chinese Pharmacopoeia (The Committee of Pharmacopoeia, 2015). The species with the third highest UV was *L. gracile* (UV = 0.12). The main medicinal uses of *L. gracile* are expectorant, sedative and diuretic (Table 3). These four species are very common in Qingtian.

We used the Cognitive Salience index to represent the typicality and representativeness of each species for herbal teas in Qingtian.

Table 1
Informant consensus factor (F_{ic}) by ailment categories.

SN	Ailment category	N_t (Species)	N_{ur} (Use citations)	F_{ic}
1	Clear away heat and detoxify	87	243	0.64
2	Diuretic	41	95	0.57
3	Detumescence	28	61	0.55
4	Promote blood circulation	21	54	0.62
5	Cool blood	20	46	0.58
6	Dental medicine	9	42	0.80
7	Cleanse liver and improve eyesight	13	41	0.70
8	Expectorant	14	41	0.68
9	Cough suppressant	16	40	0.62
10	Anti-hemorrhagic	18	34	0.48
11	Promote digestion and relieve dyspepsia	6	24	0.74
12	Relieve summer-heat	6	18	0.71
13	Sedative	3	10	0.78
14	Dispel wind-damp	5	10	0.56
15	Anthelmintic	3	8	0.71
16	Pain relief	6	7	0.17
17	Gynecopathy	2	6	0.80
18	Anti-malarial	2	5	0.75
19	Treat headache	1	4	1.00
20	Relieve sore throat	1	4	1.00
21	Tonification	2	4	0.67
22	Antidysenteric	3	4	0.33
23	Sweat suppressant	1	3	1.00
24	Reduce blood press	1	3	1.00
25	Treat kidney stones	1	2	1.00
26	Treat flatulence	1	2	1.00
27	Anticancer	2	2	0.00
28	Promote lactation	2	2	0.00
29	Evacuate pus	1	1	–
30	Induce sweat	1	1	–
31	Itch relief	1	1	–

Table 2
The frequency of citation of species included in the five categories with the highest F_{ic}.

Frequency of citation (FC)									
Dental medicine		Gynecopathy		Sedative		Anti-malaria		Promote digestion and relieve dyspepsia	
Arenaria serpyllifolia L.	0.02	*Celosia cristata* L.	0.02	*Crocus sativus* L.	0.02	*Artemisia annua* L.	0.07	*Acalypha australis* L.	0.02
Bidens pilosa L.	0.16	*Mirabilis jalapa* L.	0.16	*Lophatherum gracile* Brongn.	0.16	*Torilis scabra* (Thunb.) DC.	0.05	*Agrimonia pilosa* Ldb.	0.16
Cirsium japonicum Fisch. ex DC.	0.05			*Mentha haplocalyx* Briq.	0.05			*Crataegus pinnatifida* Bunge	0.14
Conyza canadensis (L.) Cronq.	0.37							*Cyperus rotundus* L.	0.21
Goodyera schlechtendaliana Rchb. f.	0.23							*Kalimeris indica* (L.) Sch. -Bip.	0.02
Eleocharis dulcis (N. L. Burman) Trinius ex Henschel	0.07							*Phyllanthus niruri* L.	0.02
Ottelia alismoides (Linn.) Pers.	0.02							*Rostellularia procumbens* (L.) Nees	0.05
Potamogeton distinctus A. Benn.	0.05								
Potentilla discolor Bge.	0.05								

Table 3
Plants and traditional knowledge worthy of further attention.

SN	Plant species	Category	Plant parts used	CS	UV
1	*Conyza canadensis* (L.) Cronq.	Dental medicine	Whole plant	0.33	0.09
2	*Mirabilis jalapa* L.	Gynecopathy	Whole plant	0.15	0.09
3	*Lophatherum gracile* Brongn.	Expectorant	Whole plant	0.35	0.12
4	*Plantago asiatica* L.	Clear away heat and detoxify; diuretic; cool blood	Whole plant	0.27	0.15
5	*Goodyera schlechtendaliana* Rchb. f.	Dental medicine	Whole plant	0.26	0.15
6	*Actinidia eriantha* Benth.	Clear away heat and detoxify	Root	0.41	0.10
7	*Agrimonia pilosa* Ldb.	Promote digestion and relieve dyspepsia	Whole plant	0.11	0.08

The cognitive salience of 129 species ranged from 0.00 to 0.41 (Appendix A). The species with the 10 highest CS scores were *Actinidia eriantha* Benth., *P. vulgaris* L., *L. gracile* Brongn., *C. canadensis* (L.) Cronq., *Commelina communis* L., *P. asiatica* L., *G. schlechtendaliana* Rchb. f., *Scutellaria barbata* D. Don, *Ardisia japonica* (Thunb) Blume and *Leonurus japonicus* Houttuyn. The

highest typicality and representativeness based on cognitive salience and frequency of citation was recorded for *A. eriantha* Benth.

3.5. Comparison of herbal tea traditions between Qingtian and Lingnan region

Of the total 337 species, 129 species are used in Qingtian and 241 species are used in Lingnan. Of these, 33 species are used in both Qingtian and Lignan. The coefficient of similarity of species commonly used by Qingtian and Lingnan is 17.84%. However, for some plant species used in both Qingtian and Lingnan, the plant part used in herbal teas and the purpose of their use differed (see Table 4). This indicates these two regions have significantly different plant-cultural diversity.

Chi-square analysis showed that the habitat types of plant species used for making herbal teas varied non-significantly between Qingtian and Lingnan region ($P = 0.773$), which indicates both communities prefer to collect wild species. Also, the plant parts of the 33 common species varied significantly in the two different regions ($P = 0.000$), indicating that there were significant differences in plant parts used between the two culturally distinct communities.

4. Discussion

4.1. Traditional knowledge of Qingtian herbal teas is at risk of being lost

In this study, we used cognitive salience (CS) and frequency of citation (FC) to analyze the level of typicality or representativeness of each plant species used to make herbal tea in Qingtian (Robbins et al., 2017) (Appendix A). These measures are indicators of the level of enthusiasm for preserving traditional knowledge that prevents the loss of biodiversity and cultural diversity. The CS of 129 species ranged from 0.00 to 0.41. These analyses indicate that traditional knowledge of several herbal teas is at risk of being lost. This loss of traditional knowledge will alter local attitudes about these plants; for instance, useful medicinal tea ingredients may become viewed as useless weeds. Currently, many families no longer know how to make traditional herbal teas despite expressing a strong desire to do so. This forgotten or abandoned traditional knowledge has led to a fragmented herbal tea culture.

Traditional knowledge about the relationship between humans and their environment is the cumulative body of knowledge and practice that evolves by adaptive processes and is handed down through generations by cultural transmission; as such, traditional knowledge not only lives in “nature”, but also in a “culture” (Berkes et al., 2000; Heinrich et al., 2009). Herbal tea culture in Qingtian is largely being lost for demographic reasons. One of the main reasons for loss of the herbal tea plant-cultural diversity is emigration of the rural population. Almost every household in Qingtian has overseas Chinese. Furthermore, the population of Qingtian is aging. Although older people play an important role in preserving, disseminating and using traditional knowledge on a local level, without a younger generation cultural transmission cannot occur. Another major reason for the decrease and loss of herbal tea cultural diversity may be that local people do not fully recognize the ecosystem services (ES) of these plants, which have rarely been included in evaluation systems, such as supply services (food, herbs, raw materials, etc.) or regulating services (biodiversity, cultural service, etc.). ES assessment, which often includes traditional knowledge, is used to integrate various types of information for land management (Kovács et al., 2015; Campagne et al., 2017; Willemen et al., 2018). However, local people, who are the direct beneficiaries of ecosystem services, often fail to understand the concept. Thus, it remains unclear whether traditional knowledge plays a role in ecological services? And if so, how? Considering the potential value of rural ecosystem services in sustainable development, greater efforts should be made to raise awareness.

Ethnobotany is a science that studies how different peoples and societies interact with plants. Traditional knowledge offers wisdom and skills necessary to utilize plants (Heinrich et al., 2009). In addition, traditional knowledge obtained from ethnobotanical surveys can be used as indicators of ES assessment to provide reliable information to decision-makers who determine weed-control policy, e.g., the designation of *C. canadensis* as an invasive weed (Zhang et al., 2020). Therefore, traditional knowledge can help identify valuable “weeds” as a way of weed control. Even though Qingtian has faced a huge demographic shift over the last few decades, few studies have examined which plant materials are used for herbal teas and how increased emigration has affected traditional knowledge of herbal teas (Wang, 2013; Zhan, 2014). We confirmed that Qingtian emigrants take seeds abroad for planting, including *Houttuynia cordata* Thunb., which indicates potential acculturation. Developing targeted strategies to ensure sustainable access and increased consumption of herbal teas will require further assessment to identify species used for herbal teas in Qingtian. More importantly, conservation of plant diversity and cultural diversity are connected. Sustainable development depends on interactive development of both plant and cultural diversity (Li, 2013). Current conservation management approaches attempt to ensure that wild plants with sustainable uses remains within range of human populations. Excavating clues from the remaining herbal tea traditional knowledge in Qingtian is conducive to the preservation of plant diversity and cultural diversity of species (Long et al., 2003).

4.2. Assessing the prospective value of HTs used by Qingtian people

In Qingtian herbal teas are used as a therapeutic form of T&CM. Identifying plant materials used in medicinal herbal teas is fundamental for drug discovery. Traditional knowledge in Qingtian reflects a sophisticated understanding of how to use plants in herbal teas as remedies to 31 ailments (Table 1). We compared the plants used for herbal teas in Qingtian to Chinese Pharmacopoeia as an approach to developing and utilizing the therapeutic potential of these plants. In our survey, a total of 67 plant species used in herbal teas were not listed in the Chinese Pharmacopoeia; in addition, the plant parts of 21 species used in herbal teas were inconsistent with those recorded in the Chinese Pharmacopoeia. Furthermore, most plant species used in herbal teas are listed as weeds (92.2%). Therefore, these commonly used plant species are found near farmland and are both safe and effective; however, traditional knowledge of these plant species has yet to be verified scientifically.

F_{ic} values indicate the cultural coherence of the selection of a set of species used in the treatment of a certain ailment. In this study, F_{ic} values ranged from 0 to 1; higher F_{ic} values indicate greater consistency in the use of these species among informants surveyed. We recommend the utilization and further investigation of those plants we have identified as having higher typicality or representativeness, including *A. eriantha* (clear away heat and detoxify), *C. canadensis* (dental medicine), *M. jalapa* (gynecopathy), *L. gracile* (expectorant), *G. schlechtendaliana* (dental medicine), *P. asiatica* (clear away heat and detoxify, diuretic, cool blood) (Table 3).

A. eriantha is used to make herbal teas that clear away heat and detoxify the body. Previous studies have supported this use by showing that polysaccharides in *A. eriantha* can activate lncRNA and mRNA expression profiles in immune cell “macrophages”

Table 4
A comparison of plant materials commonly used for herbal tea in Qingtian and Lingnan.

Species in common	Qingtian		Lingnan	
	Ailment category	Plant part used	Ailment category	Plant part used
Imperata cylindrica (L.) Beauv.	Diuretic, cough suppressant	Rhizome	Clear away heat and diuretic	Rhizome
Patrinia scabiosaefolia Fisch. ex Trev.	Clear away heat and detoxify, detumescence, promote blood circulation	Rhizome	Clear away heat and detoxify	Whole plant
Eleocharis dulcis (N. L. Burman) Trinius ex Henschel	Dental medicine	Tuber	Clear away heat and detoxify, diuretic, cool blood, expectorant, laxative	Tuber
Plantago asiatica L.	Clear away heat and detoxify, diuretic, cool blood	Whole plant	Clear away heat and dampness, diuretic	Whole plant, seed
Lophatherum gracile Brongn.	Expectorant, sedative, diuretic	Whole plant	Clear away heat, sedative	Leaf, root
Hypericum japonicum Thunb. ex Murray	Clear away heat and detoxify, cleanse liver and improve eyesight	Whole plant	Anti-inflammatory and detoxify	Whole plant
Liquidambar formosana Hance	Relieve pain	Fruit	Regain consciousness	Fruit
Lygodium japonicum (Thunb.) Sw.	Clear away heat and detoxify, diuretic, promote blood circulation	Aerial part	Clear away heat	Pollen
Carthamus tinctorius L.	Promote blood circulation	Flower	Promote blood circulation to promote menstruation, relieve pain	Flower
Artemisia annua L.	Clear away heat and detoxify, relieve summer-heat, anti-malaria	Whole plant	Clear away heat and cool blood, relieve summer-heat and anti-malaria	Whole plant
Polygonum chinense L.	Clear away heat and detoxify, cleanse liver and improve eyesight	Aerial part	Clear away heat	Whole plant
Agastache rugosa (Fisch. et Mey.) O. Ktze.	Relieve summer-heat	Aerial part	Dispel damp, stimulate the appetite and relieve vomiting	Whole plant
Celosia cristata L.	Expectorant, gynecopathy	Flower	Anti-hemorrhagic, anti-bacterial	Flower
Centella asiatica (L.) Urban	Clear away heat and detoxify, diuretic, detumescence	Whole plant	Anti-viral, anti-bacterial, reduce blood pressure	Whole plant
Cirsium japonicum Fisch. ex DC.	Clear away heat and detoxify, anti-hemorrhagic, dental medicine, cool blood	Root	Cool blood and anti-hemorrhagic, detoxify	Aerial part, root
Gynostemma pentaphyllum (Thunb.) Makino	Clear away heat and detoxify, tonification, reduce blood press	Whole plant	Anti-tumor, tonification	Aerial part
Pogonatherum crinitum (Thunb.) Kunth	Clear away heat and detoxify, diuretic, cool blood, anti-hemorrhagic	Whole plant	Clear away heat, diuretic	Whole plant
Gentiana scabra Bunge	Cleanse liver and improve eyesight	Whole plant	Clear away heat, dispel damp	Root, rhizome
Agrimonia pilosa Ldb.	Promoting digestion and relieve dyspepsia, anti-dysenteric, anthelmintic, tonification	Whole plant	Anti-hemorrhagic, anti-dysenteric, anthelmintic	Whole plant
Portulaca oleracea L.	Clear away heat and detoxify, cool blood, anti-dysenteric	Aerial part	Clear away heat and detoxify, cool blood, anti-dysenteric	Whole plant
Ilex pubescens Hook. et Arn.	Clear away heat and detoxify, promote blood circulation, cool blood	Root	Anti-viral	Root, leaf
Lonicera japonica Thunb.	Clear away heat and detoxify	Flower	Clear away heat and detoxify	Flower, stem
Crataegus pinnatifida Bunge	Promote digestion and relieve dyspepsia	Fruit	Promote digestion and relieve dyspepsia, promote blood circulation	Fruit
Belamcanda chinensis (L.) Redouté	Expectorant	Rhizome	Clear away heat and detoxify, expectorant and relieve sore throat	Rhizome
Acorus tatarinowii Schott	Detumescence, relieve pain	Rhizome	Dispel damp, promote digestion and relieve dyspepsia, expectorant, strengthen intelligence	Rhizome
Polygonum hydropiper L.	Clear away heat and detoxify, cleanse liver and improve eyesight	Whole plant	Clear away heat, diuretic	Whole plant
Tetrapanax papyrifer (Hook.) K. Koch	Promote lactation	Stem pith	Clear away heat, diuretic, promote lactation	Stem pith
Prunella vulgaris L.	Clear away heat and detoxify, cleanse liver and improve eyesight, detumescence	Flower	Clear away heat, detumescence, cleanse liver and improve eyesight	Whole plant
Commelina communis Linn.	Clear away heat and detoxify	Whole plant	Clear away heat and detoxify, reduce blood press	Whole plant
Dendranthema indicum (L.) Des Moul.	Clear away heat and detoxify, cleanse liver and improve eyesight	Flower	Clear away heat and detoxify, cleanse liver and improve eyesight	Flower
Emilia sonchifolia (L.) DC.	Clear away heat and detoxify, detumescence	Whole plant	Anti-bacterial, anti-inflammatory	Whole plant
Leonurus japonicus Houttuyn	Clear away heat and detoxify, diuretic, detumescence	Whole plant	Promote blood circulation and dispel stasis, diuretic and detumescence	Whole plant
Gardenia jasminoides Ellis	Promote blood circulation	Fruit	Clear away heat, relieve summer-heat, letting out skin eruptions	Fruit, flower

(Chen et al., 2019). In addition, the roots of *A. eriantha* have been shown to have antitumor and immunomodulatory activity (Xu et al., 2009). In traditional Chinese medicine *A. eriantha* roots are used to treat gastric carcinoma, nasopharyngeal carcinoma, breast carcinoma, and hepatitis (Sun et al., 2015). *Conyza canadensis* was identified by informants as one of the top 10 mostly frequently used plant species in herbal teas in Qingtian. Although it is an important dental medicine, it is a troublesome weed. *G. schlechtendaliana* is also used to treat toothaches, although its active agent remains unclear. The *Chinese materia medica* (Editorial Board of Chinese Materia Medica, 1999) and *Dictionary of Chinese medicine* note that *Mirabilis jalapa* is used to treat abnormal vaginal discharge (Jiangsu New Medical College, 1977). Local people in Qingtian reported using *P. asiatica* and *Plantago depressa* in herbal teas to the clear away heat and detoxify the body. Although *P. depressa* is included in Chinese Pharmacopoeia (The Committee of Pharmacopoeia, 2015), *P. asiatica* is not. Therefore, further research is needed to verify whether *P. asiatica* is used as a substitute or adulterant of *P. depressa*. Nevertheless, previous studies have demonstrated antiviral and immuno-regulatory effects of *P. asiatica* (Chiang et al., 2003).

Traditional Chinese medicine and herbal teas share fundamental principles. Herbal teas, unlike prescription drugs, are focused on daily health care. But as national strategies are increasingly integrated into global public health policy, key species that have not been included in Chinese Pharmacopoeia require more high-quality phytochemical and pharmacological studies to evaluate the efficacy and safety of short-term and long-term consumption of these herbal teas (Das et al., 2017). Moreover, traditional knowledge should serve as a basis for improving the bioactivity and taste of herbal teas. Similarly, herbal tea sellers should improve their understanding of herbal teas, including the plant species, storage methods, and their uses.

4.3. Comparison of herbal tea traditions between Qingtian and Lingnan region

The recognition of T&CM has driven the development of the global herbal tea market. Lingnan is famous for its herbal tea. Liu et al. (2013) recorded 241 species used for herbal teas in the Lingnan region (China). Because the climate in Qingtian is similar to that in Lingnan, we compared the herbal tea plant resources in Qingtian and Lingnan region. There are 33 plant species in common between Qingtian and Lingnan region, and the coefficient of similarity is low. Moreover, the traditional knowledge of these 33 species is not exactly the same, including the plant parts used and their functions. This suggests that future research on these 33 plant species should characterize the chemical composition and bioactivity of different plant parts, investigate possible herb–drug interactions of T&CM, and screen for potential drugs.

5. Conclusion

Herbal teas may play a role in improving plant diversity in our diet and improving some of our daily ailments through drug and food homology. This inventory adds to the databank of medicinal and edible plants used in T&CM which can be targeted to search for new drugs. In addition, our study demonstrates that F_{ic} and UV provide objective measures to select species for the herbal tea industry. However, the biological activities of plant species identified for both T&CM and herbal teas should be evaluated to validate traditional knowledge. We hope local people will continue to use herbal teas at home to prevent and treat some ailments, so as to conserve plant resources and species sourced. This study may also provide insights to decision makers on potential weed control approaches.

Authors' contribution

YJL and SQ conceived and designed the study. YJL, ZZ and JZ conducted field surveys and experiments. YJL, RCH and SSS analyzed the data. RCH, ZZ and XLS identified the plant species. YJL drafted the manuscript. SQ revised the manuscript. All authors read and approved the final manuscript.

Declaration of competing interest

The authors declare no conflict of interests.

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Appendix A. Supplementary data

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