Journal of Ethnopharmacology 260 (2020) 113012

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jethpharm

Documenting the heritage along the Silk Road: An ethnobotanical study of medicinal teas used in Southern Xinjiang, China

Aysajan Abdusalam[a], Yu Zhang[b,c], Maliyamu Abudoushalamu[d], Patiguli Maitusun[a], Cory Whitney[e], Xue-fei Yang[b,c], Yao Fu[b,c,*]

[a] College of Life and Geographic Sciences, Key Laboratory of Biological Resources and Ecology of Pamirs Plateau in Xinjiang Uygur Autonomous Region, Kashi University, Kashi, Xinjiang, 844000, China
[b] Department of Economic Plants and Biotechnology, Yunnan Key Laboratory for Wild Plant Resources, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, 650201, China
[c] Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences, Menglun, Mengla, Yunnan, 666303, China
[d] The First People's Hospital of Aksu Region, Xinjiang, 843000, China
[e] Department of Horticultural Sciences (INRES) / Center for Development Research (ZEF),University of Bonn, Bonn, 53121, Germany

ARTICLE INFO

Keywords:
Medicinal tea
Southern xinjiang
Traditional knowledge
Health promoting

ABSTRACT

Ethnopharmacological relevance: People in Southern Xinjiang, China have been consuming medicinal teas for healthcare since before the ancient Silk Road markets began. Several pharmaceutical studies have illustrated the potential healthcare benefits of medicinal teas used in Southern Xinjiang, China. However, little information is available from the literature about the diversity of the species used and related traditional knowledge of these medicinal teas.

Aims of the study: (i) create a comprehensive record of medicinal tea plant species (MTPS) and combinations used with related traditional knowledge for healthcare in Southern Xinjiang, China; (ii) assess safety of MTPS, and (iii) address conservation status for sustainable use of MTPS.

Materials and methods: We employed both field and market surveys from 2014 to 2019 in 10 counties/cities and four main medicinal tea markets by using semi-structured interviews. We interviewed 236 informants and 70 medicinal tea shop vendors. The commonly used MTPS were ranked by Frequency of Citation. Safety issues were assessed based on expert knowledge and with reference to the official list of Medicinal Plants Used as Food. Conservation implications of plant use were assessed as part of the interviews and this was cross referenced with official records.

Results: The surveys revealed 145 different plants from 65 families used for making medicinal teas, expanding the list of known Chinese herbal tea species from 782 to 884. Leguminosae, Rosaceae, Lamiaceae and Apiaceae were dominant families. Herbs (60.7%, 88 species) were the most commonly used plant types; fruits (23.1%, 50 species) and seeds (22.2%, 48 species) were commonly used parts. Nearly half (42.1%) of the plant species were introduced from abroad. Respondents reported more than 50 types of healthcare uses of medicinal teas. Tonic (13.7%, 71 species) and promoting digestion (9.6%, 50 species) were the most frequently mentioned healthcare uses. The majority of commonly used plant species were spices (20 species, 50%) and aromatic plants (10 species, 25%). *Cinnamomum cassia* (L.) J.Presl, *Piper longum* L. *Syzygium aromaticum* (L.) Merr. & L. M. Perry and *Gardenia jasminoides* J. Ellis were the most cited species. High doses of *Piper longum* L., *Crocus sativus* L., *Curcuma longa* L, and *Senna alexandrina* Mill. May have negative health implications. Assessments of conservation status and sustainable use of tea species indicate that wild harvesting of *Nardostachys jatamansi* (D. Don) DC. and *Pterocarpus indicus* Willd. Should be controlled and cultivation technologies should be improved.

Conclusions: We found high plant species diversity and rich traditional knowledge of medicinal teas used in Southern Xinjiang, China. The traditional healthcare uses of some of the medicinal teas are also supported by pharmaceutical evidence. Others should be investigated further. Conservation pressures exist for commonly used wild species. China's 'Healthy China 2030' policy should do more to take traditional cultural practices into account. In doing so, both local and national government agendas may seek to promote sustainable harvest and

* Corresponding author. Department of Economic Plants and Biotechnology, Yunnan Key Laboratory for Wild Plant Resources, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, 650201, China.
E-mail address: fuyao@mail.kib.ac.cn (Y. Fu).

https://doi.org/10.1016/j.jep.2020.113012
Received 7 February 2020; Received in revised form 22 May 2020; Accepted 22 May 2020
Available online 25 May 2020
0378-8741/

to protect traditional knowledge so that this cultural heritage continues to serve human well-being into the future.

1. Introduction

Healthy food has become a global trend and many people now take a holistic approach to personal health, following traditional customs and ways of understanding of healthy food (Verpoorte, 2015). In 2016 China's government issued the 'Healthy China 2030' Policy, which explicitly placed human health among the core political priorities for national development (Tan et al., 2017). Unhealthy diets are considered one of the major contributing factors to the rapidly increasing rates of chronic diseases in China (China's Central Committee, 2016, 2019). Therefore, one of the key aims of China's national health policy is to promote healthy diets for the general public.

Herbal teas, here defined as water decoctions or infusions of various plant ingredients, have long been used for healthcare and as part of a healthy diet. Consumption of herbal teas has been a common dietary practice, and a time-honored cultural phenomenon in China where they are considered one of the most important ways to maintain health (Xiao et al., 2014). About two thirds of the provinces of China have a core cultural habit of regular herbal tea consumption (Fu et al., 2018). The most well-known example is the cooling herbal tea used in Southern China (Liu et al., 2013; Li et al., 2017). More than 50 recipes of cooling herbal tea have been listed as part of China's national intangible cultural heritage (Liu et al., 2013). Healthcare effects of various herbal teas used in China have been verified in controlled animal studies, such as effects of sweet tea, *Lithocarpus litseifolius* (Hance) Chun, for dietary obesity (Zhou et al., 2013), anti-diabetic effects of honeysuckle flower tea (*Lonicera japonica* Thunb) (Zhou et al., 2016), and hepatoprotective effect of Five-Golden-Flowers Tea, a tea mixture of *Rosa rugosa* Thunb. (rose), *Osmanthus fragrans* Lour. (sweet osmanthus), *Dendranthema morifolium* (Ramat.) Tzvelev (chrysanthemum), honeysuckle, and *Jasminum sambac* (L.) Aiton (jasmine) (Zhao et al., 2018).

Southern Xinjiang (Southern part of Xinjiang Uygur Autonomous region of China) in the southern part of Tianshan Mountain Range was one of the most important trading centres along the ancient Silk Road from Han dynasty (202 B.C.-8 B.C.) (Yuan et al., 2016). People in Southern Xinjiang have been trading and consuming herbal teas, called 'Durilk chay' or'Dora chay' (literally translated as medicinal tea) since before the ancient Silk Road markets. The word 'chay' is the transliteration of Han Chinese word 'cha' meaning tea (Dong, 1996). Both words refer to both *Camellia sinensis* (L.) Kuntze as well as many other plant species consumed in similar drink forms (Fu et al., 2018). The medicinal teas of the region are consumed by local people at home, in tea houses, and in bars and restaurants. Drinking medicinal tea is considered to have health-promoting effects (Wang et al., 1996). Several studies have illustrated the potential healthcare benefits of medicinal teas used in Southern Xinjiang, China (Wang et al., 1996; Zhang et al., 2018; Bai et al., 2019). However, this common dietary practice is not well known among the general public outside the region or by policy makers at the national level.

Little information is available from the literature about the diversity of the species used and related traditional knowledge of medicinal tea in Southern Xinjiang, China. These represent an important part of the cultural heritage of China, and are potential sources for discoveries of healing plant-based pharmaceuticals, as of yet unknown to modern medicine. Traditional knowledge on the use of these species is at risk of being lost (Zhao, 2012) and local plant populations may also be threatened. Therefore, in this paper we aim to provide a comprehensive record of medicinal tea plant species (MTPS) and combinations used with related traditional knowledge in Southern Xinjiang, China. Health implications of plant uses and treatments are discussed. Conservation status for sustainable use of the plant species is addressed. The work offers protection for traditional medicinal tea knowledge as intellectual property, and provides guidance for further scientific investigations on health effects, safety and conservation of medicinal teas. Species-specific data of treatments and plant interactions in mixed tea may help in the development of novel healthcare products. It is also expected to enrich the related contents of the 'Healthy China' policy.

2. Methodology

2.1. Study area

The study was conducted in Southern part of Xinjiang Uygur Autonomous region of China. The region has an arid continental climate with a desert basin (Tarim basin) surrounded by high mountains (Yuan and Yang, 1990). The average temperature is around -5 °C in winter and 23 °C in summer, with about 77 mm annual precipitation (Hu et al., 2001). The region is around 384,200 km^2 with a population of roughly 10.4 million (Chao and Zhang, 2017). The region has a rich cultural diversity with more than 30 different ethnic groups (Gu, 2011).

2.2. Ethnobotanical survey of plant species used for medicinal teas

We employed a two-step process of data collection from 2014 to 2019: step one was field survey and step two was market survey. The surveys were designed to investigate plant species used by local people as medicinal tea. Informed consent was given by all informants during field and market surveys.

During the field surveys we interviewed 236 informants through snowball sampling in 10 counties/cities of the Xinjiang Uygur Autonomous region, including Kashgar City, Shule, Markit and Shache Counties of Kashgar prefecture; Yutian and Lop Counties of Hotan Prefectures; Artux City of Kizilsu Kirghiz Autonomous Prefecture; Wushi County of Aksu Prefecture; Gongliu County of Ili Kazak Autonomous Prefecture and Hejing County of Bayingol Mongolian Autonomous Prefecture (red dots in Fig. 1). We gathered five types of data: 1) the local names for MTPS, 2) healthcare uses and basic properties of the species, 3) plant parts used for making tea, 4) the processing and preparation methods, and 5) any safety issues related to the use of the tea.

During the market surveys we interviewed vendors in70 medicinal teashops. These vendors represent a special kind of expert. They are responsible not only for the management of the tea shop, marketing and selling, but also have an in-depth knowledge on the value chain of the tea and give customers advice about the application of the tea for medicinal and nutritional uses. We worked with these experts in four main medicinal tea markets, including Kashgar old town bazaar and Kashgar Western and Central Asian bazaar for international trade in Kashgar city, Trading center of Traditional Chinese medicine in Hotan City, and Yutian bazaar in Yutian County, which are the most important trading centres of MTPS in Southern Xinjiang (red triangles in Fig. 1). Plant species reported from field surveys as medicinal tea were verified through market survey. We recorded all the MTPS sold in each surveyed teashop. In addition, we purchased specimens of medicinal tea mixtures in surveyed teashops whenever available and asked vendors about healthcare uses of the tea mixtures.

Voucher specimens and samples were collected in local medicinal tea markets during the field and market surveys under the guidance of local experts. Some species which were not purchased from the markets were collected from the field. Plant species were identified according to Flora of Xinjiang (Commissione Redactorum florae Xinjiangensis, 2014) and Flora of China (www.efloras.org; www.iplant.cn). Botanical names

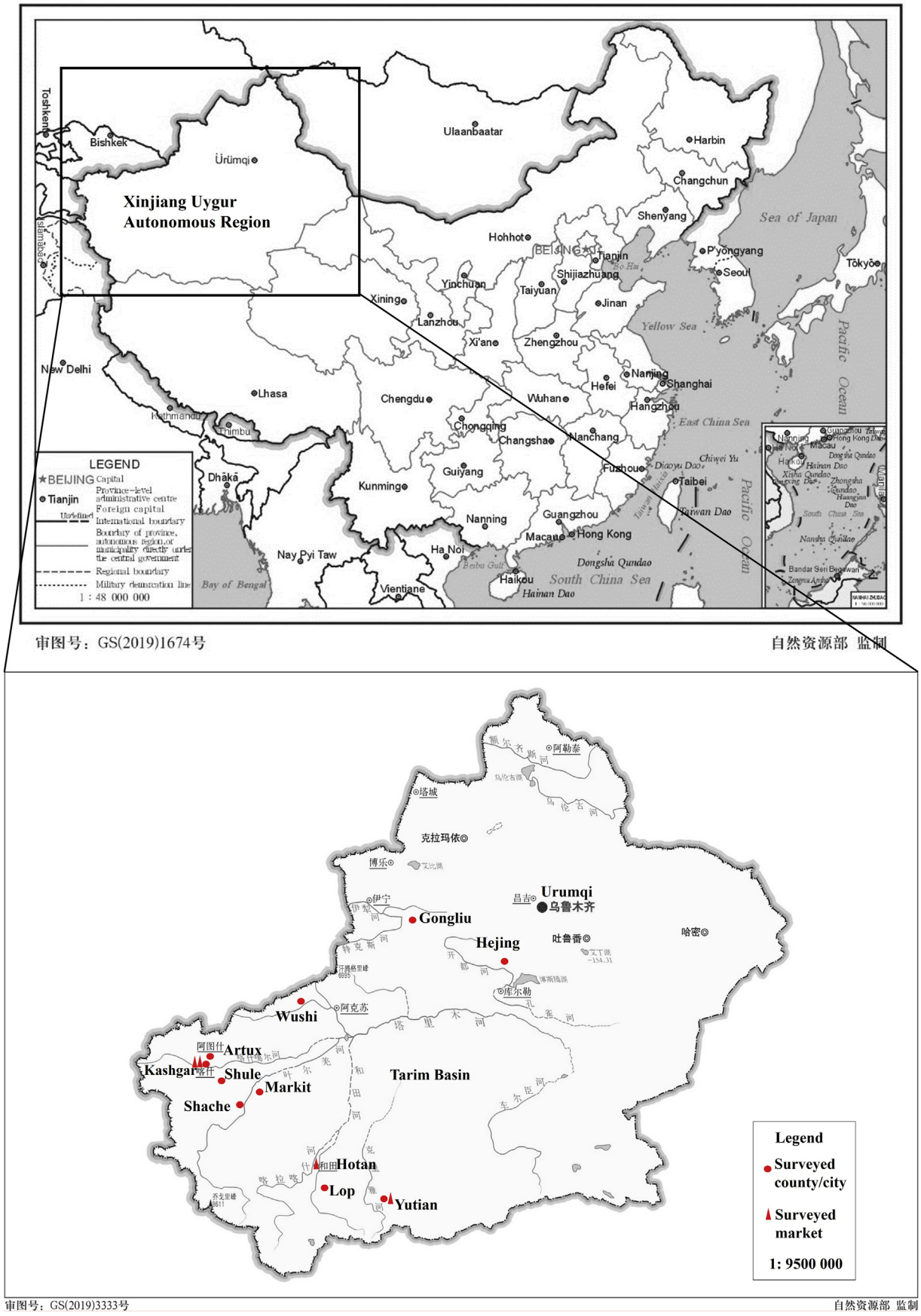

Fig. 1. Location of the study sites where the field (red dots) and market surveys (red triangles) took place in 10 counties/cities and four main markets respectively in the Xinjiang Uygur Autonomous region, China. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

of the plant species were verified through The Plant List database (www.theplantlist.org). All the specimens were collected as plates and herbarium samples and deposited at the Kunming Institute of Botany (Supplementary file A). Data on botanical origin of the plant species (indigenous to Xinjiang, indigenous to other provinces of China, or introduced from abroad) were obtained from Flora of China and Flora of Xinjiang (Supplementary file A).

Plant names and descriptions were used to describe folk categories according to local nomenclature in terms of color, taste, shape, etc. For instance only one species of garlic (*Allium sativum* L.) was identified in the region yet there were three folk categories, differentiated according to bulb color. The folk categories for this species includes the common type with white skin, called 'samsak', another with red skin called 'kizil postilik samsak', and a third with purple skin called 'sosun samsak'.

2.3. Traditional healthcare uses of medicinal teas

We used the interviews to collect data on traditional healthcare uses and related basic properties ('hot', 'warm', 'neutral', 'cool', 'cold') of each MTPS, and each of the medicinal tea mixtures. We then cross-checked these interview responses and complemented the work with secondary sources, including book of Uygur Medicine of Chinese Materia Medica (UMCMM) (中华本草维吾尔药卷) (Editorial board of Chinese Materia Medica, 2005).

2.4. Safety issues of medicinal tea use

We discussed safety issues with local healers and medicinal teashop venders and asked if there were any important health issues to pay attention to or things not to do when consuming the species as medicinal tea. We also searched for evidence of adverse events and case reports from the Chinese literature on the commonly mentioned species. We identified whether the plant species have been recorded in the official list of Medicinal Plants Used as Food (MPUF) issued by the National Health Commission (NHC, 2014). Medicinal plant species consumed by Chinese people as food over a long history without reported adverse effects are generally listed in this NHC publication. Therefore, we considered a listing in this publication to be confirmation of the safety of the plant.

2.5. Sources and conservation status of plant species used

During the market survey we asked medicinal teashop vendors about the sources (wild or/cultivated) of the species that they sell. We crosschecked the information through secondary sources, including UMCMM (Editorial board of Chinese Materia Medica, 2005), Flora of Xinjiang (Commissione Redactorum florae Xinjiangensis, 2014), and Flora of China (www.efloras.org; www.iplant.cn).

We also checked conservation status of the species through Information System of Chinese Rare and Endangered Plants (ISCREP: http://www.iplant.cn/rep/), as well as CITES Appendix II which includes species not necessarily threatened with extinction, but in which trade must be controlled in order to support long term sustainable use.

2.6. Data synthesis and analysis

We recorded all the data in the field and subsequently assessed it in the R programming language (R Core Team, 2017) using the ethnobotanyR package (Whitney, 2020). We categorized traditional healthcare uses according to the two ethnomedical classification systems: 1) traditional Chinese medicine system (Wang et al., 2008; WHO, 2007), and 2) the widely accessible and accepted resource International Classification of Primary Care (ICPC) system (WICC, 2015), which classifies diseases in relation to parts of the body and aligns with ethnomedical reality (Staub et al., 2015).

The commonly used MTPS were ranked by Frequency of Citation (FC) index, i.e., the number of informants that mention a useful species (Tardío and Pardo-de-Santayana, 2008). In our case, FC of a species was equal to one (FC = 1) when the species was reported by one shop vendor as medicinal tea. Species with FC more than nine (i.e. the species has been reported by more than nine shop vendors as medicinal tea) were considered to be commonly used.

For surveyed medicinal tea mixtures, the commonly used species were identified by counts of occurrence in all the purchased medicinal tea mixtures (i.e. 'counts of occurrence = 1' means that a species has only occurred in one purchased medicinal tea mixture product). Folk biological classification of reported MTPS were analyzed and presented based on Berlin (1973).

3. Results

3.1. Demographic profile of informants

During the field survey, a total of 236 informants were interviewed 106 male and 130 female. The age of the informants ranged from 24 to 85 (66.5%, age ≥ 50). Among these 142 (60.2%) were farmers, 31 (13.1%) were local healers, and others were grocery shop (9.3%) and restaurant owners (5.9%), and vegetable or fruit vendors (4.2%).

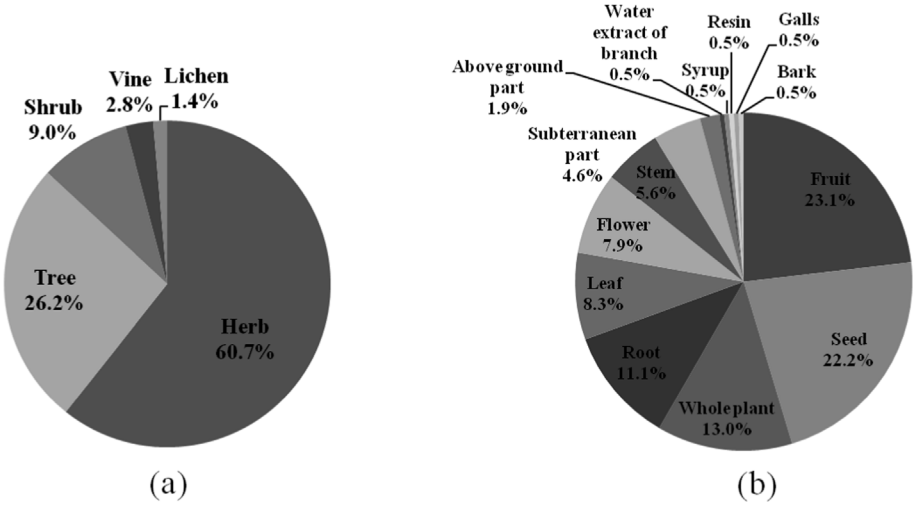

Fig. 2. (a) Percentage of plant species in each habit; (b) Percentage of plant parts used as medicinal tea (total number of uses = 216).

3.2. Plant species used for making medicinal teas

The surveys revealed 145 different plants from 65 families and 129 genera (including 141 species and 4 additional infraspecific taxa) used for making medicinal teas (Supplementary file A). Leguminosae was the dominant family with 16 species, followed by Rosaceae with 10 species, Lamiaceae and Apiaceae with 9 species. Herbs (60.7%, 88 species) were commonly used for medicinal teas, followed by trees, shrubs, and vines (Fig. 2a). Two lichen, *Usnea diffracta* Vain and *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, were used locally for making medicinal teas.

The tea species had varying botanical origins. Nearly half (42.1%) were introduced from abroad, 35.2% were from other provinces of China, while 22.7% were naturally distributed locally (Supplementary file A).

Folk categories for species tended to be differentiated according to color, taste, and shape. In addition to three kinds of garlic (*Allium sativum* L.), there were two kinds of apricot (*Prunus armeniaca* L.) locally named 'oruk' and 'aqqik oruk' (bitter taste apricot). There were four grape (*Vitis vinifera* L.) varieties named 'uruksiz kok uzum' (green grape without seeds), 'uruksiz kizil uzum' (red grape without seeds), 'gunqa uzum' (grape with smaller size) and 'kuruk munak uzum' (grape which is sparkling and clear). *Terminalia chebula* Retz. had three folk categories, including 'helila', 'kara helila' (the fruit with black color), 'serik helila' (the fruit with yellow color). Some different species were considered similar and shared the same local name. Both *Ocimum basilicum* L. and *Origanum vulgare* L. had the shared name 'rayhan'. Both *Usnea diffracta* Vain and *Parmotrema tinctorum* (Despr. ex Nyl.) Hale had the shared name 'oxna'.

3.3. Traditional healthcare uses

Respondents reported more than 50 types of healthcare uses of medicinal teas according to the traditional Chinese medicine system. Tonic (for nutrient improvement; body strength and restoration) (13.7%, 71 species) was the most mentioned healthcare use, followed by promoting digestion (9.6%, 50 species), diuretic (8.3%, 43 species), relieving pain (6.7%, 35 species), dispelling wind (wind is considered as a pathogenic factor in Traditional Chinese medicine) (5.8%, 30 species), Alleviating swelling (5.0%, 26 species) and regulating menstruation (5.0%, 26 species) (Supplementary file A). Based on the ICPC system, those healthcare uses could be grouped into 20 broader categories: Whole body (Health maintenance, Pain general, Dispersing pathogens, Swelling, Fever, Anti-inflammation, Bleeding, Weakness/tiredness), Blood, Digestive, Eye, Cardiovascular, Neurological, Psychological, Respiratory, Skin, Metabolic/Nutritional, Urological, Childbearing, and Female/male Genital systems. Most of the healthcare uses were grouped into the category of digestive system (82 species, 15.8%) and health maintenance (72 species, 13.9%) (Fig. 3). The majority of species (93.8%, 136) were considered multifunctional.

In terms of basic properties of surveyed medicinal teas, 'warmth' is the dominant property (42.1%, 67 species), followed by 'neutral' (19.5%, 31 species), 'hot' (15.1%, 24species), 'coolness' (11.9%, 19 species) and 'cold' (11.3%, 18 species). Most species (81.4%, 118 species) were listed in UMCMM (Supplementary file A).

Various plant parts were used, the commonly used parts were fruits and seeds, accounting for 23.1% (50 species for fruit) and 22.2% (48 species for seed) respectively (Fig. 2b). All plant parts were dried and usually put into hot water for 3–5 min before consumption. Healthcare functions of species were different when used in single or mixed recipes. Most species (80%, 116 species) were mixed, some (16.6%, 24 species) were used alone and in mixed formulas, and a few species (3.4%, 5 species) were used alone (Supplementary file A). The healthcare use of *Allium fistulosum* L. alone was to treat or prevent flu, and mixed with other herbs to regulate menstruation, promote urination, and alleviate swelling. *Cydonia oblonga* Mill. was used for suppressing cough, or mixed with other herbs to tonify stomach, liver and kidneys.

Healthcare uses were different among folk species (Supplementary file A) "sosun samsak" (garlic with purple skin bulb) was be used for tonifying stomach, relieving toxicity, and expelling parasite, while "kizil postilik samsak" (garlic with red skin bulb) was used for promoting digestion, regulating menstruation and relieving pain. "oruk" (apricot) was used for tonifying liver, heart and kidney, while "aqqik oruk" (apricot with bitter taste) is used for dispelling phlegm, suppressing cough, and relieving pain. In addition, different parts were used to treat different health problems. For example, the bark of *Cinnamomum cassia* (L.) J. Presl (Chinese cinnamon) was used for

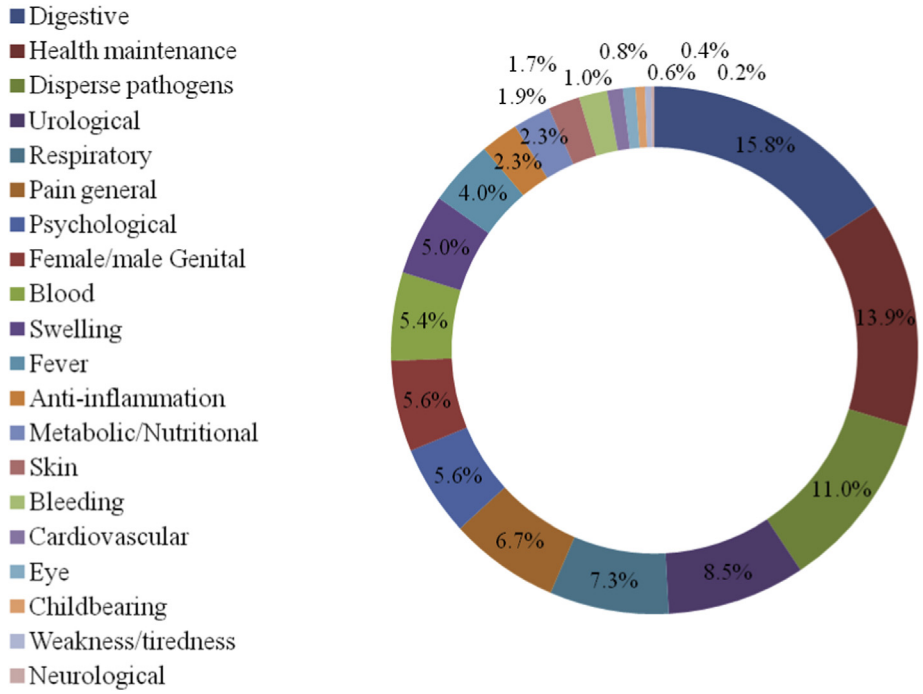

Fig. 3. Percentage of traditional healthcare uses of medicinal tea plant species (total number of uses = 519) following the ICPC classification (WICC, 2015).

Table 1
The forty commonly used medicinal tea plant species ranked by Frequency of Citation (FC).

FC[a]	Family	Latin name	Local name	Chinese name	Habit	Use part	Healthcare uses[e]	Property	wild/Cultivated	Vou. No.
55	Lauraceae	[b]*Cinnamomum cassia* (L.) J. Presl	darqin	肉桂	Tree	Bark	PD, TO, DP, TS	Hot	Cultivated	A-KAS-065
49	Piperaceae	[1b]*Piper longum* L.	pilpil	荜拔	Vine	Fruit	TO, PD	Warm	Cultivated	A-KAS-003
49	Myrtaceae	[b]*Syzygium aromaticum* (L.) Merr. & L. M. Perry	kalamqur	丁香	Shrub	Flower	DW, TR, RP, TT	Warm	Cultivated	A-KAS-075
49	Rubiaceae	*Gardenia jasminoides* J. Ellis	zaparhamiki	栀子	Shrub	Fruit	PD, AB, DI	Warm	Cultivated	A-KAS-067
47	Zingiberaceae	[b]*Alpinia officinarum* Hance	holinjan	高良姜	Herb	Subterranean part	PD, DP, AB, DW, TO	Hot, Warm	Cultivated	A-KAS-030
47	Rosaceae	[c]*Rosa rugosa* Thunb.	kizilgul	玫瑰	Shrub	Flower	TO, AD, QS	Warm	Cultivated	A-KAS-017
45	Zingiberaceae	[b]*Zingiber officinale* Roscoe	zanjiwil	姜	Herb	Subterranean part	PD, DW, RD	Warm	Cultivated	A-KAS-023
42	Zingiberaceae	[c]*Amomum kravanh* Pierre ex Gagnep.	laqindanaqini	白豆蔻	Herb	Fruit	TO, PD	Warm	Cultivated	B-KAS-0715
42	Compositae	[c]*Carthamus tinctorius* L.	zaragza qeqiki	红花	Herb	Flower	RM, TO, DP, ST	Warm	Cultivated	A-KAS-025
42	Piperaceae	[b]*Piper nigrum* L.	karimuq	胡椒	Vine	Fruit	PD, DW, TO	Warm	Cultivated	A-KAS-013
42	Apiaceae	[b]*Foeniculum vulgare* Mill.	arpabadyan	茴香	Herb	Fruit	IV, DW, DI, TO, RT	Warm	Cultivated/Wild	A-KAS-074
41	Zingiberaceae	[b]*Elettaria cardamomum* (L.) Maton	laqindanahindi	小豆蔻	Herb	Fruit	PD, RP, TO	Warm	Cultivated	A-KAS-054
36	Solanaceae	[c]*Lycium chinense* Mill.	alkat	枸杞	Shrub	Fruit	RW	Cold	Cultivated	A-KAS-077
31	Fagaceae	[d]*Quercus infectoria* G. Olivier	moza	没食子树	Tree	Galls	AI	Hot	Cultivated	A-KAS-071
30	Combretaceae	*Terminalia chebula* Retz.	karahelila	诃子	Tree	Fruit	CB, PD, DP, RD	Neutral	Cultivated	A-KAS-069
29	Rutaceae	[b]*Citrus reticulata* Blanco	apelsin	柑橘	Tree	Fruit	TO	Hot	Cultivated	B-HTN-1402
29	Leguminosae	[d]*Senna alexandrina* Mill.	sana	亞歷山大決明	Shrub	Leaf	TO, EP	Cold	Cultivated	A-KAS-035
27	Iridaceae	[1b]*Crocus sativus* L.	zapar	番红花	Herb	Flower	PD, TO	Hot	Cultivated	A-KAS-066
26	Zingiberaceae	[c]*Curcuma phaeocaulis* Valeton	bozuga	莪术	Herb	Subterranean part	PD, AB, DI	Warm	Cultivated	A-KAS-047
25	Lamiaceae	[c]*Pogostemon cablin* (Blanco) Benth.	pinna	广藿香	Herb	Above ground part	TO, RP, SB	Warm	Cultivated	A-KAS-041
24	Pedaliaceae	[b]*Sesamum indicum* L.	kunjut	芝麻	Herb	Seed	RC, RW, IN, TO, RM	Neutral	Cultivated	A-KAS-039
22	Lythraceae	*Punica granatum* L.	anar	石榴	Tree	Fruit	PT, TO, DI, SC	Warm	Cultivated	B-KAS-0719
19	Myristicaceae	[b]*Myristica fragrans* Houtt.	basbasa	肉豆蔻	Tree	Seed	TO, DW, DP	Warm	Cultivated	A-KAS-079
18	Lamiaceae	[b]*Mentha canadensis* L.	yalpuz	薄荷	Herb	Leaf	RT, PD, DW, RP, DI	Cool	Cultivated	A-KAS-057
18	Caprifoliaceae	[c]*Nardostachys jatamansi* (D. Don) DC.	sumbulhindi	甘松	Herb	Root	PD, MS, TO	Hot	Wild	A-KAS-020
17	Zingiberaceae	[1b]*Curcuma longa* L.	zarqiwa	姜黄	Herb	Subterranean part	RP, DW, CB, MS	Warm	Cultivated	B-KAS-0707
16	Rhamnaceae	*Ziziphus jujuba* Mill.	qilan	枣	Tree	Fruit	TO, RB, CB, RF	Warm, Neutral	Cultivated	A-KAS-056
15	Acoraceae	[b]*Acorus calamus* var. *angustatus* Besser	egir	石菖蒲	Herb	Subterranean part	PD, RM, DI, TO	Warm	Wild	A-KAS-012
14	Zygophyllaceae	*Tribulus terrestris* L.	Ogritikan	蒺藜	Herb	Fruit	TR, AS, RT	Warm	Wild	A-KAS-043
14	Lamiaceae	[b]*Ocimum basilicum* L.	rayhan	罗勒	Herb	Whole plant	AB, TO, DI	Cool	Cultivated	B-KAS-0704
14	Rosaceae	[b]*Crataegus pinnatifida* Bunge	dolana	山楂	Tree	Fruit	DW, PD, TO	Warm	Wild	A-KAS-070
14	Convolvulaceae	*Cuscuta chinensis* Lam.	aptimon	菟丝子	Herb	Whole plant	RP, RF, QS	Hot	Cultivated	A-KAS-073
14	Phyllanthaceae	[c]*Phyllanthus emblica* L.	amila	余甘子	Tree	Fruit	PD, SD, RP, TO, IV	Cool	Wild	A-KAS-049
13	Leguminosae	[b]*Glycyrrhiza* sp.	qugukbuya	甘草	Herb	Root	TO, TR, QS	Neutral	Cultivated	A-KAS-075
13	Apocynaceae	*Apocynum venetum* L.	lopnurkandiri	罗布麻	Shrub	Leaf	TR, RF, AS, RP, DI	Cool	Cultivated	B-KAS-0711
13	Santalaceae	[c]*Santalum album* L.	aksandalhindi	檀香	Tree	Stem	PD, PC	Warm	Cultivated	A-KAS-033
12	Ranunculaceae	*Coptis chinensis* Franch.	mamiranqini	黄连	Herb	Domestic cultivated	DW, MS	Cold	Cultivated	A-KAS-060
11	Araliaceae	[c]*Panax ginseng* C. A. Mey.	adamgiya	人参	Herb	Root	IB	Warm	Cultivated	C-KAS-11
11	Apiaceae	[b]*Coriandrum sativum* L.	yumgaksut	芫荽	Herb	Seed	DI, SB, RP	Warm	Cultivated	A-KAS-016
10	Lamiaceae	[b]*Lavandula angustifolia* Mill.	ustikuddus	薰衣草	Herb	Flower	TO, DP	Cool	Cultivated	A-KAS-029

[a] FC = Frequency of Citation index (Tardío and Pardo-de-Santayana, 2008) accounting for the number of medicinal teashop venders that mention a species as medicinal tea.
[b] Spice (plants which are used for flavoring, seasoning and imparting aroma to foods).
[c] Aromatic plant (plants with aroma in a general sense).
[d] Plants for which a limited intake is suggested by local healers.
[e] Activate Blood (AB), Alleviate Swelling (AS), Anti-Depression (AD), Anti-Inflammation (AI), Clear Blood (CB), Dispel Phlegm (DP), Disperse Wind (DW), Diuretic (DI), Expel Parasite (EP), Improve Blood circulation (IB), Improve Vision (IV), Increase breast milk (IN), Moisten Skin (MS), Prevent Cardiovascular disease (PC), Prevent Tooth decay (PT), Promote Digestion (PD), Quit Smoking (QS), Reduce Blood pressure (RB), Reduce Weight (RW), Regulate Menstruation (RM), Relieve Constipation (RC), Relieve Dampness (RD), Relieve Fever (RF), Relieve Pain (RP), Relieve Toxicity (RT), Soothe Throat (ST), Stop Bleeding (SB), Stop Dysentery (SD), Suppress Cough (SC), Tonic (TO), Tranquilize (TR), Treat Sleep disturbance (TS), Treat Tiredness (TT).

promoting digestion, and the fruit was used for dispelling phlegm.

3.4. Commonly used medicinal tea species

There are 40 commonly used medicinal tea species (Table 1). All the 40 species were used in traditional Chinese medicine, which were recorded in UMCMM (Editorial board of Chinese Materia Medica, 2005) and the Chinese pharmacopoeia 2015 (National Pharmacopoeia Committee, 2015).The majority of these plant species were spices (20 species, 50%) and aromatic plants (10 species, 25%). The most commonly used species were Chinese cinnamon, *Piper longum* L. (Indian long pepper), *Syzygium aromaticum* (L.) Merr. & L. M. Perry (clove), and *Gardenia jasminoides* J. Ellis (Cape jasmine). In addition, two plant species not reported in field surveys are popular and have been sold as medicinal tea in the markets for the past 10–15 years, including *Coreopsis tinctoria* Nutt (FC = 21) and *Cistanche deserticola* Y. C. Ma (FC = 19).

3.5. Commonly used recipes of medicinal tea

We purchased at total of 53 different medicinal tea mixtures during the market survey. They contained 57 plant species. The most commonly used species in tea mixtures included rose (counts of occurrence = 40), *Foeniculum vulgare* Mill. (fennel) (counts of occurrence = 35), Cape jasmine (counts of occurrence = 35), Chinese cinnamon (counts of occurrence = 34), *Elettaria cardamomum* (L.) Maton (cardamom) (counts of occurrence = 33). The tea mixtures had a wide range of healthcare uses from tonifying the stomach, nutrient improvement, warming feet and hands, improving sleep, to reducing weight and treatment of hypertension. There were also medicinal tea mixtures specifically for men and women (Supplementary file B). The most commonly reported treatment was tonifying the stomach (32 of 53 medicinal tea mixture products, 60.4%); the basic medical properties for tonifying the stomach were 'hot' (16 of 32 medicinal tea mixture products, 50%) and 'warm' (15 of 32 medicinal tea mixture products, 46.9%) (Supplementary file B). The medicinal tea mixtures are often paired with sugar and some people may add *Camellia sinensis* (L.) Kuntze for consumption as well.

3.6. Safety issues with commonly used medicinal tea

Among the 40 commonly used MTPS, 22 plant species (underlined Latin names in Table 1) were considered safe in the official list of MPUF (NHC, 2014). However, local herbalists had some guidelines for medicinal tea. They said that medicinal teas should be used within a day of preparation. People who have heart or liver disease or high blood pressure should avoid drinking medicinal tea with 'hot' properties. People who have health problems such as kidney, or stomach illnesses should not have medicinal tea with 'cold' properties. People are encouraged not to take medicinal tea with 'hot' property after they have had food with the same 'hot' property. They also mentioned that high dose of India long pepper can cause headaches, *Crocus sativus* L. (saffron) and *Curcuma longa* L. (turmeric) can have negative effects on the heart, and *Senna alexandrina* Mill. can cause flatulence and nausea. They also said that tea with *Quercus infectoria* G. Olivier should not be consumed by children under the age of seven as it can cause bleeding in the stomach and tea with saffron should not be used by pregnant women.

3.7. Conservation status of medicinal tea species

The majority of the MTPS (75.9%) were cultivated, 22.7% were wild harvested, and 1.4% came from both sources. Of the 40 commonly used MTPS, five were reported to be wild collected: *Nardostachys jatamansi* (D. Don) DC., *Acorus calamus* var. *angustatus* Besser, *Tribulus terrestris* L., *Crataegus pinnatifida* Bunge, and *Phyllanthus emblica* L.

Among all the cultivated MTPS there were 47 with botanical origin from outside Xinjiang that are now cultivated locally, including12 species from other provinces of China and 35 species from abroad (Supplementary file A). For example, *Morus alba* L. is originally grown in central and northern China and *Cuminum cyminum* L. is originally from Southwest Asia and the Mediterranean region and both are now cultivated in Xinjiang.

Some protected species are being used. Two are ranked 'Critically Endangered' in IUCN Red List (*Pterocarpus indicus* Willd. and *Panax ginseng* C. A. Mey.). One (*N. jatamansi*)is listed in CITES Appendix II, and one (*Coptis chinensis* Franch.) is a nationally protected species according to ISCREP. Both *P. ginseng* and *C. chinensis* were reported to come from cultivated sources according to our interview data.

4. Discussion

4.1. High biodiversity in medicinal tea consumption and its possible contribution to a healthy diet

Based on our survey, we found that there is a high species diversity used in medicinal teas from more than one hundred plant genera. According to our previous research on Chinese herbal teas (Fu et al., 2018) and other recent publication (Jin et al., 2018a), southern Xinjiang is among the top three provinces of China in terms of the number of herbal tea species used. More than 2/3 of reported species (102 species) were used in Southern Xinjiang only. This increased the existing Chinese herbal tea list from 782 species (Fu et al., 2018) to 884 species. For a region with relatively low biodiversity, compared with many other provinces in China, the MTPS diversity in local people's diets is high. Several studies have suggested that high biodiversity diets could have positive health effects (Torheim et al., 2004; Moursi et al., 2008; BianchiEgnell et al., 2016). High plant species diversity in herbal tea consumption could provide a wide range of nutrients and phytochemicals including important amino acids, organic acids, polyphenols, flavonoids, terpenoids, alkaloid as well as volatile oils (Zhao et al., 2013). These chemicals could play an important role in maintaining health. More research could be carried out on the healthcare implications of high plant diversity tea consumption in Southern Xinjiang, China.

High diversity use of MTPS could be explained by the rich traditional knowledge influenced by local folk medicine, as important part of traditional Chinese medicine (Wang et al., 1996; Liu et al., 2016). A wide range of plant resource availability contributes to the diversity of medicinal tea species as well. As a historical trading center of the Silk Road, various medicinal plants from distant regions have been traded in this region (Yuan et al., 2016). According to our results, medicinal teas used in Southern Xinjiang come from multiple geographical origins. Around half of the MTPS were introduced from abroad, and some of the species are still imported from other countries, including India, Pakistan and Iran. In addition, the richness of medicinal plants distributed in Southern Xinjiang is higher than other regions of Xinjiang, China (Li et al., 2015).

4.2. Healthcare effects of using spice and aromatic plants in medicinal teas

Using aromatic plants as herbal tea is a common phenomenon globally; examples are oregano (*Origanum vulgare* L.) used in Europe (Sõukand et al., 2013), lemon verbena (*Lippia citriodora* Kunth) used in South America (Shahhoseini et al., 2013), and honeybush tea (*Cyclopia intermedia* E. Mey.) used in South Africa (Kamara et al., 2003). In Southern Xinjiang this phenomenon is extremely important. Medicinal teas rely heavily on spices and aromatic plants. This practice likely formed through cultural exchange along the Silk Road. Spice and aromatic plants were often considered to have medical effects in ancient times (Torres et al., 2015). Using various aromatic plants as medicinal tea gained popularity during the Tang dynasty (618–907AD) of China.

Consumption of aromatic medicinal plants in the form of medicinal tea for healthcare purposes had become a dietary fashion by the Song dynasty (960–1279AD) (Su, 2009). During that time, various aromatic medicinal plants such as fennel and clove were imported through Southern Xinjiang to central regions of China along the Silk Road (Li, 1999). It is quite possible that local people in Southern Xinjiang learned the art of aromatic medicinal tea making then and kept this dietary culture to the present day. It is also reflected in our result that the 40 commonly mentioned MTPS were used popularly in traditional Chinese medicine.

Several of the traditional treatments have also been reported in pharmaceutical studies. We found several cases of overlap between the modern and traditional knowledge. One of the traditional healthcare uses of fennel is to tonify the stomach. Birdane et al. (2007) reported that water extract of the aerial parts of fennel (at dose of 300 mg/kg) has a gastroprotective effect on ethanol induced acute gastric mucosal injury in rat models. One of the traditional healthcare uses of Pepper (*Piper nigrum* L.) is to promote digestion. Srinivasan (2007) reported digestion promotion effects (increased salivation and gastric secretions) with Pepper in rat models and human subjects. One of the traditional healthcare uses of *Carthamus tinctorius* L. flowers is to promoting menstruation (blood stasis syndrome). This has been indirectly verified by reports of antithrombotic activities and protective effects on the cardiovascular and cerebrovascular system (Zhou et al., 2014).

Newly discovered healthcare functions were reported in consumption of the commonly used MTPS. Water extract of *C. tinctorius* flower was reported to have anti-diabetes effect in RAW 264.7 macrophage cell model (concentration of 25–100 μg/ml) (Liao et al., 2014). Water extract of ginger (*Z. officinale*) rhizome was shown to have anti-proliferative effects in cancer cells (IC50 values = 239.4 + 7.4 and 253.4 + 8.9 μg/ml) (Choudhury et al., 2010).

There were also many traditional healthcare uses of medicinal teas that remain to be tested and verified. For example, Chinese cinnamon and *Alpinia officinarum* Hance have been used to treat digestive problems in many traditional medical systems but there is little pharmaceutical evidence on this traditional use (Abubakar et al., 2018; Ribeiro-Santos et al., 2017). In addition, although some traditional healthcare uses of commonly used plant species have been verified, they have not been tested in the form of tea (i.e. water extract). For example, digestive stimulant effect of ginger has been validated in several animal models; however, the plant extracts were not tested in water extract form (Srinivasan, 2017).

Based on our survey, most of the medicinal teas used in Southern Xinjiang were mixed formulas. There are few studies that have tested the effects of combined species in traditional healthcare uses. Some evidence suggests that there may be strong positive combined effects. An investigation of the immune improvement effects of a traditional tonic of ten species (all of them are aromatic plants) mixed together as medicinal tea found that the tea mixture strongly stimulated inflammatory cytokines in cyclophosphamide (CTX)-induced immunosuppression mice model (at the dose of 50 and 100 mg/kg) (Bai et al., 2019). Future research into medicinal tea mixtures may yield important information about their healthcare implications.

4.3. A holistic healthcare practice through consumption of medicinal teas

Globally healthcare has increasingly focused on longevity and chronic conditions and has moved from disease treatment and clinic centered care to preventive and more holistic medicine (Witt et al., 2017). In Traditional Chinese Medicine, healthcare has been understood as maintaining the balance within the human body, and between human body and the outside environment (Zhang et al., 2007). Consumption of medicinal teas in Southern Xinjiang is a vivid case reflecting the holistic healthcare view.

Medicinal teas are considered a dietary therapy for healthcare in local folk medicine, which is an integrated part of traditional Chinese medicine (Wang et al., 1996). Following traditional Chinese medicine, the general principle of diet therapy for healthcare is to balance diets with local climatic conditions and individual physical conditions (Wei et al., 2010).Commonly reported healthcare uses of medicinal tea in Southern Xinjiang are tonifying/restoring and promoting digestion. This differs from our previous review study in which clearing away heat and relieving toxicity were the main healthcare uses (Fu et al., 2018). This may be partly explained by local dietary patterns and climate. Historically, the majority of foods taken by local people in Southern Xinjiang were dried with relatively few vegetables. This is dangerous since low intake of vegetables in diets has well-known negative effects on health (WHO, 2019). This is acknowledged in local folk medicine, which warns that low vegetable and low water content diets in desert dry climates can lead to various health problems, especially weakness and digestive issues (Tursun et al., 2018). Medicinal teas are used by local people to mitigate these problems (Wang et al., 1996). Future studies could investigate whether medicinal tea drinking can offset the negative effects of an otherwise low diversity diet.

The traditional knowledge of local folk medicine posits that everything in the world, including the human body has five basic properties. These range from the two extremes 'hot' and 'cold', with three stages in between, 'warm', 'neutral', and 'cool' (Tursun et al., 2018). Local people in Southern Xinjiang consider these five basic properties of both medicinal tea and individual physical status as important aspects in choosing the correct medicinal tea. According to traditional knowledge the organs of the human body also have their own basic properties. For example, the basic property of the heart and the liver is 'hot', while the stomach and kidney are 'cold'. Following this understanding, health is maintained through balancing the properties so that the organs and body as a whole is neither too 'hot' nor too 'cold'. Health problems are caused when imbalances occur (Tursun et al., 2018). It follows that the basic medical properties of the commonly used medicinal tea mixtures in our study are 'hot' and 'warm', and they are mainly used for tonifying the stomach. It also follows that people with 'hot' body should avoid medicinal teas with 'hot' properties, and they may choose medicinal tea with 'warm' properties if they have stomach problems.

The positive benefits of medicinal tea consumption in Southern Xinjiang may be partly reflected in the low rates of certain chronic diseases. According to epidemiological studies, Southern Xinjiang has considerably lower rates of diabetes than in the rest of China (Wusiman, 2015). Some regions of Southern Xinjiang also have lower obesity rates compared to the national average (He, 2014). However, the data is inconclusive and more research would be needed to draw any linkages between local medicinal tea consumption and risks of chronic diseases.

4.4. Is it safe to drink medicinal teas?

According to our fieldwork and literature reviews, the common medicinal teas in Southern Xinjiang are safe to drink. However, medicinal tea consumption should follow the traditional recipes. Teas that treat specific ailments with multiple ingredients should be used under the guidance of traditional healers. According to local healers', high doses of plants with highly active ingredients, or use by pregnant women or children can cause health problems. The official list of MPUF concurs with healers on three of the species and sets the dose limits of daily intake of Indian long pepper (≤1 g daily), saffron (≤1 g daily) and Turmeric (≤3 g daily). High doses or long-term use of *S. alexandrina* leaf has also been reported to have adverse effects in several clinical cases such as vomit, diarrhea and fainting (Zou, 2015). However, local herbalists considered *Quercus infectoria* G. Olivier dangerous for children under the age of seven, citing a risk of bleeding in the stomach. To our knowledge this issue has not been assessed in any laboratory analyses of *Q. infectoria* (Iminjan et al., 2014).

Potential issues of biological and chemical contamination should be taken into consideration, as the majority of MTPS are cultivated elsewhere and are often transported long distances. There have been a

number of reported incidences of heavy metal, pesticides and fungal contaminations of medicinal plants used in traditional Chinese medicines (Yang et al., 2016). Although national regulations on chemical and pesticide control of medicinal plants has improved considerably in the last 30 years, market supervision and development of new technologies for detection still needs to be strengthened (Ji, 2010).

4.5. Promoting sustainable development of medicinal tea plant products

There are promising market potentials for medicinal teas used in Southern Xinjiang. Although the majority of medicinal teas are sold in the form of raw materials in local markets, several commonly used recipes have been developed as herbal tea products and sold in supermarkets and e-business platforms such as 'Taobao'. According to our results, most of the plant species were cultivated. Intensification of this cultivated production could strengthen the sustainable development of medicinal tea products. However, some of the commonly used species are collected in the wild. Many species are used as medicinal tea and traditional medicines in Southern Xinjiang, which may put pressure on the wild populations. For example, *Nardostachys jatamansi* (D. Don) DC. has been used in traditional Chinese medicine, Ayurveda and Unani medicines. The species has a limited distribution in the Himalayan region and is listed in CITES (Jin et al., 2018b). Although some effort has been made on cultivation of *N. jatamansi* in China, information is still insufficient for successful widespread cultivation (Zeng et al., 2010). It may be necessary to prioritize the development of cultivation technologies for species that are under threat and also meet the required quality standards of pharmacopoeia.

5. Conclusion

The ancient Silk Road has witnessed the rise, flourish and fall of great human civilizations, the remnants of which can now only been seen in archeological sites and in museums. Medicinal tea consumption in Southern Xinjiang, China is one of the remaining living cultural heritages along the Silk Road, and is still vibrant in the daily lives of local people. The high diversity of plant species and traditional healthcare knowledge reflects the history of exchange of resources and knowledge along the Silk Road. The phenomenon of medicinal tea consumption is a vivid case of holistic healthcare, which fits well in the current health policy context in China. As China has launched the 'Belt and Road Initiative', health is one of the key common themes connecting the Belt and Road Countries and medicinal teas could offer multiple benefits from medical treatments to dietary diversity. Future research should investigate the healthcare implications of the commonly used medicinal tea mixtures for developing health-promoting diets and treatments. Local and national government agendas should seek to ensure sustainable harvest and continuation of traditional knowledge so that this cultural heritage continues to serve human well-being into the future.

Authors' contributions

Aysajan Abdusalam and Xue-fei Yang designed the study. Aysajan Abdusalam conducted both field and market surveys, and made major contribution to data collection and extraction. Yao Fu conducted market survey; collected and analyzed the data, and drafted the manuscript. Yu Zhang conducted the market survey and identified all the voucher specimens. Maliyamu Abudoushalamu and Patiguli Maitusun made considerable contribution to field and market survey data collection. Cory Whitney helped with the data analysis and made critical revisions to the manuscript.

Funding

This work was supported by the Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences (Y4ZK111B01), The Inventory and database construction project of herbal medicine along the "Belt and Road Countries (2018FY100700), the Yunnan Innovative Talents Program, China (2018HC009), and National Natural Science Foundation of China (31860121).

Declaration of competing interest

All authors declare that they have no conflicts of interest.

Acknowledgements

We are grateful that Prof. Antony Balfour Cunningham provided insightful suggestions on conducting this study. Prof. Michael Heinrich and Dr. Caroline S. Weckerle provided valuable suggestions on revising the manuscript. We would like to thank the two anonymous reviewers who provided valuable suggestions to improve this paper. We thank Mr. Jianwen Li helped on identifying lichens collected from this study. Map of China and Map of Xinjiang Autonomous region of China were provided by Map Technology Center of Ministry of Natural Resources of China (http://bzdt.ch.mnr.gov.cn/).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jep.2020.113012.

References

Abubakar, I.B., Malamib, I., Yahayac, Y., Sule, S.M., 2018. A review on the ethnomedicinal uses, phytochemistry and pharmacology of *Alpinia officinarum* Hance. J. Ethnopharmacol. 224, 45–62.

Bai, Y., Jiang, Y., Liu, T., Li, F., Zhang, J., Luo, Y., Zhang, L., Yan, G., Feng, Z., Li, X., Wang, X., Hu, W., 2019. Xinjiang herbal tea exerts immunomodulatory activity via TLR2/4-mediated MAPK signaling pathways in RAW264.7 cells and prevents cyclophosphamide-induced immunosuppression in mice. J. Ethnopharmacol. 228, 179–187.

Berlin, B., 1973. Folk systematics in relation to biological classification and nomenclature. Annu. Rev. Ecol. Systemat. 4, 259–271.

Bianchi, C.M., Egnell, M., Huneau, J.F., Mariotti, F., 2016. Plant protein intake and dietary diversity are independently associated with nutrient adequacy in French adults. J. Nutr. 146, 2351–2360.

Birdane, F.M., Cemek, M., Birdane, Y.O., Gülçin, İ., Büyükokuroğlu, M.E., 2007. Beneficial effects of *Foeniculum vulgare* on ethanolinduced acute gastric mucosal injury in rats. World J. Gastroenterol. 13 (4), 607–611.

Chao, W., Zhang, C., 2017. Research on the Inter-ethnic relations of the floating population in Southern Xinjiang-based on the Perspective of residential segregation index method. Journal of Tarim University 29 (3), 57–61.

China's Central Committee, 2016. The plan of healthy China 2030. http://www.gov.cn/xinwen/2016-10/25/content_5124174.htm accessed 25.09.19.

China's Central Committee, 2019. Healthy China initiative (2019-1030). http://www.gov.cn/xinwen/2019-07/15/content_5409694.htm accessed 25.09.19.

Choudhury, D., Das, A., Bhattacharya, A., Chakrabarti, G., 2010. Aqueous extract of ginger shows antiproliferative activity through disruption of microtubule network of cancer cells. Food Chem. Toxicol. 48, 2872–2880.

Commissione Redactorum Florae Xinjangensis, 2014. Flora Xinjangensis, simplified edition. Xinjiang Science & Technology Publishing House, Urumqi.

Dong, X., 1996. Preliminary study of Uygur tea culture and related language. Xinjiang Daxue Xuebao (Journal of Xinjiang University) 24 (4), 105–107.

Editorial board of Chinese Materia Medica, 2005. Uygur Medicine of Chinese Materia Medica, first ed. Shanghai Scientific & Technical Publishers, Shanghai.

Fu, Y., Yang, J.C., Cunningham, A.B., Towns, A.M., Zhang, Y., Yang, H.Y., Li, J.W., Yang, X.F., 2018. A billion cups: the diversity, traditional uses, safety issues and potential of Chinese herbal teas. J. Ethnopharmacol. 222, 217–228.

Gu, H., 2011. Development of minority peoples' cultures in Xinjiang. Journal of Language and Literature Studies (Yuwen Xuekan) 12, 62–72.

Hu, R., Fan, Z., Wang, Y., 2001. Assessment about the impact of climate change on environment in Xjinjiang since recent 50 years. Arid. Land Geogr. 24 (2), 97–103.

He, J., 2014. Research on Prevalence and Characteristic of Obesity and Relationship to the Related Diseases Among Rural Adult Residents in Hazakh and Uygur Populatoin from Xinjiang. Shihezi University, Shihezi, China.

Iminjan, M., Amat, N., Li, X.H., Upur, H., Ahmat, D., He, B., 2014. Investigation into the toxicity of traditional Uyghur medicine *Quercus infectoria* galls water extract. PloS One 9 (3), 1–8.

Ji, S., 2010. Research progress on methods for determination of pesticide residues in Chinese Materia Medica. Chin. Pharmaceut. J. 45 (17), 1287–1294.

Jin, B., Liu, Y., Xie, J., Luo, B., Long, C., 2018a. Ethnobotanical survey of plant species for herbal tea in a Yao autonomous county (Jianghua, China): results of a 2-year study of traditional medicinal markets on the Dragon Boat Festival. J. Ethnobiol. Ethnomed. 14, 58.

Jin, Q., Li, Y., Qun, P., Xiang, H., Liu, Y., 2018b. Comprehensive evaluation of quality of *Nardostachys* Radix et Rhizoma and *Nardostachys* Herba by multidimensional statistical analysis. Chin. Tradit. Herb. Drugs 49 (4), 919–927.

Kamara, B.I., Brandt, E.V., Ferreira, D., Joubert, E., 2003. Polyphenols from Honeybush tea (*Cyclopia intermedia*). J. Agric. Food Chem. 51, 3874–3879.

Li, H.Z., 1999. A brief history of aromatic medicine imported to China from Arab countries. Journal of Medicine & pharmacy of Chinese Minorities 12 (5), 165.

Li, H., Wang, H., Song, J., Li, X., Xie, C., 2015. Climatic features and geographical distribution of medicinal plants in Xinjiang. Arid. Land Geogr. 38 (1), 36–42.

Li, D.L., Zheng, X.L., Duan, L., Deng, S.W., Ye, W., Wang, A.H., Xing, F.W., 2017. Ethnobotanical survey of herbal tea plants from the traditional markets in Chao Shan, China. J. Ethnopharmacol. 205, 195–206.

Liao, H., Banbury, L., Liang, H., Wang, X., Lu, X., Hu, L., Wu, J., 2014. Effect of honghua (Flos Carthami) on nitric oxide production in RAW 264.7 cells and alpha-glucosidase activity. J. Tradit. Chin. Med. 34, 362–368.

Liu, Y., Ahmed, S., Long, C., 2013. Ethnobotanical survey of cooling herbal drinks from southern China. J. Ethnobiol. Ethnomed. 9, 82.

Liu, W., Gao, Z., Jia, X., Upur, Halmurat, 2016. Uyghur medicine on ancient and modern times Silk Road. Mod. Chin. Med. 18 (10), 1253–1256.

Moursi, M.M., Arimond, M., Dewey, K.G., Trèche, S., Ruel, M.T., Delpeuch, F., 2008. Dietary diversity is a good predictor of the micronutrient density of the diet of 6- to 23-month-old children in Madagascar. J. Nutr. 138, 2448–2453.

National Health Commission of the People's Republic of China (Nhc), 2014. Regulation on herbal plants listed as dual use of food and medicine according to traditions. http://www.nhc.gov.cn/sps/s3585/201411/67ac54fb05ed46929adc63f2db31d4bf.shtml accessed 18.03.19.

National Pharmacopoeia Committee, 2015. Pharmacopoeia of People's Republic of China. China Health Media Group, Beijing, China Part 1.

R Core Team, 2017. R: A Language and Environment for Statistical Computing. [R Version 3.4.1 (2017-06-30) 'Single Candle'] 3.4.1.

Ribeiro-Santos, R., Andrade, M., Madella, D., Martinazzo, A.P., Moura, L.A.G., Melo, N.R., Sanches-Silva, A., 2017. Revisiting an ancient spice with medicinal purposes: Cinnamon. Trends Food Sci. Technol. 62, 154–169.

Shahhoseini, R., Beyraghdar, A., Karimi, S., Ebadi, M., 2013. Essential oil content and composition of Lemon Verbena (*Lippia citriodora* Kunth.) during different phenological stages. Journal of Medicinal Plants and By-products 2, 205–208.

Sõukand, R., Quave, C.L., Pieroni, A., Pardo-de-Santayana, M., Tardío, J., Kalle, R., Łuczaj, Ł., Svanberg, I., Kolosova, V., Aceituno-Mata, L., Menendez-Baceta, G., Kołodziejska-Degórska, I., Pirożnikow, E., Petkevičius, R., Hajdari, A., Mustafa, B., 2013. Plants used for making recreational tea in Europe: a review based on specific research sites. J. Ethnobiol. Ethnomed. 9, 58.

Srinivasan, K., 2007. Black pepper and its pungent principle-piperine: a review of diverse physiological effects. Crit. Rev. Food Sci. Nutr. 47, 735–748.

Srinivasan, K., 2017. Ginger rhizomes (*Zingiber officinale*): a spice with multiple health beneficial potentials. Pharma. Nutrition 5, 18–28.

Staub, P.O., Geck, M.S., Weckerle, C.S., Casu, L., Leonti, M., 2015. Classifying diseases and remedies in ethnomedicine and Ethnopharmacology. J. Ethnopharmacol. 174, 514–519.

Su, N., 2009. Research on Chinese Ancient Tea and Soup for Health Care. Ph.D. thesis. China Academy of Chinese Medical Sciences, Beijing, China.

Tan, X., Liu, X., Shao, H., 2017. Healthy China 2030: a vision for health care. Value in Health Regional Issues 12C, 112–114.

Tardío, J., Pardo-de-Santayana, M., 2008. Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain). Econ. Bot. 62 (1), 24–39.

Torres, J.E.D.L.T., Gassara, F., Kouassi, A.P., Brar, S.K., Belkacemi, K., 2015. Spice use in food: properties and benefits. Crit. Rev. Food Sci. Nutr. https://doi.org/10.1080/10408398.2013.858235.

Torheim, L.E., Ouattara, F., Diarra, M.M., Thiam, F.D., Barikmo, I., Hatly, A., Oshaug, A., 2004. Nutrient adequacy and dietary diversity in rural Mali: association and determinants. Eur. J. Clin. Nutr. 58, 594–604.

Tursun, Y., Chen, J., Zhao, H., Tao, Y., Li, M., Wang, X., Hu, C., Abula, H., 2018. The effects of the factors of dry cold food and dry cold environment on biological characterization of the mice. Western Journal of Chinese Medicine 31 (1), 61–63.

Verpoorte, R., 2015. Food and medicine: old traditions, novel opportunities. J. Ethnopharmacol. 167, 1.

Wang, W., Sha, D., Ai, E., Ma, Y., Yi, B., Liu, F., Wang, X., 1996. The pharmacological effects of Uygur herbal tea. Journal of Medicine & Pharmacy of Chinese Minorities 1, 38–40.

Wang, J., Fu, Y., Yao, H.W., Liu, Y., Zeng, N., Xia, H.L., 2008. Effects-based classification of Chinese medicine. Lishizhen Med. Mater. Med. Res. 19 (12), 2889–2891.

Wei, M.X., Guo, J., Liu, Z.Q., 2010. Investigation of the principles of diet therapy in traditional Chinese medicine. Lishzhen Medicine and Materia Medica Research 21 (11), 2967–2968.

Whitney, C., 2020. EthnobotanyR: Calculate Quantitative Ethnobotany Indices [R Package v 0.1.7]. Comprehensive R Archive Network (CRAN). https://doi.org/10.6084/m9.figshare.11791830.

Witt, C.M., Chiaramonte, D., Berman, S., Chesney, M.A., Kaplan, G.A., Stange, K.C., Woolf, S.H., Berman, B.M., 2017. Defining health in a comprehensive context: a new definition of integrative health. Am. J. Prev. Med. 53 (1).

World Health Organization (WHO), 2007. WHO international standard terminologies on traditional medicine in the western pacific region. Geneva, Switzerland. http://www.wpro.who.int/publications/who_istrm_file.pdf?Ua=1.

World Health Organization (WHO), 2019. Global health observatory (GHO) data: unhealthy diet, situation and trends. https://www.who.int/gho/ncd/risk_factors/unhealthy_diet_text/en/ accessed 20.02.01.

World Organization of Family Doctors' International Classification Committee (WICC), 2015. International classification of primary care (ICPC). https://www.globalfamilydoctor.com/groups/WorkingParties/wicc.aspx accessed 08.13.19.

Wusiman, R., 2015. Application of GIS Technology to Analyze Spatial Distribution of Diabetes in Xinjiang. Master Thesis. Xinjiang Medical University, Urumqi, China.

Xiao, W., Liu, Y., Xiao, P., Xu, L., He, C., Peng, Y., Liu, H., 2014. The integration of food and medicine: a new trend of health. Modern Chinese Medicine 16 (6), 486–492.

Yang, Y., Tian, K., Tian, H., 2016. Study on exogenous pollution of TCM resources and its management and control in China. China Pharmacy 27 (31), 4885–4887.

Yuan, C., Shu, C., Wang, M., Xiao, Z., Zhang, W., 2016. Application and development of economic plants in "one Belt and one Road" (chapter central Asia and west Asia). Chinese Wild Plant Resources 35 (2) 3-4,13.

Yuan, F., Yang, F., 1990. The basic geomorphologic characteristics of Xinjiang, China. Arid. Land Geogr. 13 (3), 1–5.

Zeng, J., Hu, T., Xiang, B., Xia, Y., Yang, Y., 2010. Effect of seek stem and seeding period on seedling of *Nardostachys jatamansi* (D . Don) DC. Resource Development &Market 26 (5), 395–396.

Zhang, L., Hu, W., Lu, Y., Zhang, J., Zhang, Q., Feng, Z., Shen, T., Bai, Y., 2018. Research on nutrient content and aroma components in Uighur medicinal tea. Food Sci. Technol. 43, 60–66.

Zhang, Y.P., Yang, W., Yu, Z., 2007. Concept of health in traditional Chinese medicine. J. Tradit. Chin. Med. 48 (2), 186–187.

Zhao, C.N., Tang, G.Y., Liu, Q., 2018. Five-golden-flowers tea: green extraction and hepatoprotective effect against oxidative. Molecules 23, 2216. https://doi.org/10.3390/molecules23092216.

Zhao, J., Deng, J.W., Chen, Y.W., Li, S.P., 2013. Advanced phytochemical analysis of herbal tea in China. J. Chromatogr. A 1313, 2–23.

Zhao, W.H., 2012. Transmission, investigation and development of traditional knowledge in Uyghur medicine. Chinese Journal of Basic Medicine in Traditional Chinese Medicine 18 (9), 1049–1050.

Zhou, C.J., Huang, S., Liu, J.Q., Qiu, S.Q., Xie, F.Y., Song, H.P., Li, Y.S., Hou, S.Z., Lai, X.P., 2013. Sweet tea leaves extract improves leptin resistance in diet-induced obese rats. J. Ethnopharmacol. 145, 386–392.

Zhou, L.Y., Zhang, T.Y., Lu, B., Yu, Z.Y., Mei, X.Y., Abulizi, P., Ji, L.L., 2016. *Lonicera japonica* flos attenuates diabetic retinopathy by inhibiting retinal angiogenesis. J. Ethnopharmacol. 189, 117–125.

Zhou, X., Tang, L., Xu, Y., Zhou, G., Wang, Z., 2014. Towards a better understanding of medicinal uses of *Carthamus tinctorius* L. in traditional Chinese medicine: a phytochemical and pharmacological review. J. Ethnopharmacol. 151, 27–43.

Zou, H., 2015. Analysis of toxicology and reasonable medication of clinical adverse reactions of *Senna* leaf. Chinese Medicine Modern Distance Education of China 13 (19), 157–158.