



Nutritional and Functional Properties of Wild Food-Medicine Plants From the Coastal Region of South China

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Abstract

Food-medicine plants play an important role in providing nutrition and treating chronic diseases, especially in many minority communities and developing regions. The coastal region of South China has abundant resources of medicinal plants. A long history of cross-cultural medicinal practices among different minority groups has facilitated the development of a remarkable dietary culture by using food-medicine plants. However, integrative ethnobotanical research on both nutritional and functional properties of the food-medicine plants in this region is still limited. In this study, 27 commonly used wild food-medicine plants were recorded and analyzed from the coastal region of South China. Most of them are good sources for calcium (47.83-1099.89 mg/100 g fresh weight), dietary fiber (3.00-31.87 mg/100 g fresh weight), iron (1.17-24.73 mg/100 g fresh weight), and vitamin C (0.44-68.32 mg/100 g fresh weight). *Solanum americanum* has the highest average nutritive value and is also considered to be good sources for proteins (7.90 g/100 g fresh weight). Medicinal properties of the studied species can be classified into 8 categories: treatment of the damp-heat syndrome, digestive diseases, urologic diseases, arthropathy, respiratory diseases, gynecological diseases, snake or insect bites, and uses as a tonic. Treating the damp-heat syndrome or expelling warm pathogenic factors is the most commonly used ethnomedicinal practice in the study area. The present study highlights that the local ethnomedicinal practices are deeply influenced by local natural conditions and customs. Food-medicine plants with superior key nutrients have been used regularly in the diet as medicinal food to alleviate common endemic diseases.

Keywords

food-medicine plants, ethnic food plants, nutritional properties, functional properties, coastal region of South China

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In many cases, the use of plants as food or medicine can be difficult to differentiate,¹⁻⁴ and the overlap between these 2 categories of uses is multidimensional.⁵ Some plants may be used only as a tonic or functional food to improve health instead of to treat a specific disease, but some others may be used as both food and medicine, even with the same organ parts and application methods.^{3,6,7} The food-medicine continuum is considered to play an important role in the treatment of chronic diseases and the improvement of physical fitness, especially in some developing countries and minority tribal areas.⁶⁻¹¹ Therefore, integrative research on both food and medicine has become the trends of ethnopharmacological studies,^{2,3,6,8,9,12-15} and has been suggested by the World Health Organization.¹⁶ However, most previous studies have focused on the bioculture relationship between food and medicinal plants and (or) the decisive factors about the use and perceptions of food-medicines.^{1,3,13,17}

South China is one of the most well-known regions for traditional Chinese medicine (TCM), and the region is home

to the South China traditional medicine known as nan-yao (literally south-medicine in TCM). According to recent investigations, more than 600 medicinal plants in this region have been documented to be used by the different minority

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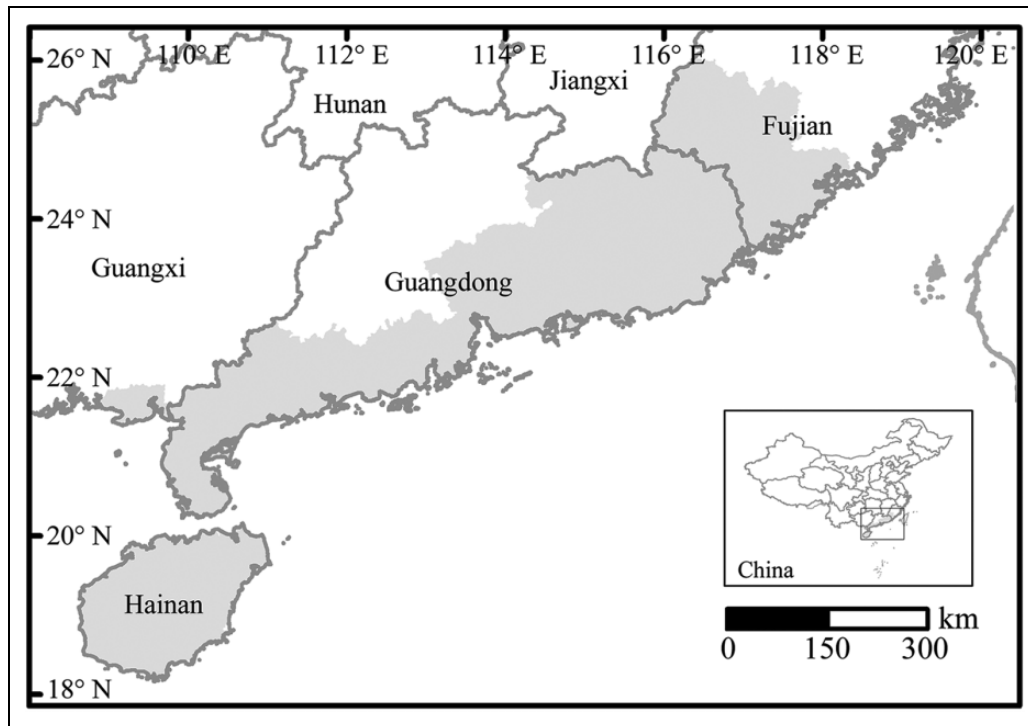


Figure 1. Location of the study areas (shaded area).

groups (eg, Li nationality, Yao nationality, and Miao nationality).^{11,18-20} Moreover, the efficacy, medicinal parts and methods can vary drastically among the minority groups and even in different Han groups, such as Cantonese, Hakka, and Hoklos.^{21,22} With the abundant resources of medicinal plants as well as the cross-cultural medication practices, edible medicinal plants are widely accepted and used in the diet of the local people. This combinational food-medicine dietary habit has facilitated the development of a distinct dietary culture in South China, for example, the medicinal soup and “liáng chá” (herbal tea) culture,^{20,21} and the highly localized health practices. For example, the Cantonese prefer to drink “liáng chá” to resist some ailments caused by the usually warm-wet climate in the Canton (Guangdong) region.^{20,23} Ethnopharmacological studies concerning nutritional properties of the food-medicine continuum and the documentation of the diverse medication practices can contribute to improve our public health knowledge and assist in informing the health policy.

Most previous ethnobotanical studies reported the medicinal properties of ethnomedicinal plants from the inland regions of South China.^{11,18,19,21-23} Yet species of local food-medicine plants and their nutritional properties are still poorly documented. With the calling on better understanding plants and people in harmony in plant sciences,²⁴ it is important to document and study the plants and their utilizations in food and medicine in areas with rich cultural diversity.

The present study focuses on documenting the use by the minority groups and the nutritional properties of wild food-medicine plants in the coastal regions of South China to answer

the following questions: (1) What are the common plant species consumed as the food-medicine continuum in daily life? (2) What are the nutritional and functional properties of these food-medicine plants? (3) Is there any relationship between the frequently used food-medicine plants and the common endemic diseases? (4) What are the diverse methods that the different minority groups apply while using the edible and medicinal plants?

Materials and Methods

Sampling and Ethnobotanical Data Collection

The field study covered 54 villages of south Fujian, Guangdong, Guangxi, and Hainan provinces of the coastal regions of South China (Figure 1). Yao nationality, Zhuang nationality, Li nationality, Miao nationality, and She nationality as well as Cantonese, Hakka, and Hoklos of the Han groups are the major minority groups in this region. The local traditional medication practice may be also influenced by the adjacent Dong nationality and Mulao nationality. Therefore, our study interviewed local people from all these groups. During the interview, 11 questions were asked concerning plant species, local name, harvest period, edible parts, edible methods, medicinal parts, medicinal use methods, efficacy, preparation methods, cultivation, and commercialization. Local healers were considered as the key informants for the ethnobotanical information. We also investigated the local traditional markets and restaurants to further document the information of edible plants. We further consulted the monograph of Chinese ethnopharmacology.²⁵

All the samples for the nutritional analyses and voucher specimens were collected in the field investigation during 2016. Each sample comprised 500 g of the edible portion. The edible part was randomly

collected from a minimum of 25 healthy individual plants of one population at the harvest time. For widespread species, 2 to 3 populations (geographic interval at least 100 km apart) were collected. Voucher specimens were identified according to Flora of Hainan,²⁶ Flora of Guangdong,²⁷ and Flora Reipublicae Popularis Sinicae.²⁸ Sources of samples and voucher information are included in Supplementary Table S1.

Sample Preparation for Nutritional Analyses

The edible part was collected in the field and immediately washed first with tap water and then with distilled water to remove soil and other debris, then air-dried at room temperature. Cleaned samples were cut into smaller pieces and dried at 60°C to constant weight, then ground into fine powder (2-mm-mesh pore size) and stored at room temperature.

Nutritional Evaluation

Total protein, dietary fiber, calcium, iron, carotene, and vitamin C were analyzed from the dried samples and treated as the key nutrients, following Grubben²⁹ to calculate the average nutritive value (ANV) and to evaluate the nutritive value of vegetables. Each composition was measured twice from the same homogenized sample. We used the moisture value of each species from the published literature (Supplementary Table S2) to estimate the proximate composition of 100 g fresh edible part and calculate ANV and percent daily value.

Total Protein. Total proteins were determined from the nitrogen content by using the Kjeldahl method in conforming with AOAC 978.04.³⁰ An amount of 0.5 g of dried sample was digested in sulfuric acid to measure the total protein with the percent nitrogen converted to protein using a factor of 6.25.

Total Dietary Fiber Assay. Because the samples consisted of leaves, stems, or fruits of the plant parts and the starch contents are less than 2%, the total dietary fiber was assayed employing the AOAC nonenzymatic-gravimetric method 993.21.³⁰ The dried sample (0.5 g) was suspended in 25 mL H₂O and incubated for 90 minutes at 37°C to solubilize water-soluble components and then the water-soluble fiber was precipitated by 95% ethanol. Total dietary fiber was determined by the weight of residue corrected for protein and ash content.

Calcium and Iron. The AOAC Atomic Absorption Spectrophotometric method 975.03 was used to estimate calcium and iron contents.³⁰ Test solutions were prepared by the wet ash method. Accurately weighed 0.5 g dry sample was soaked with 20 mL HNO₃:HClO₄ (4:1, v/v) solution at room temperature overnight. Then it was heated on a hot plate to digest, slowly at first, until frothing ceased. If charring occurred, more HNO₃:HClO₄ (4:1, V/V) solution was added. The sample was heated until white fumes appeared and HNO₃ was almost completely evaporated. The residual liquid (2-3 mL) was cooled and transferred into a 50 mL volumetric flask and diluted with deionized water to the 50 mL volume. Concentrations were determined by atomic absorption spectrophotometer using the following wavelengths: Ca (422.7 nm) and Fe (248.3 nm).

Carotene. The carotene content was measured by β-carotene and determined with the high-performance liquid chromatography (HPLC) method.^{31,32} The β-carotene was extracted from 10 g homogenized portions with petroleum ether:acetone (80:20, v/v). Extracting solution was then evaporated to dryness at 30°C. The residue was dissolved with a little petroleum ether and then purified by alumina column chromatography with petroleum ether:acetone (95:5, v/v) as the eluent. The final solution was diluted with eluent into 10 mL and then filtered through 0.45 μm membrane filters for HPLC analysis. Chromatography was performed with a monomeric C₁₈ column (4.6 mm × 150 mm). The mobile phase consisted of methanol:acetonitrile (90:10, v/v), with a flow rate of 1.2 mL/min. The detector wavelength was set at 448 nm for the detection of β-carotene.

Vitamin C. The vitamin C concentration was determined by the titrimetric method (AOAC method 967.21) using 2,6-dichloroindophenol as a titrant.³⁰ A sample of 5 g was extracted with the metaphosphoric acid (2%, w/v)–oxalic acid (2%, w/v) solution. The extracting solution was triturated until the test portion was in suspension. It was then diluted with the metaphosphoric acid (2%, w/v)–oxalic acid (2%, w/v) solution to 100 mL, mixed, and filtered. Then 10 mL filtrate was transferred into a 50 mL conical flask and titrated against 2,6-dichloroindophenol until the solution changed to pink color and persisted at least 15 seconds.

Data Analysis

The nutritional data of the edible parts and the use methods per species, medicinal parts and efficacies of the plant species by each minority group are summarized in Table 3. The differences between edible and medicinal parts as well as the medicinal uses by the different minority groups were compared. The categories of medicinal uses were summarized according to the functional properties of the plants corresponding to the endemic diseases.

Nutrient concentrations are reported on a per 100 g dry-weight basis and expressed as the mean value ± standard deviation (mean ± SD). The results were statistically analyzed using the JMP 13.1.0 software (SAS Institute Inc, Cary, NC). Analysis of variance (ANOVA) was conducted to analyze data at the 95% confidence level followed by the Duncan's test for multiple comparisons.

Results and Discussion

Food-Medicine Plant Species in the Study Areas

A total of 27 wild food-medicine plant species belonging to 23 genera and 17 families were recorded in this study (Supplementary Table S1). All these 27 species have been commonly used by the local people either as seasonal wild fruits (ie, *Melastoma dodecandrum* Lour. and *Rosa laevigata* Michx.) or as vegetables (the remaining species). Twenty-two of them have been reported as folk medicines of South China.^{11,18,19,21,22} Nevertheless, 5 of the species have been used as traditional medicines in other regions beyond South China. They are *Amaranthus blitum* L. in Malaysia,³³ *A. viridis* L. in India and Nepal,³⁴ *Commelina benghalensis* L. in India,³⁵ and *Eleutherococcus trifoliatus* (L.) S. Y. Hu and *Patrinia villosa* Juss. in southwest China.^{36,37}

Table 1. Proximate Composition of the Edible Parts (100 g, Dry Weight) of the Studied Species.

Taxa*	Proteins (g)	Vitamin C (mg)	Carotene (mg)	Fiber (g)	Fe (mg)	Ca (mg)
<i>Alternanthera sessilis</i>	18.19 ± 0.06 ^{defghi}	32.28 ± 1.48 ^{ijkl}	82.53 ± 0.40 ^{hi}	52.35 ± 1.20 ^{abcdefg}	95.74 ± 1.68 ^{bc}	2448.53 ± 11.51 ^{def}
<i>Amaranthus blitum</i>	29.12 ± 0.06 ^a	56.49 ± 1.78 ^{efghi}	159.65 ± 10.39 ^{efghi}	53.04 ± 1.06 ^{abcdefg}	52.77 ± 0.75 ^{cde}	1527.38 ± 30.00 ^{defgh}
<i>A. spinosus</i> -1	17.85 ± 0.06	7.83 ± 0.13	184.00 ± 0.00	65.81 ± 0.82	77.49 ± 2.10	1128.92 ± 24.41
<i>A. spinosus</i> -2	19.09 ± 0.04	24.40 ± 1.27	305.50 ± 0.71	47.75 ± 4.03	37.57 ± 0.23	2657.54 ± 32.18
<i>A. spinosus</i> -3	21.58 ± 0.03	9.72 ± 0.22	449.10 ± 8.12	35.00 ± 0.28	39.08 ± 1.94	4267.43 ± 37.07
<i>A. spinosus</i> (average)	19.51 ^{cdefg}	13.98 ^{lm}	312.87 ^{cdef}	49.52 ^{abcdefg}	51.38 ^{de}	2684.63 ^{cde}
<i>A. viridis</i> -1	28.70 ± 0.01	57.37 ± 0.47	182.45 ± 6.29	59.49 ± 0.97	45.52 ± 1.56	2141.44 ± 43.31
<i>A. viridis</i> -2	19.20 ± 0.07	45.84 ± 0.91	103.00 ± 1.41	58.28 ± 0.78	25.02 ± 0.14	3765.08 ± 2.53
<i>A. viridis</i> -3	25.48 ± 0.06	64.01 ± 1.01	271.50 ± 0.71	38.45 ± 0.49	28.97 ± 0.25	2452.47 ± 8.44
<i>A. viridis</i> (average)	24.46 ^{abcd}	55.74 ^{efghi}	185.65 ^{efgh}	52.07 ^{abcdefg}	33.17 ^{defg}	2786.33 ^{bcd}
<i>Anredera cordifolia</i>	12.30 ± 0.01 ^{ijkl}	65.61 ± 0.35 ^{cdefg}	567.50 ± 23.33 ^a	46.95 ± 0.78 ^{cdefg}	18.32 ± 0.57 ^{defg}	1685.61 ± 42.74 ^{defgh}
<i>Artemisia argyi</i>	21.94 ± 0.07 ^{bcde}	12.32 ± 0.20 ^{lm}	324.00 ± 5.66 ^{bcdef}	47.85 ± 1.20 ^{bcdefg}	21.43 ± 0.41 ^{defg}	1608.68 ± 69.22 ^{defgh}
<i>Asystasia gangetica</i>	21.19 ± 0.08 ^{bcde}	29.38 ± 1.21 ^{ijklm}	494.00 ± 0.00 ^{ab}	47.90 ± 1.13 ^{bcdefg}	43.59 ± 2.95 ^{defg}	2420.88 ± 34.11 ^{def}
<i>Celosia argentea</i> -1	20.80 ± 0.02	46.14 ± 0.07	324.50 ± 3.54	41.61 ± 1.11	66.78 ± 0.39	3499.36 ± 44.02
<i>C. argentea</i> -2	20.87 ± 0.01	15.04 ± 0.36	191.00 ± 8.49	58.45 ± 0.69	92.91 ± 2.50	1918.43 ± 56.02
<i>C. argentea</i> -3	21.22 ± 0.08	23.44 ± 0.17	289.00 ± 8.91	43.60 ± 0.85	33.39 ± 0.81	2714.12 ± 38.32
<i>C. argentea</i> -4	17.48 ± 0.03	34.31 ± 0.27	122.00 ± 4.24	43.75 ± 1.63	35.45 ± 0.14	2310.30 ± 11.19
<i>C. argentea</i> (average)	20.09 ^{cdef}	29.73 ^{ijkl}	231.63 ^{defgh}	46.85 ^{cdefg}	57.13 ^{cd}	2610.55 ^{de}
<i>Cheilocostus speciosus</i>	10.55 ± 0.08 ^{ijkl}	44.88 ± 0.95 ^{fghijk}	ND	38.30 ± 0.42 ^{efg}	15.21 ± 0.54 ^{efg}	2088.03 ± 37.84 ^{defg}
<i>Commelina benghalensis</i>	16.91 ± 0.01 ^{efghij}	72.46 ± 1.11 ^{bcdef}	335.41 ± 5.86 ^{bcde}	33.95 ± 0.92 ^g	59.06 ± 1.66 ^{cd}	1612.32 ± 39.96 ^{defgh}
<i>C. communis</i>	12.54 ± 0.09 ^{ijkl}	17.37 ± 0.49 ^{klm}	80.65 ± 2.33 ^{hi}	64.44 ± 0.70 ^{abcd}	105.14 ± 0.34 ^{ab}	891.78 ± 0.33 ^{ghi}
<i>Eleutherococcus trifoliatius</i>	20.67 ± 0.04 ^{cdef}	82.88 ± 0.60 ^{bcde}	134.00 ± 4.24 ^{ghi}	56.94 ± 0.46 ^{abcdefg}	11.60 ± 0.71 ^{efg}	356.91 ± 4.45 ^{hi}
<i>Emilia sonchifolia</i> -1	24.37 ± 0.08	17.25 ± 0.76	251.70 ± 6.65	78.29 ± 1.02	51.79 ± 0.97	1432.52 ± 2.58
<i>E. sonchifolia</i> -2	19.15 ± 0.08	20.01 ± 0.63	437.00 ± 5.66	46.05 ± 0.64	42.37 ± 0.34	555.59 ± 6.30
<i>E. sonchifolia</i> -3	18.94 ± 0.01	38.79 ± 0.63	396.40 ± 1.98	48.05 ± 0.92	47.67 ± 0.06	1750.60 ± 0.99
<i>E. sonchifolia</i> (average)	20.82 ^{cde}	25.35 ^{ijklm}	361.70 ^{bcd}	57.46 ^{abcdefg}	47.28 ^{def}	1246.24 ^{fghi}
<i>Eryngium foetidum</i>	14.11 ± 0.04 ^{fghijk}	86.03 ± 3.13 ^{bcd}	196.10 ± 4.10 ^{defgh}	41.55 ± 0.35 ^{defg}	53.29 ± 0.23 ^{cde}	356.11 ± 0.32 ^{hi}
<i>Gynura divaricata</i>	19.22 ± 0.02 ^{cdefgh}	11.00 ± 1.20 ^{lm}	313.50 ± 2.12 ^{cdef}	59.20 ± 1.27 ^{abcdef}	13.59 ± 0.92 ^{efg}	1350.17 ± 14.92 ^{efgh}
<i>Melastoma dodecandrum</i>	7.90 ± 0.07 ^{kl}	21.05 ± 0.04 ^{klm}	0.59 ± 0.02 ⁱ	67.33 ± 0.74 ^{abc}	141.08 ± 3.70 ^a	420.84 ± 1.47 ^{hi}
<i>Pandanus tectorius</i>	8.76 ± 0.04 ^{kl}	2.20 ± 0.00 ^m	ND	35.25 ± 0.49 ^{fg}	11.77 ± 0.13 ^{efg}	5499.46 ± 24.65 ^a
<i>Patrinia villosa</i> -1	12.30 ± 0.08	89.97 ± 0.83	340.00 ± 7.07	67.61 ± 0.38	19.87 ± 0.47	584.31 ± 8.11
<i>P. villosa</i> -2	14.22 ± 0.10	33.47 ± 0.18	430.00 ± 5.66	53.24 ± 0.44	14.70 ± 0.51	312.73 ± 11.44
<i>P. villosa</i> (average)	13.26 ^{hijkl}	61.72 ^{defgh}	385.00 ^{bc}	60.42 ^{abcde}	17.28 ^{efg}	448.52 ^{hi}
<i>Perilla frutescens</i> var. <i>purpurascens</i>	13.13 ± 0.07 ^{ghijkl}	23.49 ± 0.17 ^{ijklm}	228.88 ± 0.13 ^{cdefgh}	71.65 ± 0.44 ^{ab}	140.06 ± 0.64 ^a	859.30 ± 10.12 ^{ghi}
<i>Plantago asiatica</i>	17.67 ± 0.08 ^{efghi}	61.19 ± 1.99 ^{cdefgh}	234.00 ± 1.41 ^{cdefgh}	45.65 ± 1.06 ^{cdefg}	41.18 ± 0.16 ^{defg}	3924.78 ± 26.53 ^{bc}
<i>Polygonum perfoliatum</i>	12.19 ± 0.08 ^{ijkl}	11.03 ± 0.09 ^{lm}	73.45 ± 0.92 ^{hi}	73.40 ± 0.87 ^a	9.94 ± 0.19 ^{efg}	4084.15 ± 106.82 ^b
<i>Portulaca oleracea</i> -1	21.90 ± 0.11	26.37 ± 0.96	153.50 ± 2.12	59.70 ± 0.59	90.89 ± 3.57	2149.25 ± 43.20

(continued)

Table 1. (continued)

Taxa*	Proteins (g)	Vitamin C (mg)	Carotene (mg)	Fiber (g)	Fe (mg)	Ca (mg)
<i>P. oleracea</i> -2	10.45 ± 0.16	37.24 ± 0.14	175.50 ± 0.71	34.10 ± 0.42	187.15 ± 1.98	983.51 ± 5.00
<i>P. oleracea</i> -3	17.28 ± 0.09	43.67 ± 1.34	313.00 ± 2.83	37.70 ± 0.28	68.44 ± 3.39	2116.71 ± 10.61
<i>P. oleracea</i> (average)	16.54 ^{efghij}	35.76 ^{hijkl}	214.00 ^{defgh}	43.83 ^{cdefg}	115.50 ^{ab}	1749.83 ^{defgh}
<i>Rosa laevigata</i>	7.19 ± 0.08 ^l	127.18 ± 0.35 ^a	6.24 ± 0.43 ⁱ	59.32 ± 0.73 ^{abcdef}	3.31 ± 0.09 ^{fg}	439.45 ± 2.88 ^{hi}
<i>Smilax china</i>	25.05 ± 0.04 ^{abc}	88.06 ± 2.04 ^{bc}	89.14 ± 0.58 ^{hi}	57.05 ± 0.49 ^{abcdefg}	10.48 ± 0.07 ^{efg}	520.68 ± 0.72 ^{hi}
<i>Solanum</i> <i>americanum</i> - 1	29.35 ± 0.05	49.25 ± 1.26	523.35 ± 2.33	63.03 ± 0.54	31.53 ± 1.23	818.14 ± 4.94
<i>S. americanum</i> -2	22.06 ± 0.05	41.22 ± 0.84	462.00 ± 8.91	48.75 ± 0.21	45.46 ± 0.06	2368.92 ± 7.65
<i>S. americanum</i> -3	28.88 ± 0.13	46.86 ± 0.23	704.86 ± 4.14	35.30 ± 0.71	41.42 ± 2.82	2031.77 ± 40.03
<i>S. americanum</i> (average)	26.76 ^{ab}	45.78 ^{ghij}	563.40 ^a	49.03 ^{cdefg}	39.47 ^{def}	1739.61 ^{defg}
<i>S. torvum</i> -1	13.56 ± 0.22	84.52 ± 0.33	14.05 ± 0.21	44.99 ± 0.79	7.14 ± 0.12	182.60 ± 1.90
<i>S. torvum</i> -2	15.12 ± 0.06	93.97 ± 1.53	19.25 ± 1.34	48.77 ± 0.88	5.62 ± 0.03	255.85 ± 2.54
<i>S. torvum</i> -3	20.76 ± 0.28	98.26 ± 0.29	7.19 ± 0.09	72.36 ± 0.28	7.83 ± 0.32	428.25 ± 4.71
<i>S. torvum</i> (average)	16.48 ^{efghi}	92.25 ^b	13.50 ⁱ	55.37 ^{abcdef}	6.87 ^g	288.90 ⁱ
<i>Talinum</i> <i>paniculatum</i> -1	20.09 ± 0.05	36.77 ± 0.09	252.50 ± 2.12	40.00 ± 0.14	31.56 ± 1.53	874.40 ± 15.98
<i>T. paniculatum</i> -2	21.78 ± 0.04	28.25 ± 0.07	308.95 ± 8.56	38.25 ± 0.49	51.10 ± 0.06	1071.77 ± 11.94
<i>T. paniculatum</i> (average)	20.94 ^{cde}	32.51 ^{ijkl}	280.73 ^{cdefg}	39.13 ^{efg}	41.33 ^{defg}	973.09 ^{ghi}

*Numerical labels used for differentiating the samples from different localities (location information provided in Supplementary Table S1). ND indicates not detected. Values are given as average ± standard deviation (n = 2). For each column, different letters mean significant differences (P < 0.05) among species.

Some of the food-medicine plants are endemic and even commercialized in the coastal regions of South China (Figure 2). The most distinctive endemic food plant is *Patrinia villosa*, which is a traditional medicine well-known for its anti-inflammatory, antitumor, and antibacterial properties.³⁷⁻⁴⁰ This species tastes extremely bitter and it has the unpleasant foot odor, but its young shoot (Figure 2a) is a popular vegetable in Meizhou City, Guangdong Province. *Patrinia villosa* is under large-scale cultivation with a relatively high price (¥5/kg for fresh weight [FW]; ¥60/kg for dry weight [DW]). The young scape and young stems of *Cheilocostus speciosus* (J. Koenig) C. D. Specht (Figure 2g) have been used as an endemic wild vegetable in Hainan Province and can be sold at a relatively high price at ¥10 to ¥18/kg (FW). Because harvesting the tender upper part of the stem of *Pandanus tectorius* Parkinson ex Du Roi (Figure 2h) needs to cut down the whole tree, *P. tectorius* has been used as a vegetable mostly during the times of food scarcity. The fruits of *Melastoma dodecandrum* (Figure 2f) are popular as wild fruits in the study areas and can also be used to make wine and jelly candy.

Our study reports *Asystasia gangetica* (L.) T. Anderson (Figure 2c) as a wild vegetable in China for the first time. It is only used and cultivated in Chenmai County, Haikou City and Wenchang City of Hainan Province. *Asystasia gangetica* has also been used as a traditional leaf vegetable in South Africa,⁴¹ western Kenya,⁴² Vietnam,⁴³ and India.⁴⁴

Other commercialized food-medicine plants include *Artemisia argyi* Lévl. et Van., *Eleutherococcus trifoliatus*, *Eryngium*

foetidum L., *Gynura divaricata* (L.) DC., *Plantago asiatica* L., *Portulaca oleracea* L., *Rosa laevigata*, *Smilax china* L. (Figure 2i), *Solanum americanum* Mill., *Solanum torvum* Swartz (Figure 2d and e) and *Talinum paniculatum* (Jacq) Gaertn, of which *A. argyi*, *Eleutherococcus trifoliatus*, *Eryngium foetidum*, *G. divaricata*, *Plantago asiatica*, *Portulaca oleracea*, *Smilax china* and *T. paniculatum* are also cultivated.

Of the 27 species, *Amaranthus blitum*, *A. spinosus* L., *A. viridis*, *Anredera cordifolia*, *Eryngium foetidum*, *Solanum americanum*, *S. torvum* and *Talinum paniculatum* are naturalized species originally from other continents.⁴⁵⁻⁴⁸ The coastal area of South China opened its door early to the west for trading. With the open culture and the frequent economic exchanges with Europe and America, the coastal region of South China has been viewed as a key area for the initial introduction of many naturalized plants into China.⁴⁹⁻⁵²

Nutritional Properties

The proximate composition of dry and fresh edible parts of the studied food-medicine plants is presented in Table 1 and Supplementary Table S2, respectively. The ANV calculated by the FW and the results are shown in Supplementary Table S2. Suggested serving size for the studied species were obtained from the National Nutrient Database for Standard Reference, Release 28 of US Department of Agriculture.⁵³ For the leafy vegetables, the standard serving size followed the standard of Chinese cabbage (1 cup, 70 g; NDB No. 11116). For the stem

Table 2. Serving Size, Daily Value, and Percent Daily Value of the Studied Species.

Taxa	Serving Size (g)	Percent Daily Value				
		Proteins	Vitamin C	Fiber	Fe	Ca
<i>Alternanthera sessilis</i>	70.00	4.58	6.78	26.38	67.02	30.85
<i>Amaranthus blitum</i>	70.00	8.15	13.18	29.70	41.04	21.38
<i>A. spinosus</i>	70.00	4.92	2.94	24.96	35.97	33.83
<i>A. viridis</i>	70.00	6.85	13.01	29.16	25.80	39.01
<i>Anredera cordifolia</i>	70.00	1.10	4.90	8.41	4.56	7.55
<i>Artemisia argyi</i>	70.00	4.64	2.17	20.26	12.60	17.03
<i>Asystasia gangetica</i>	70.00	4.45	5.14	20.12	25.43	25.42
<i>Celosia argentea</i>	70.00	3.49	4.30	16.27	27.55	22.66
<i>Commelina benghalensis</i>	70.00	2.58	9.21	10.36	25.03	12.30
<i>C. communis</i>	70.00	1.44	1.66	14.80	33.53	5.12
<i>Cheilocostus speciosus</i>	134.00	2.43	8.62	17.65	9.74	24.06
<i>Eleutherococcus trifoliatus</i>	70.00	9.03	30.17	49.74	14.07	7.79
<i>Emilia sonchifolia</i>	70.00	2.19	2.22	12.08	13.81	6.55
<i>Eryngium foetidum</i>	70.00	2.65	13.48	15.62	27.83	3.35
<i>Gynura divaricata</i>	70.00	9.79	4.67	60.32	19.23	34.39
<i>Melastoma dodecandrum</i>	68.00	1.38	3.06	23.48	68.33	3.67
<i>Pandanus tectorius</i>	58.00	2.03	0.43	16.36	7.59	63.79
<i>Patrinia villosa</i>	70.00	3.36	13.03	30.62	12.16	5.68
<i>Perilla frutescens</i> var. <i>purpurascens</i>	70.00	3.25	4.84	35.43	96.19	10.62
<i>Plantago asiatica</i>	70.00	3.78	10.92	19.56	24.50	42.03
<i>Polygonum perfoliatum</i>	70.00	2.52	1.90	30.36	5.71	42.23
<i>Portulaca oleracea</i>	70.00	1.62	2.92	8.59	31.44	8.57
<i>Rosa laevigata</i>	62.50	4.83	71.17	79.67	6.17	14.75
<i>Solanum americanum</i>	70.00	11.06	15.77	40.53	45.31	35.95
<i>S. torvum</i>	82.00	5.44	25.35	36.52	6.29	4.76
<i>Talinum paniculatum</i>	70.00	2.49	3.22	9.31	13.66	5.79
Daily value ^a		50 g	60 mg	25 g	18 mg	1000 mg

^aDaily value based on a caloric intake of 2000 calories as established by the US Food and Drug Administration.⁵⁴

vegetable *Cheilocostus speciosus*, the standard of asparagus (1 cup, 134 g; NDB No. 11011) was followed; and for *Pandanus tectorius*, we followed the standard of radishes (1 cup, 134 g; NDB No. 11011). For the fruits, we followed the standards of eggplant (1 cup, 82 g; NDB No. 11209) for *Solanum torvum*, blueberries (50 berries, 68 g; NDB No. 09050) for *Melastoma dodecandrum*, and apples (½ cup, 62.50 g; NDB No. 09003) for *Rosa laevigata*. Furthermore, daily value data of each nutrient category (relative to a 2000-cal diet) were obtained from the US Food and Drug Administration.⁵⁴ Then, the percent daily value was calculated for a serving size for each studied species. Serving size, daily value, and percent daily value are shown in Table 2.

The range of protein content is from 7.19 ± 0.08 g (*Rosa laevigata*) to 29.12 ± 0.06 g (*Alternanthera sessilis* (L.) R. Br. ex DC.) of 100 g DW and from 0.79 g (*Anredera cordifolia*) to 7.90 g (*Solanum americanum*) of 100 g FW. The dietary fiber content varied from 33.95 ± 0.92 g (*Commelina benghalensis*) to 73.40 ± 0.87 g (*Polygonum perfoliatum* L.) of 100 g DW and from 3.00 g (*Anredera cordifolia*) to 31.87 g (*Rosa laevigata*) of 100 g FW. The calcium content fluctuated between 288.90 mg (*Solanum torvum*) to 5499.46 ± 24.65 mg (*Pandanus tectorius*) of 100 g DW, while 47.83 mg (*Eryngium foetidum*) and 1099.89 mg (*Pandanus tectorius*) of 100 g

FW. The iron content ranged from 3.31 ± 0.09 mg (*Rosa laevigata*) to 141.08 ± 3.70 mg (*Melastoma dodecandrum*) of 100 g DW and 1.17 mg (*Anredera cordifolia*) to 24.73 mg (*Perilla frutescens* var. *purpurascens* (Hayata) H. W. Li) of 100 g FW. The carotene content was not detected (<0.04 mg/kg) for *Pandanus tectorius* and *Cheilocostus speciosus*. The lack of carotene was probably caused by the special edible parts of the 2 species. For *Pandanus tectorius*, its edible part is the “pith” of the young stem and almost no pigment can be found there. Among the remaining species, the highest carotene content was detected from *Anredera cordifolia* (567.50 ± 23.33 mg) of 100 g DW and *Solanum americanum* (166.32) of 100 g FW. The range of vitamin C content was from 2.20 mg (*Pandanus tectorius*) to 127.18 ± 0.35 mg (*Rosa laevigata*) of 100 g DW and 0.44 mg (*Pandanus tectorius*) to 68.32 mg (*Rosa laevigata*) of 100 g FW.

Solanum americanum has the highest ANV, as well as higher concentrations of several nutrients from each serving (11.06%, 15.77%, 40.53%, 45.31%, and 35.95% of the daily value for proteins, vitamin C, fiber, Fe and Ca, respectively). All the studied species can be considered good sources of dietary fiber. Their contribution of the daily fiber value per serving is between 8.41% (*Anredera cordifolia*) and 79.67% (*Rosa laevigata*). The contribution of proteins is limited. Only

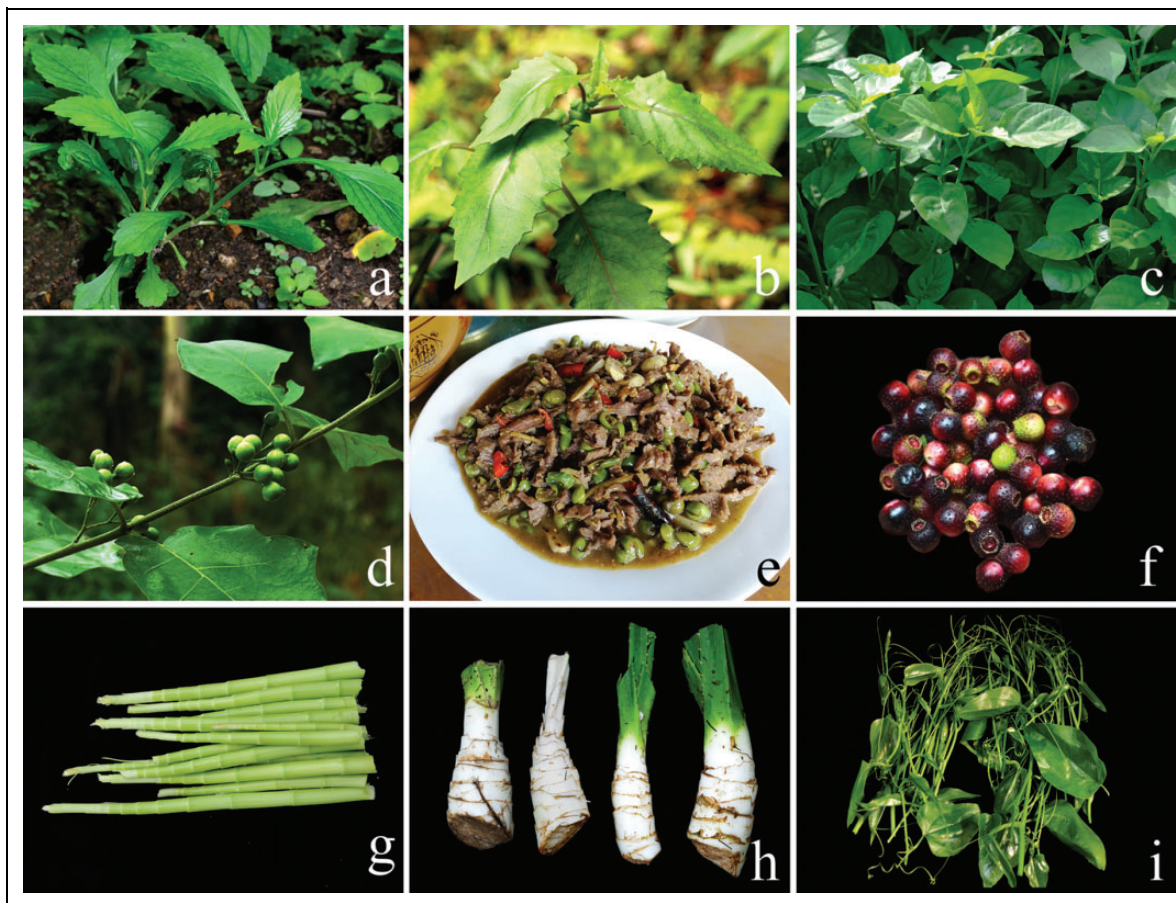


Figure 2. Edible parts of some endemic and commercialized food-medicine plant from the study area. a, *Patrinia villosa*. b, *Gynura divaricata*. c, *Asystasia gangetica*. d, *Solanum torvum*. e, *S. torvum*, show stir-fry with beef. f, *Melastoma dodecandrum*. g, *Cheilocostus speciosus*. h, *Pandanus tectorius*. i, *Smilax china*. Photographed by Yuan Xu.

Gynura divaricata (9.79%) and *Solanum americanum* (11.06%) have higher percent daily value of proteins that is near or higher than 10%. Wild fruit, *Rosa laevigata* with 71.17% percent daily value, provides the maximum contribution for vitamin C per serving. *Plantago asiatica* (10.92%), *Amaranthus viridis* (13.01%), *Patrinia villosa* (13.03%), *Amaranthus blitum* (13.18%), *Eryngium foetidum* (13.48%) and *Solanum americanum* (15.77%) were considered good sources of vitamin C and *Solanum torvum* (25.35%) and *Eleutherococcus trifolius* (30.17%) are considered excellent sources with the percent daily value higher than 20%. The studied species also have a prominent iron content. Twenty species have percent daily value more than 10% and they range from 12.60% (*Patrinia villosa*) to 96.19% (*Perilla frutescens* var. *purpurascens*) per serving. For the contribution of calcium per serving, *Perilla frutescens* var. *purpurascens* (10.62%), *Commelina benghalensis* (12.30%), *Rosa laevigata* (14.75%) and *Artemisia argyi* (17.03%) are good sources and *Amaranthus blitum* (21.38%), *Celosia argentea* L. (22.66%), *Cheilocostus speciosus* (24.06%), *Asystasia gangetica* (25.42%), *Alternanthera sessilis* (30.85%), *Amaranthus spinosus* (33.83%), *Gynura divaricata* (34.39%), *Solanum americanum* (35.95%), *Amaranthus viridis* (39.01%), *Plantago asiatica*

(42.03%), *Polygonum perfoliatum* (42.23%) and *Pandanus tectorius* (63.79%) are excellent sources.

Functional Properties

The medicinal efficacies of the investigated food-medicine plants are shown in Table 3 and can be classified into 8 categories (Figure 3): treatment of damp-heat syndrome (eg, aphtha, cutaneous pruritus, eczema, epistaxis, fever, pharyngalgia and swelling and pain of eye; 17 species), digestive diseases (eg, chronic gastroenteritis, constipation, dysentery, enteritidis and stomachache; 13 species), urologic diseases (eg, dysuria, hematuria, lithangiuria, nephritis, stranguria, urethritis and urocystitis; 9 species), arthropathy (eg, fracture, joint pain, lumbago, rheumatism and traumatic injury; 9 species), respiratory diseases (eg, asthma, bronchitis, cough, pertussis, pneumonia and tuberculosis; 7 species), gynecological diseases (eg, abnormal leukorrhea, abnormal menstruation, dysmenorrhea; mastitis, metrorrhagia and metrorrhagia; 4 species), snake or insect bites (2 species) and uses as a tonic (eg, to cure anemia, asthenia, and hyp immunity; 4 species).

Usually, tonic is the most frequently used category in traditional Chinese food-medicine plants (eg, *Panax ginseng* C. A.

Table 3. Edible and Medicinal Use of the Studied Species.

Taxa	Edible Parts and Uses	Medicinal Parts and Efficacy
<i>Alternanthera sessilis</i>	Young shoots: blanching and then stir-fry.	Whole plant: cure dysentery, epistaxis, hemoptysis, hematochezia, urethritis, mastitis, dysuria; external use to treatment of sore and furuncle, eczema, dermatitis, or snakebite.
<i>Amaranthus blitum</i>	Seedlings, young shoots and leaves: stir-fry, used in soups or egg pancakes, boiled and consumed in sauces.	Whole plant: cure dysentery, hot eyes, acute mastitis, hemorrhoids; seed: used for diuresis or improving eyesight.
<i>A. spinosus</i>	Seedlings, young shoots and leaves: stir fry, used in soups or egg pancakes, boiled and consumed in sauces.	Zhuang nationality Roots: cure dysentery and hemorrhoids; whole plant: cure dysentery, hemorrhoids, or metropotosis.
<i>A. viridis</i>	Seedlings, young shoots and leaves: stir fry, used in soups or egg pancakes, boiled and consumed in sauces.	Whole plant: used for heat-clearing and detoxifying or diuresis
<i>Anredera cordifolia</i>	Tender leaves and stems: stir fry, cooked in soups or with noodles Tubercles: boiled like potatoes.	Mulao nationality Vines and tubercles: used for replenishing blood
<i>Artemisia argyi</i>	Tender leaves: used in soups or egg pancakes; juice used for pastry.	Yao nationality Whole plant: treatment of emmeniopathy, stomachache, sore and furuncle, fetal irritability, or scrofula. Dong nationality Whole plant: treatment of emmeniopathy, stomachache, or scrofula. Mulao nationality Whole plant: treatment of dysmenorrhea or abnormal menstruation. Miao nationality Leaves: used for dysmenorrhea, metrorrhagia and metrostaxis, fetal irritability; external use to cure joint pain or cutaneous pruritus.
<i>Asystasia gangetica</i>	Young shoots and leaves: blanching then stir-fry.	Zhuang nationality Aerial parts: subside swelling when bruise or traumatic injury, cure metropotosis or rectocele.
<i>Celosia argentea</i>	Young shoots and leaves: stir-fry or boiled and consumed in sauces Young inflorescences: stew with meat.	Li nationality Whole plant: used for heat-clearing and damp-drying, cooling blood and hemostasis or anti-pruritus; Seed: used for sore red swollen eyes; inflorescence: used for cooling blood and hemostasis, removing liver-fire for improving eyesight. She nationality Whole plant and seed: used for swelling and pain of eye, cataract, cutaneous pruritus. Mulao nationality Aerial parts: cure sore red swollen eyes or epistaxis. Miao nationality Seeds: cure sore red swollen eyes or keratitis.
<i>Cheilocostus speciosus</i>	Tender stems: peel off the older leaf sheath then stir fry, stews or braise with meat.	Zhuang nationality Rhizomes: cure stomachache, fracture or impotence.
<i>Commelina benghalensis</i>	Young shoots: stir fry, boiled in soups, dried and stew with meat.	Li nationality Rhizomes: used to diuresis detumescence, expelling wind-damp.
<i>C. communis</i>	Young shoots: stir-fry, boiled in soups, dried and stew with meat.	Whole plant: cure scanty dark urine, dysentery characterized by blood in the stool or furunculosis Dong nationality Whole plant: cure lumbago and edema. Miao nationality Inflorescences: cure keratitis, sore red swollen eyes, xerophthalmia, nyctalopia.
<i>Eleutherococcus trifolius</i>	Young shoots: blanching in water to remove the bitter principle and then stir fry or consumed in sauces, dried and boiled in soups.	Yao nationality Roots and leaves: used in abnormal menstruation, rheumatagia, arthralgia, or pertussis. Zhuang nationality: Root and leaf: used in abnormal menstruation, rheumatagia, fracture or bee sting. Mulao nationality Root and leaf: used for irregular menstruation or cold and cough. Miao nationality: Roots: cure cough, enteritidis, lithangiuria, diarrhea, rheumatoid arthritis, fracture, mastitis, or sore and ulcer.
<i>Emilia sonchifolia</i>	Seedlings, young shoots and leaves: stir fry, used in soups.	Yao nationality Whole plant: ingested to cure cold, pharyngalgia, pneumonia, urinary tract infection or diarrhea; external use to treatment of scabies, traumatic injury, or snakebite. Zhuang nationality: Whole plant: ingested to cure dysentery, urocystitis, hemafecia, or bleeding from hemorrhoids; external use to treat scabies, traumatic injury, or snakebite. Li nationality Whole plant: used for heat-clearing and detoxifying, sore swollen poison, or hemafecia. Dong nationality Whole plant: used for treating flu, fever, swelling and pain in throat, nephritis, colitis, hepatitis, dysentery, cervicitis.

(continued)

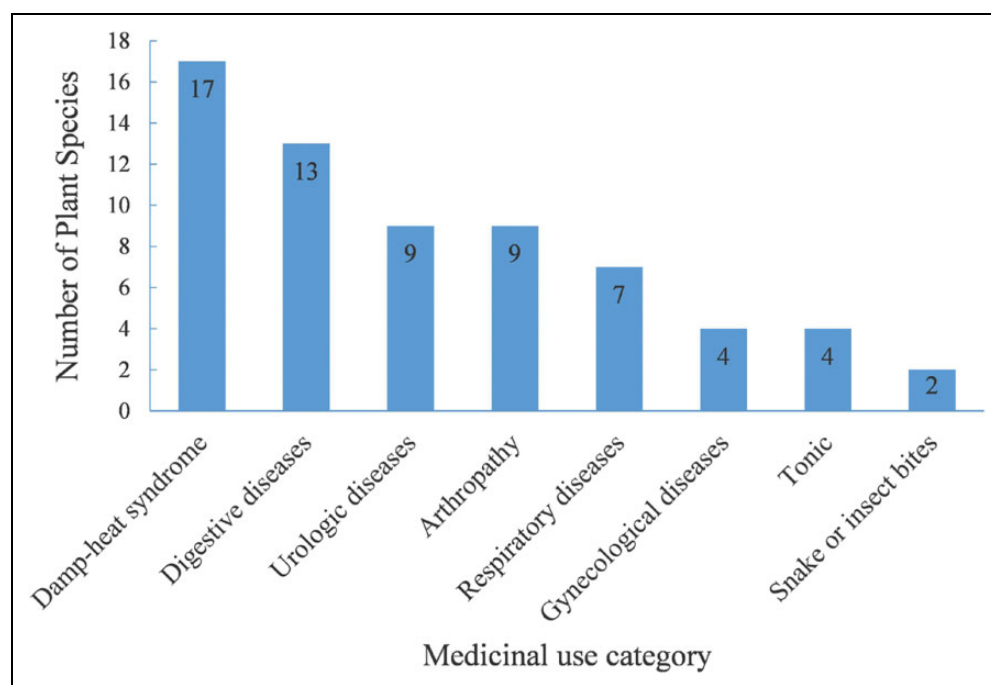
Table 3. (continued)

Taxa	Edible Parts and Uses	Medicinal Parts and Efficacy
		Mulao nationality Whole plant: cure cold and fever. Miao nationality Whole plant: cure acute mastitis, sore and furuncle, tympanitis, acute tonsillitis, chronic gastroenteritis, urinary tract infection, or sprain.
<i>Eryngium foetidum</i>	Seedlings, tender leaves: stir fry, boiled and consumed in sauces, used as spice or condiment (raw or cooked), mixed with meat stuffing.	Yao nationality Whole plant: cure cold, bronchitis, diarrhea, oxyhepatitis, or odontalgia.
<i>Gynura divaricata</i>	Seedlings, young shoots and leaves: stir fry, used in soups, boiled and consumed in sauces, cooked with noodles.	Yao nationality Leaves: used as ascaricide. Zhuang nationality Whole plant: cure traumatic injuries, carbuncle, or injury infection prevention clinically.
<i>Melastoma dodecandrum</i>	Mature fruits: eaten raw, natural pigment.	Mulao nationality Whole plant: cure protracted dysentery. Yao nationality Whole plant: cure dysentery and enteritis. Zhuang nationality Roots: cure diarrhea or abnormal leukorrhea; whole plant: cure dysentery and enteritis; young leaf: used as hemostatics when incised wound. She nationality Whole plant or roots: cure rheumatism, hernia, dysmenorrhea, metrorrhagia and metrostaxis, dysentery with bloody stool, hemorrhoids and fistula, rubella.
<i>Pandanus tectorius</i>	Tender stems: peel off the rind and then stir fry Mature fruits: stew with meat.	Dong nationality Whole plant: cure enteritis, dysentery or leukorrhagia. Miao nationality: Whole plant: cure habitual abortion. Li nationality Roots: cure cold, fever, hepatitis, cirrhotic ascites, nephritic edema, stranguria, rheumatic arthralgia or hernia; young leaves: cure cold and fever, heatstroke, gingival bleeding or crushed with soybean and then apply to affected areas for treatment of boils; cure cold and fever, stranguria with turbid urine, heat diarrhea, hernia, aphtha; fruits: used for dysentery, cough, stomachache, orchitis, hemorrhoids, dysuria, or cataract
<i>Patrinia villosa</i>	Young shoot and leaf: dried and used for soups.	Zhuang nationality Roots: cure icteric hepatitis or treatment of fester cause by snakebite. She nationality Whole plant: cure appendicitis or constipation.
<i>Perilla frutescens</i> var <i>purpurascens</i>	Tender leaves: spice (eg, cooked with fish or seafood).	Mulao nationality Whole plant: cure swelling and pain of eye, swollen welling-abscess or dysentery. Leaves: used for treating diuresis, analgesia or cold; seeds: used for eliminating phlegm, antitussive or relieving asthma.
<i>Plantago asiatica</i>	Seedlings and tender leaves: fresh stir fry or used in soups, dried and then used as tea.	Li nationality Seeds and whole plant: urinary tract infection, urinary calculus, nephritis or diarrhea. Mulao nationality Seeds: cure nephritis or urinary tract infection.
<i>Polygonum perfoliatum</i>	Young shoots: blanching and then stir fry.	Yao nationality: Whole plant: treatment of eczema, children's diarrhea, snakebite, or used as ascaricide. Zhuang nationality Whole plant: treatment of cutaneous pruritus. Dong nationality Whole plant: stomachache, abdominal distention and pain, eczema or snakebite.
<i>Portulaca oleracea</i>	Tender leaves and stems: stir fry, used in soups or egg pancakes, boiled and consumed in sauces, mixed with meat stuffing.	Miao nationality Whole plant: cure cold, enteritis, diarrhea, snakebite or centipede bite. Li nationality Whole plant: used for heat-clearing and detoxifying, dysentery. Mulao nationality Whole plant: cure tuberculosis, hemoptysis, hemaecia, or hematuria.
<i>Rosa laevigata</i>	Mature fruits: eaten raw or made into wine.	Yao nationality Roots: treatment of used as ascaricide. She nationality Fruits: cure spermatorrhea, frequent micturition, metrorrhagia and metrostaxis, prolonged diarrhea and dysentery. Dong nationality Roots and fruits: cure tuberculosis, furuncle, metrorrhagia and metrostaxis. Mulao nationality Roots, leaves, flowers and fruits: cure spermatorrhea, enuresis, lingering dysentery, leukorrhea. Miao nationality Roots and fruits: cure spermatorrhea, impotence, children diarrhea or rectocele.

(continued)

Table 3. (continued)

Taxa	Edible Parts and Uses	Medicinal Parts and Efficacy
<i>Smilax china</i>	Young shoots: blanching in boiling water and then stir fry or consumed in sauces.	Yao nationality Rhizomes: treatment of bone fracture. Zhuang nationality Rhizomes: cure gynecopathy or arthritis. Li nationality Rhizomes: diminish inflammation and relieve coughing. She nationality Whole plant: cure arthralgia, traumatic injury, enterogastritis, dysentery. Mulao nationality Rhizomes: used for reinforcing kidney to strengthen yang. Miao nationality Rhizome: cure rheumatalgia, numbness of sinews and bones, enteritis, diarrhea, diabetes, or treatment of cancer.
<i>Solanum americanum</i>	Young shoots and leaves: stir fry, used in soups, boiled and consumed in sauces, added in conjee.	Dong nationality Whole plant: cure urodynia or sore and furuncle. Miao nationality Aerial parts: treatment for sore and furuncle, urinary tract infection or dysuria; root: cure hemoptysis or irregular menstruation.
<i>S. torvum</i>	Young fruits: stir fry with beef.	Roots: cure cold, chronic cough, stomachache, toothache, amenorrhea, swollen welling-abscess, traumatic injury; leaves: used for innominate inflammatory; fruit: improving eyesight.
<i>Talinum paniculatum</i>	Tender leaves and stems: stir fry, used in soups, boiled and consumed in sauces Older root: stew with meat.	Zhuang nationality Root: strengthen immunity and invigorate health effectively, cure metropotosis, rectocele, lung vacuity cough. Dong nationality Roots: used as a tonic. Mulao nationality Roots: cure cough and hemoptysis. Miao nationality Roots: used as a tonic.

**Figure 3.** Species number used for different diseases.

Mey. and *Dioscorea polystachya* Turcz.), but the majority of food-medicine plants in the coastal region of South China have been used to treat the damp-heat syndrome (nearly 61%; Figure 3). Only 4 studied species, *Anredera cordifolia*, *Rosa laevigata*, *Talinum paniculatum* and *Pandanus tectorius* (fruit) are used as a tonic (Table 3; Figure 3). This dominant use of plants to treat damp-heat syndrome as well as the similar “liáng chá” (cool herb tea) culture in the region were likely developed to adapt to the local warm-wet climate in the coastal region of South China.^{20,23}

Other common medicinal uses of food-medicine plants are to treat digestive diseases, urologic diseases, and arthropathy. These uses are likely closely related to the dietary habit and lifestyle of the local people. Because of their habit of eating raw seafood, anti-inflammatory and antibacterial food-plants are important supplement to the diet of the local people to prevent digestive diseases (eg, enteritis and diarrhea). Regular high-salt and high-purine diet intake increases the occurrences of hypertension, edema, dysuria and urarthritis. Food-medicine plants (like *Plantago asiatica*) that are used to treat urologic

diseases can promote sodium and trioxypurine excretion to alleviate the above diseases. Besides, many local people frequently work on the ship, and rheumatism and bruises are hence common problems in the study area. Thus, the food-medicine plants that can treat arthropathy are always regarded as a household medicine or functional food in the coastal regions of South China.

Diversity and Differences in the Application Methods

The diversity of the application methods between food and medicine is mostly reflected in the different used parts of edible and medicinal plants (Table 3). Based on the edible parts and medicinal parts of the plant species, 3 different categories can be recognized.

First, the edible and medicinal parts are the same, but the harvest time is different. Usually, the harvest time for the edible parts is during the young stages, while that for medicinal parts is at the full-blooming stage. This category includes almost all the leafy vegetables (*Alternanthera sessilis*, *Amaranthus blitum*, *A spinosus*, *A viridis*, *Anredera cordifolia*, *Artemisia argyi*, *Asystasia gangetica*, *Commelina benghalensis*, *Commelina communis* L., *Emilia sonchifolia* (L.) DC. ex DC., *Eryngium foetidum*, *Gynura divaricata*, *Patrinia villosa*, *Perilla frutescens* var. *purpurascens*, *Polygonum perfoliatum*, *Portulaca oleracea* and *Solanum americanum*). All these species are most frequently used as “everyday” food, and most of them (except *Artemisia argyi* and *Anredera cordifolia*) are used to treat the damp-heat syndrome, likely to relieve ailments caused by the hot and humid climate in the coastal region of South China.

Second, edible and medicinal parts overlap. Most species included in this category have multiple medicinal parts and they are partly used as food, such as *Pandanus tectorius* (roots and fruits used as medicine, and fruits used as food), *Plantago asiatica* (the whole plant and seeds used as medicine, and the leaves used as food), *Solanum torvum* (roots, leaves and fruits used as medicine, and young fruits used as food), and *Rosa laevigata* (roots, leaves, flowers and fruits used as medicine, and fruits used as food). Only *Talinum paniculatum* has 2 edible parts (young stems, including some young leaves, and roots) and 1 medicinal part (roots). These species are often treated as functional foods with strong therapeutic effects and cannot be used as the “everyday” food.

The last category includes species with strictly different parts used for food and medicinal purposes, such as *Cheilocostus speciosus* (rhizomes used as medicine, and tender stems and tender scapes used as food), *Eleutherococcus trifolius* (roots and leaves used as medicine, and young shoots used as food), *Melastoma dodecandrum* (the whole plant, roots and young leaves used as medicine, and the mature fruits used as food), and *Smilax china* (the whole plant and rhizomes used as medicine, and the young shoots used as food). All these species are popular TCM and have been cultivated on a large scale.

The medicinal utilization methods are diverse in the coastal regions of South China. Medicinal parts for the same species

can be different when used by different ethnic groups, even with different efficacies. Efficacies also can be various with different preparation methods (eg, external or internal use). For example, the efficacies of *Smilax china* are antiphlogosis and antitussive by the Li nationality, while the species is used to treat rheumatism and traumatic injury by other minority groups. The common efficacy of *Gynura divaricata* is to treat dysentery, but it may also be used to treat traumatic injuries and carbuncle for external use. The root of *Solanum torvum* is used for curing cold, chronic cough, stomachache, toothache, amenorrhea, swollen welling-abscess and traumatic injury, while the leaves are used for innominate inflammatory, and the fruits are used for improving eyesight.

Local Preferences of Food-Medicine Plants

Local preferences and ethnic use of food-medicine plants were normally affected by the local natural conditions, customs, as well as the long-term tradition of using medicinal plants.⁵⁵⁻⁵⁷ As a result of permanently living in the warm-wet zone in the coastal regions of South China, the local people particularly prefer the bitter foods. They regard food plants with bitter taste to be effective as heat-clearing agents. This perception is widespread and has influenced the consumption of both medicinal and food plants in the coastal region of South China.²⁰ The concept of bitterness also conforms to the TCM knowledge that bitter medicinal plants usually have the cold property. Other studies have also reported that bitterness may have some additional medicinal properties.^{3,58,59} For example, the Sylheti people believe bitter food can treat diabetes.³

Conclusions

The coastal region of South China harbors abundant species diversity of food-medicine plants with at least 27 commonly used species documented by the present study. Most of them are good sources for dietary fiber, calcium, iron and vitamin C, with which the percent daily value is more than 10% per serving. Our study confirmed that the unique warm-wet climate in coastal South China has deeply influenced the consumption of the medicinal and food plants of the local ethnic groups. The most common medicinal use of the studied species is for heat-clearing, which is to treat some ailments caused by the specific hot-wet climatic conditions. Furthermore, the local people hence prefer to eat bitter food. The medicinal and edible parts are similar for most of the heat-clearing plants, and the medicinal parts may be used for “everyday” food at the young stage. Medicinal and edible parts of the functional food plants often overlap, and these species usually have strong therapeutic effects and cannot be used as “everyday” food. Almost all the heat-clearing plants are also cultivated and commercialized.

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Author Contributions

R-JW and YX designed the study; R-JW, YX, DL, and G-TW carried out the field study and compiled the database; R-JW, G-TW, and DL identified the plant species; YX and JW drafted the manuscript; YX and DL conducted experiments; YX, DL, and JW analyzed the data; R-JW, JW, and YX revised the manuscript. All authors read and approved the final manuscript.


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Ethical Approval

Not applicable.

Supplemental Material

Supplemental material for this article is available online.

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