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Eating "rubbish"? Exploring the herbal secrets of "*Laji-He*," a traditional herbal rice snack from southern China

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Abstract

Background *Laji-He* is a traditional rice-based snack from the Beibu Gulf region in southern China. In the Beibu Gulf region, "*Laji-He*" (literally "garbage *He*") signifies the removal of toxins from the body, making it a truly "green" food. *Laji-He* holds essential cultural and medicinal value, incorporating various medicinal plants into its preparation. Despite its local importance, there is limited scientific documentation on the ethnobotanical properties and cultural relevance of the plants used. This study aims to analyze the medicinal plant used in *Laji-He* and its implication in human medicine.

Methods Ethnobotanical surveys and interviews were conducted in the Beibu Gulf region, covering local markets and communities. Voucher specimens were collected and identified for each plant collected, using botanical references, while the relative frequency of citation index was used to assess the cultural importance of each plant. Additionally, the medicinal properties of these plants were categorized based on traditional Chinese medicinal theory and modern pharmacological literature. A detailed review of historical texts and local chronicles was also performed to trace the historical development and cultural changes of *Laji-He*.

Results A total of 63 medicinal plants from 36 families and 53 genera were documented, with Rubiaceae, Fabaceae, and Lamiaceae being the most frequently represented families. The most commonly used plants, such as *Paederia foetida*, *Piper sarmentosum*, *Houttuynia cordata*, *Centella asiatica*, and *Morus alba*, were primarily utilized for their heat-clearing, detoxifying, and wind-dampness expelling properties. *Laji-He* serves as a symbol of cultural identity and community cohesion, particularly during traditional festivals and family gatherings, reinforcing collective memory and local heritage.

Conclusions *Laji-He* is a traditional functional snack, with the plants used in its preparation serving as both food and medicine. Preserving and promoting the culture of *Laji-He* can contribute to enhancing food security and sovereignty at both the local and national levels.

Keywords Medicinal plants, Ethnobotany, Beibu Gulf, Traditional knowledge, Food culture

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Introduction

He (粄, pronounced hé) is a traditional snack with a long history originating from the Lingnan region in southern China [1]. Its origins can be traced back to the pre-Qin period (before 221 BCE). Initially, in ancient times, within the region known as Nanyue (encompassing parts of present-day southern China), local inhabitants mainly practiced slash-and-burn agriculture. They would grind grains and tuber crops into a sticky paste, wrap it around meat and vegetables, and consume it, forming the prototype of *He* [1]. Over time, *He* evolved in the Lingnan region into an important food for festivals and religious ceremonies, used both as offerings to deities and ancestors and as festive gifts [1].

Among the various types of *He*, the "*Laji-He*" from the Beibu Gulf region of the Guangxi Zhuang Autonomous Region is particularly unique and is pronounced as / laap^{6} saap^{3} e^{55}/. According to our field investigations, it is prepared by mixing fresh leaves of various medicinal plants—such as *Paederia scandens*, *Lonicera japonica*, *Artemisia argyi*, and *Houttuynia cordata*—with rice or glutinous rice. This mixture is then ground into a paste and shaped into cakes (Fig. 1). Every year, on the eighth day of the fourth month in the lunar calendar, local residents prepare and consume this traditional green snack to pray for health and peace. Although the name "*Laji-He*" literally translates to "garbage *He*," which may sound unappealing, in local culture, it symbolizes the elimination of "garbage" or toxins from the body, making it a truly "green food." Not only does it have a unique flavor, but it is also rich in the health benefits provided by traditional medicinal plants. The process of making *Laji-He* reflects the residents' profound understanding of local plant resources in the Beibu Gulf region, reflecting how they integrate extensive knowledge of medicinal plants into their daily culinary practices.

The Lingnan region has a long-standing tradition of utilizing its diverse array of medicinal plants, which are not only applied in medicine but also deeply integrated into everyday diets [2]. For local residents, food serves not only as sustenance but also as a means to enhance health and prevent illness. The concept of "food and medicine from the same source" is deeply embedded in Lingnan culture, shaping a distinctive approach to both diet and health. The region's rich biodiversity of medicinal plants plays a crucial role in this practice. For instance, these plants are commonly used in soups or brewed into herbal teas for daily health maintenance [3–5]. Within this context, *Laji-He* exemplifies this tradition, highlighting the unique application of medicinal plants in local

Fig. 1 Different types of *Laji-He*. **A** Selling *Laji-He*, **B**–**D** Different kinds of *Laji-He* sold in markets

cuisine, which holds a significant place in Lingnan cultural practices.

Although *Laji-He* holds significant cultural importance in the Beibu Gulf region, there are no academic reports on the specific medicinal plants used, their origins, or their cultural significance. Based on our investigation, the selection of medicinal plants in *Laji-He* is not solely based on flavor but also reflects a deep understanding and application of their medicinal properties. Therefore, it is essential to conduct a systematic ethnobotanical study to document and analyze the plant species used in *Laji-He* and their cultural characteristics, filling this research gap and uncovering the unique aspects of this tradition. This study aimed to (i) explore the traditional culture and preparation process of *Laji-He*, (ii) record the medicinal plant species used in *Laji-He,* (iii) discuss the medicinal properties of the plants used in *Laji-He*, to provide a scientific foundation for the preservation and transmission of this traditional food culture while offering new perspectives for modern society in the fields of food and health.

Study area and methodologies

This study employed a comprehensive approach, integrating literature analysis, field surveys, and interviews to systematically investigate the medicinal plants used in the preparation of *Laji-He*. Initially, we gathered and analyzed a wide range of literature on traditional foods and medicinal plants from the Lingnan region, with a particular focus on the Beibu Gulf coastal areas of Guangxi. Through this process, we identified the types and characteristics of medicinal plants commonly used in *Laji-He*.

The study area

The Beibu Gulf region, located along the southern coast of China and bordering Vietnam, encompasses several coastal cities within the Guangxi Zhuang Autonomous Region, including Fangchenggang, Qinzhou, and Beihai. This region faces the Beibu Gulf, which is part of the South China Sea. As one of China's key maritime economic zones, the Beibu Gulf serves as a gateway for Guangxi's external trade and economic development. The region experiences a subtropical monsoon climate, characterized by warm and humid conditions, with an average annual temperature ranging from 22 to 24 °C, fostering rich biodiversity and supporting the growth of various plant and animal species [6]. This climate makes the Beibu Gulf an important area for both ecological conservation and economic activities related to marine resources.

The Beibu Gulf region in southern China is home to a diverse range of ethnic groups, including the Zhuang, Kinh, Yao, Miao, and Han. Among them, the Han people constitute the largest ethnic group, making up the majority of the population. According to local government reports, as of the end of 2023, the populations of Beihai City, Qinzhou City, and Fangchenggang City were approximately 1.84 million, 3.32 million, and 1.05 million, respectively. The local culture combines maritime traditions with influences from traditional agriculture, creating unique customs, languages, and practices. Historically, the region was under the jurisdiction of Guangdong for an extended period, coupled with its geographical proximity to Guangdong. These factors have contributed to Cantonese becoming the most widely spoken language in the area. Furthermore, due to the significant number of residents engaged in maritime industries, the local population commonly worships the Dragon God, a deity in Chinese mythology believed to govern the seas.

Based on the preliminary findings from the literature, we designed a detailed survey route and timeline for the fieldwork. Key field sites were selected from major cities and counties along the Beibu Gulf coast, including Fangcheng District, Gangkou District, Dongxing City, Qinbei District, Qinnan District, Hepu County, and Haicheng District. (The specific study sites are listed in Table 1, Fig. 2.) To ensure comprehensive coverage, we combined market surveys and local interviews. We also conducted in-depth investigations with market vendors, local elders, and cultural knowledge bearers known for their expertise in traditional medicine.

Data collection

Between 2021 and 2024, six ethnobotanical surveys were conducted in the local region. We utilized the snowball sampling method to identify ideal informants for in-depth interviews, which provided valuable insights into the local names, parts used, frequency of use, collection environments, and seasonal availability of the medicinal plants incorporated in *Laji-He* [7]. To ensure a diverse sample and minimize bias in the selection process, we automatically considered vendors selling *Laji-He* at the markets and elderly individuals with experience in its preparation as key informants. Using the snowball method, we further inquired with these vendors to identify other individuals who make or are involved in the preparation of *Laji-He*, thus helping us identify additional potential informants. In the study area, we surveyed 125 participants, including 54 males and 71 females, aged 12 to 75 years. The majority of the respondents were of Han ethnicity. Among them, 36 were key informants, while the remaining 89 general participants were recruited from marketplaces and villages. Among the respondents, most were engaged in farming and fishery activities, with a smaller proportion working as vendors (primarily

Table 1 The detailed study sites of *Laji-He*

No	Location	Longitude (DMS)	Latitude (DMS)
1	Guomao Market, Dongxing County	107° 58′ 2.06" E	21° 32′ 51.00" N
2	Nasuo Market, Fangcheng District	108° 6′ 48.62" E	21° 43′ 13.70" N
3	Jinhai Market, Gangkou District	108° 20′ 43.74" E	21° 37′ 57.82" N
4	Nawan Village, Fangcheng District	108° 11′ 58.84" E	21° 46′ 24.45" N
5	Binjiang Market, Fangcheng District	108° 21′ 4.62" E	21° 45′ 49.98" N
6	Beihai Nanzhu Market	109° 7′ 24.59" E	21° 28′ 57.52" N
7	Gongguan Town Market, Hepu County	109° 36′ 15.12" E	21° 47′ 34.43" N
8	Next to Huanzhu Square, Hepu County	109° 11′ 21.27" E	21° 40′ 20.19" N
9	Shankou Village, Hepu County	109° 43′ 50.11" E	21° 36′ 33.97" N
10	Zhendong Village, Hepu County	108° 58′ 14.47" E	21° 37′ 55.75" N
11	Dasi Town Market, Qinbei District	108° 26′ 48.85" E	22° 8′ 2.94" N
12	Hongfa Market, Qinbei District	108° 37′ 37.26" E	21° 58′ 46.21" N
13	Shayuan Market, Qinnan District	108° 36′ 56.56" E	21° 57′ 9.24" N
14	Tunnan Village, Qinnan District	108° 30′ 33.78" E	21° 58′ 24.01" N

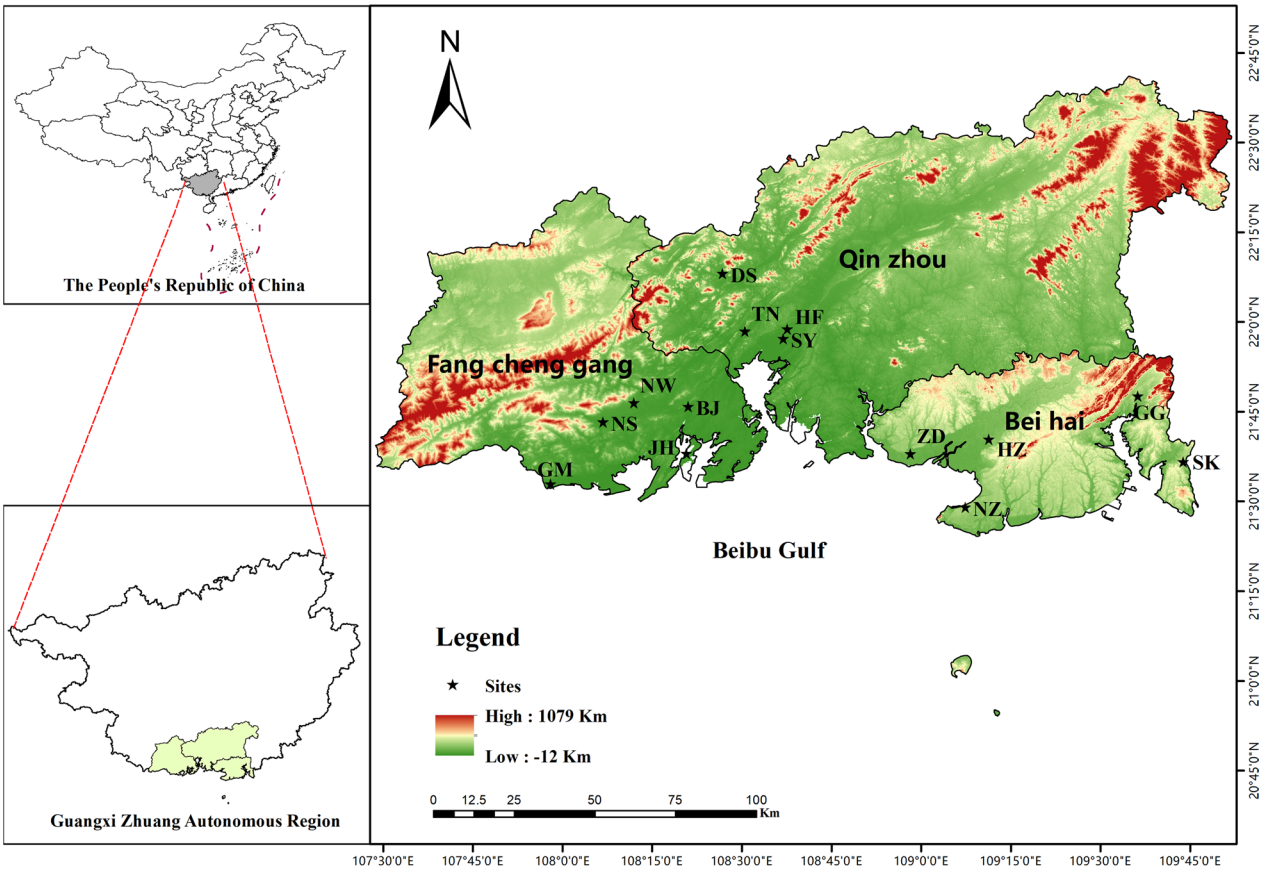

Fig. 2 The study area. GM: Guomao Market, NS: Nasuo Town Market, NW: Nawan village, BJ: Binjiang Market, JH: Jinhai Market, DS: Dashi Town Market, TN: Tunnan village, HF: Hongfa Market, SY: Hongfa Market, ZD: Zhendong village, HZ: Huanzhu Plaza, NZ: Nanzhu Market, GG: Gongguan Town Market, SK: Gongguan Town Market

producers and sellers of *Laji-He*) or in other professions, such as teachers, civil servants, and traditional doctors, who were mainly buyers of *Laji-He*.

To ensure comprehensive and accurate data collection, we combined semi-structured and informal interviews [8]. All interviews were conducted with informed consent, following a thorough explanation of the study's purpose and scope to participants, ensuring they fully understood and voluntarily agreed to participate [9]. This approach allowed the interviewees to freely express their views, free from any external pressure, and decide on their level of involvement. During the discussions, we carefully recorded the specific uses, processing techniques, and applications of each medicinal plant in *Laji-He*. Additionally, we have also collected voucher specimens of these plants in the fields or on the markets, which were later used in follow-up interviews for cross-verification.

During the field surveys and interviews, voucher specimens of the medicinal plants used in *Laji-He* were collected [9]. For plants that were difficult to identify, follow-up investigations were conducted in the field across different seasons to collect complete specimen materials. Each specimen was documented through detailed photographs of the plant, its habitat, and close-up images of its flowers and fruits. The voucher specimens are stored at the Herbarium of the Guangxi Zhuang Autonomous Region Institute of Traditional Chinese Medicine (GXMI). Additionally, the collection location, GPS coordinates, habitat information, phenology, plant characteristics, local names, scientific names, and local uses were carefully recorded [9]. Following this, the specimens were thoroughly identified by consulting the eFlora of China (http://www.efloras.org/), the Chinese Virtual Herbarium (https://www.cvh.ac.cn/), and the World Flora Online (https://www.worldfloraonline.org/) database. In cases where plant identification remained unclear, further expert opinions were requested from specialists in the relevant fields.

After all the work above, we compiled the results of the field surveys and specimen identifications into an ethnobotanical inventory of the medicinal plants used in *Laji-He*. This inventory includes plant local names, scientific names, taxonomic information and detailed usage information, providing a foundational dataset to support further research and development.

Data analysis

We utilized the Relative Frequency of Citation (RFC) index to assess the importance of medicinal plants used in *Laji-He* within the local community [10]. The RFC index is calculated using the following formula:

$$RFC = \frac{FCS}{N}$$

The RFC index is calculated by dividing the number of informants who cited a particular plant (F.C.) by the total number of informants (N), providing a value between 0 and 1 [10]. This method allows us to quantify how commonly each plant is recognized and utilized in the community, highlighting key species that play significant roles in local cultural and medicinal practices.

Additionally, a systematic investigation of the historical origins of *Laji-He* was also carried out, revealing its evolution and transmission within regional traditions. Building upon this, we further explored the social functions of *Laji-He*, focusing on its role in religious rituals, health practices, and community cohesion. Through a comparative analysis of similar traditional foods from surrounding regions, this study highlights the unique characteristics of *Laji-He* and its significance within the ethnobotanical food culture of southern China.

Results

Traditional culture and preparation process of *Laji-He*

The origin of *Laji-He* is closely linked to the rich folklore and traditional culture of the Beibu Gulf region in Guangxi. Every year, on the eighth day of the fourth lunar month, a traditional festival is celebrated, and consuming *Laji-He* on this day has become a custom passed down through generations. The name *Laji-He* is thought to come from the belief that this dish, made from a blend of medicinal herbs and rice, helps cleanse the body of harmful substances, often referred to as "garbage," symbolizing illness—hence the name "garbage rice cakes."

According to local folklore, the eighth day of the fourth lunar month is also considered the day when deities bring medicinal herbs to the human world. According to the locals, on this day, the toxicity of herbs is believed to be extremely low, and even normally toxic plants can be consumed without causing harm. This day is thus referred to as the "Herb Festival." As a result, locals enjoy consuming various herbs on this day to promote health and ward off illness. This belief encourages people to experiment with a wide range of herbs, and many households add over 20 different herbs to *Laji-He* on this day, believing that the more herbs included, the stronger their medicinal effects. In addition to eating *Laji-He*, locals also boil herbs to bathe their children, believing this ritual wards off evil and prevents illness. Thus, *Laji-He* is more than just a traditional food; it is a cultural symbol of health and blessings.

Our interviews revealed that *Laji-He* is also consumed on the third day of the third lunar month and the fifth day of the fifth lunar month (Dragon Boat

Festival), which are also important traditional festivals locally, but the scale and frequency of consuming the *Laji-He* are much smaller compared to the eighth day of the fourth lunar month. In Beihai, for instance, *Laji-He* is mainly made with *Paederia foetida* and a few other plants, with limited use of additional species.

We also conducted a detailed investigation of the *Laji-He* preparation process (Fig. 3). The first step involves soaking the rice (or glutinous rice) either the day before or on the day of preparation, followed by draining and cleaning the soaked rice. The rice is then mixed with finely chopped herbal leaves and ground into a fine powder using a machine. To ensure a better texture, the ground rice flour is sifted, resulting in a finer and smoother consistency. Next, the mixture is then shaped into various forms, such as strips, rectangular blocks, or round cakes, depending on individual preference, and placed in an oiled steamer tray. The steamer water is brought to a boil, and the *Laji-He* is steamed for approximately 15 min. Once fully steamed, the *Laji-He* emits a pleasant fragrance of plants and rice. It can be eaten directly or cut into strips and boiled with sugar syrup to make sweet soup of *Laji-He*, offering a richer flavor.

Analysis of the diversity of medicinal plants in *Laji-He*

We recorded a total of 63 medicinal plants belonging to 53 genera within 36 families used in the preparation of *Laji-He* in the Beibu Gulf region (Table 2). The majority of the species are used in detoxification in TCM.

In terms of family distribution, Rubiaceae is the most represented, with six species, followed by Fabaceae with five species, and Lamiaceae with four species. As shown in Table 3, families with five or more species account for only 5.56% of the total number of families, but represent 17.46% of the total species. Families with 2–4 species make up 36.11% of the total families and nearly half (49.21%) of the total species, indicating the significant role of these moderately sized families in the formulation. Single-species families, which make up 58.33% of the total families, contribute 33.33% of the total species.

The distribution of genera is relatively dispersed, with Paederia and Persicaria being the most represented, each containing three species. This pattern suggests that the

Fig. 3 Preparation process of *Laji-He*. **A** Herbal medicine selling stand, **B** Pairing medicinal herbs, **C** Medicinal herb combinations, **D** Medicinal herbs mixed with glutinous rice, **E** Herb and glutinous rice mixture ground into powder, **F** Herb and glutinous rice mixed powder, **G** Molding *Laji-He*, **H** Steamed *Laji-He*, **I** *Laji-He* sweet soup

Table 2 Inventory of plant materials used in *Laji-He*

Scientific name	Local name	Family	Life form	Resource type	Medicinal effects of TCM	RFC	Voucher ID
Paederia foetida L	Gei shi teng	Rubiaceae	Liana	Wild	Dispel wind-damp, promote digestion, clear heat and detoxify, alleviate abdominal pain	0.8817	YY240514003
Piper sarmentosum Roxb	Ga lou	Piperaceae	Herb	Cultivated/wild	Clear heat and detoxify, relieve cough and phlegm, treat bruises and injuries, alleviate diarrhea, promote blood circulation	0.7742	YY240515009
Houttuynia cordata Thunberg	Yu xing cao	Saururaceae	Herb	Wild	Clear heat and detoxify, treat dysentery, alleviate rhinitis, relieve constipation and diuresis, treat carbuncles and sores	0.7312	YY240514008
Centella asiatica (L.) Urban	Ji xue cao	Apiaceae	Herb	Wild	Clear heat and detoxify, treat toothache, relieve dysmenorrhea, reduce liver swelling, treat scars	0.7204	YY240515010
Morus alba L	Sang	Moraceae	Tree	Cultivated	Clear heat and detoxify, dispel wind-damp, improve eyesight, relieve cough and phlegm, treat acne, promote bowel movement, reduce swelling, treat dysentery	0.7097	YY240515003
Liquidambar formosana Hance	Feng mu	Altingiaceae	Tree	Wild	Clear heat and detoxify, dispel wind-damp, treat dysentery, relieve heatstroke, stop bleeding, expel parasites	0.6989	YY240514007
Persicaria chinensis (L.) H. Gross	Huo tang teng	Polygonaceae	Herb	Wild	Dispel wind-damp, treat leukorrhea in women, treat bruises and injuries, alleviate tinnitus, strengthen qi and blood	0.6989	YY240515022
Litsea cubeba (Lour.) Persoon	Shan cang zi	Lauraceae	Tree	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, relieve cough and phlegm, promote digestion, strengthen spleen and stomach	0.6667	YY240514025
Mentha canadensis L	Bo he	Lamiaceae	Herb	Cultivated	Clear heat and detoxify, treat carbuncles and sores, stop bleeding, treat eye diseases	0.6667	YY240515011
Murdannia bracteata (C. B. Clarke) J. K. Morton ex D. Y. Hong	Tan huo cao	Commelinaceae	Herb	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, relieve cough and phlegm, expel parasites	0.6237	YY240514022
Peristrophe bivalvis (L.) Merrill	Hong lan cao	Acanthaceae	Herb	Cultivated/wild	Clear heat and detoxify, moisten the lungs, relieve cough and phlegm, treat bruises and injuries, treat nocturnal emission	0.6237	YY240514024
Portulaca oleracea L	Ma chi xian	Portulacaceae	Herb	Wild	Postpartum conditioning, treating carbuncles and sores, treating pediatric umbilical sores, reducing swelling	0.5806	YY240515017
Hypericum japonicum Thunb. ex Murray	Tian ji huang	Hypericaceae	Herb	Wild	Clear heat and detoxify, treat bruises and injuries, treat dysentery, stop bleeding, calm the mind, expel parasites	0.5591	YY240514009
Perilla frutescens (L.) Britton	Zi su	Lamiaceae	Herb	Hultivated	Clear heat and detoxify, dispel wind-damp, stop bleeding, treat common cold, calm the mind, relieve cough and phlegm, expel parasites	0.5591	YY240514023
Artemisia indica Willdenow	Ai cao	Asteraceae	Herb	Wild	Warm meridians and stop bleeding, treat irregular menstruation, dispel wind-damp, treat dysentery, treat carbuncles and sores, treat dermatitis	0.5161	YY240514013

Table 2 (continued)

Scientific name	Local name	Family	Life form	Resource type	Medicinal effects of TCM	RFC	Voucher ID
Peristrophe japonica (Thunb.) Bremekamp	Si zi cao	Acanthaceae	Herb	Cultivated/wild	Clear heat and detoxify, relieve cough and phlegm, treat leukorrhea in women, treat hemorrhoids, treat sore throat	0.5161	YY240515008
Semiliquidambar cathayensis H. T. Chang	Ban bian feng	Altingiaceae	Tree	Wild	Dispel wind-damp, treat beriberi, treat bruises and injuries	0.4946	YY240514002
Hedyotis effusa Hance	Gou gan cai	Rubiaceae	Herb	Wild	Clear heat and detoxify, treat bruises and injuries, treat eczema	0.4946	YY240514005
Alternanthera philoxeroides (C. Martius) Grisebach	Lian zi cao	Amaranthaceae	Herb	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, expel parasites	0.4839	YY240514017
Rhus chinensis Mill	Yan fu bao	Anacardiaceae	Shrub	Wild	Clear heat and detoxify, treat carbuncles and sores, treat nasal inflammation	0.4839	YY240516002
Clerodendrum cyrtophyllum Turcz	Lu bian qing	Lamiaceae	Shrub	Wild	Clear heat and detoxify, treat oral ulcers, treat dysentery, treat sore throat	0.4839	YY240516008
Phyllanthus emblica L	You gan zi	Phyllanthaceae	Tree	Wild	Clear heat and detoxify, moisten the lungs and stop cough, treat common cold, treat toothache, treat sore throat	0.4731	YY240516006
Alternanthera sessilis (L.) R. Brown ex Candolle	Lian zi cao	Amaranthaceae	Herb	Wild	Clear heat and detoxify, treat dysentery, treat carbuncles and sores, treat eczema, treat dermatitis	0.4624	YY240514018
Eriobotrya japonica (Thunb.) Lindley	Pi pa	Rosaceae	Tree	Cultivated	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, relieve cough and phlegm, treat bruises and injuries, expel parasites	0.4516	YY240514015
Glycosmis pentaphylla (Retzius) Candolle		Rutaceae	Tree	Wild	Relieve cough and phlegm, disperse blood stasis and reduce swelling, promote digestion, treat bruises and injuries, treat common cold, treat carbuncles and sores	0.4409	YY240516011
Melicope *pteleifolia (Champion* ex Bentham) T. G. Hartley	San cha hu	Rutaceae	Tree	Wild	Clear heat and detoxify, treat bruises and injuries, treat eczema, treat dermatitis	0.4301	YY240514006
Grona styracifolia (Osbeck) H. Ohashi & K. Ohashi	Guang jin qian cao	Fabaceae	Herb	Cultivated/wild	Clear heat and detoxify, dispel wind-damp, promote diuresis and bowel movement	0.4301	YY240516004
Vitex negundo L	Huang jing	Verbenaceae	Shrub	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, treat gastritis, expel parasites	0.4194	YY240514016
Tadehagi triquetrum (L.) Ohashi	Hu lu cha	Fabaceae	Shrub	Wild	Clear heat and detoxify, treat carbuncles and sores, relieve cough and phlegm	0.4086	YY240515012
Persicaria thunbergii (Siebold & Zucc.) H. Gross	Liu	Polygonaceae	Herb	Wild	Treat gout, clear heat and detoxify	0.3871	YY240514001

Table 2 (continued)

Scientific name	Local name	Family	Life form	Resource type	Medicinal effects of TCM	RFC	Voucher ID
Prunus persica (L.) Batsch	Tao zi	Rosaceae	Tree	Cultivated	Clear heat and detoxify, promote blood circulation, promote bowel movement, treat diarrhea, promote digestion, relieve dysmenorrhea, treat bruises and injuries, treat eczema, treat ringworm, treat carbuncles and sores, treat nocturnal emission, treat dysentery	0.3871	YY240516007
Palhinhaea cernua (L.) Vasc. & Franco	Song jin teng	Lycopodiaceae	Herb	Wild	Dispel wind-damp, detoxify and reduce swelling, treat bruises and injuries, treat urticaria, treat edema	0.3871	YY240516010
Clausena lansium (Lour.) Skeels	Huang pi guo	Rutaceae	Tree	Cultivated	Clear heat and detoxify, relieve cough and phlegm, alleviate abdominal pain, promote digestion, strengthen the stomach, reduce swelling, treat common cold	0.3763	YY240515016
Paederia lanuginosa Wall	Gei shi teng	Rubiaceae	Liana	Wild	Dispel wind-damp, promote digestion, clear heat and detoxify, alleviate abdominal pain	0.3548	YY240514012
Schefflera heptaphylla (L.) Frodin	E zhang feng	Araliaceae	Tree	Wild	Dispel wind-damp, treat bruises and injuries, treat stomach pain, treat common cold, treat dermatitis, treat eczema, stop bleeding	0.3548	YY240516003
Baeckea frutescens L	Sao ba ye	Myrtaceae	Shrub	Wild	Dispel wind-damp, relieve itching, treat cystitis, treat common cold, treat burns, treat eczema, treat dermatitis, treat pemphigus, treat tinea pedis, promote diuresis	0.3441	YY240516009
Mussaenda pubescens W. T. Aiton	Xi liang teng	Rubiaceae	Shrub	Wild	Clear heat and detoxify, treat common cold, treat tonsillitis, treat pharyngitis, treat enteritis	0.3226	YY240515021
Astragalus sinicus L		Fabaceae	Herb	Wild	Dispel wind and improve eyesight, strengthen spleen and qi, detoxify and relieve pain, treat acute conjunctivitis, treat neuralgia, treat herpes zoster, treat boils and abscesses, treat hemorrhoids	0.3226	YY240516015
Plumbago zeylanica L	Bai hua dan	Plumbaginaceae	Shrub	Cultivated/wild	Clear heat and detoxify, dispel wind-damp, reduce swelling, treat bruises and injuries, treat tinea, treat wind-damp bone pain, treat stomach pain	0.3011	YY240515013
Paederia pertomentosa Merr. ex Li	Gei shi teng	Rubiaceae	Liana	Wild	Treat jaundice, treat dysentery, promote digestion, treat irregular menstruation, treat hepatitis, treat diarrhea, treat stomach pain	0.3011	YY240516014
Lygodium microphyllum (Cav.) R. Br	Hai jing sha	Lygodiaceae	Herb	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, relieve cough and phlegm, treat dysentery, treat diarrhea, treat leukorrhea in women	0.2903	YY240514019
Boehmeria nivea (L.) Gaudichaud-Beaupre	Qu ma	Urticaceae	Shrub	Wild	Clear heat and detoxify, stop bleeding, promote blood circulation, calm the mind, treat leukorrhea in women, treat traumatic injuries	0.2903	YY240515002

Table 2 (continued)

Scientific name	Local name	Family	Life form	Resource type	Medicinal effects of TCM	RFC	Voucher ID
Blumea balsamifera (L.) Candolle	Da feng ai	Asteraceae	Liana	Wild	Clear heat and detoxify, dispel wind-damp, treat bruises and injuries, treat eczema, treat dermatitis, treat carbuncles and sores, treat common cold, relieve dysmenorrhea	0.2903	YY240515006
Ficus hirta Vahl	Wu zhi mao tao	Moraceae	Shrub	Wild	Dispel wind-damp, promote blood circulation and remove blood stasis, treat bruises and injuries, treat leukorrhea in women, treat orchitis, treat amenorrhea	0.2903	YY240515020
Combretum indicum (L.) Jongkind	Shi jun zi	Combretaceae	Shrub	Wild	Clear heat and detoxify, promote bowel movement, treat toothache, alleviate abdominal pain, treat pediatric indigestion	0.2796	YY240515005
Saururus chinensis (Lour.) Baillon	San bai cao	Saururaceae	Herb	Wild	Clear heat and detoxify, promote diuresis and reduce swelling, treat leukorrhea in women, treat eczema, treat carbuncles and sores	0.2796	YY240515007
Persicaria maackiana (Regel) Nakai ex Mori	Liu	Polygonaceae	Herb	Wild	Clear heat and detoxify, treat enteritis, treat dysentery	0.2796	YY240515015
Sapindus saponaria L	Xi shou guo	Sapindaceae	Tree	Wild	Clear heat and detoxify, improve eyesight, treat toothache, remove freckles, treat diarrhea, treat sore throat	0.2796	YY240516012
Solanum americanum Mill	Bai hua cai	Solanaceae	Herb	Wild	Clear heat and detoxify, promote bowel movement, treat bruises and injuries, treat acne, stop bleeding, remove lice, treat carbuncles and sores	0.2688	YY240515004
Tradescantia spathacea Swartz	Wan nian qing	Commelinaceae	Liana	Cultivated/wild	Clear heat and detoxify, stop bleeding, promote blood circulation, treat bruises and injuries, treat abscesses, treat traumatic injuries	0.2366	YY240515001
Neyraudia reynaudiana (Kunth) Keng ex Hitchcock		Poaceae	Herb	Wild	Clear heat and drain dampness, reduce swelling and detoxify, treat nephritis edema, treat snake bites	0.2258	YY240516005
Phyllodium elegans (Lour.) Desvaux	La wan	Fabaceae	Shrub	Wild	Dispel wind-damp, treat bruises and injuries, treat toothache, treat scalp infections, disperse blood stasis and reduce swelling, treat pediatric indigestion	0.2151	YY240516001
Polygala chinensis L	Gang ba huan	Polygalaceae	Herb	Wild	Treat cough and sore throat, treat pediatric indigestion, treat bruises and injuries, treat scrofula, treat carbuncles, treat snake bites	0.1935	YY240514004
Vitex rotundifolia L. f	Man jing	Lamiaceae	Shrub	Wild	Treat bruises and injuries, dispel wind-damp, stop bleeding, reduce swelling and relieve pain, treat migraine	0.1935	YY240515014
Schizocapsa plantaginea Hance	Wa tou ji	Dioscoreaceae	Herb	Wild	Clear heat and detoxify, treat acute gastroenteritis, treat toothache, treat bruises and injuries, dispel wind-damp, stop bleeding, calm the mind, expel parasites, treat irregular menstruation	0.1828	YY240514020

Table 2 (continued)

Scientific name	Local name	Family	Life form	Resource type	Medicinal effects of TCM	RFC	Voucher ID
Drynaria roosii Nakaike	Gen sui bu	Polypodiaceae	Herb	Wild	Treat bruises and injuries, stop bleeding, treat carbuncles and sores, alleviate tinnitus	0.1720	YY240514010
Pluchea indica (L.) Lessing		Asteraceae	Shrub	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind	0.1720	YY240514014
Crotalaria assamica Bentham	Zhu shi dou	Fabaceae	Herb	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, relieve cough and phlegm, tonify liver and kidney, treat nocturnal emission, treat dysentery, treat leukorrhea in women	0.1720	YY240514026
Hedyotis hedyotidea (Candolle) Merrill	Zhu hong teng	Rubiaceae	Shrub	Wild	Clear heat and detoxify, stop bleeding, reduce swelling, treat carbuncles and sores, treat eczema, treat dermatitis, treat common cold, treat bruises and injuries, treat hemorrhoids	0.1720	YY240515019
Drynaria bonii Christ	Gen sui bu	Polypodiaceae	Herb	Wild	Clear heat and detoxify, dispel wind-damp, stop bleeding, calm the mind, treat bruises and injuries	0.1613	YY240514011
Dioscorea persimilis Prain & Burkill	Huai shan	Dioscoreaceae	Liana	Wild	Clear heat and detoxify, treat chilblains, relieve cough and phlegm, strengthen spleen and stomach, reduce swelling, promote diuresis, treat dysentery	0.1505	YY240514021
Scleria terrestris (L.) Fassett		Cyperaceae	Herb	Wild	Dispel wind and eliminate dampness, relax muscles and activate collaterals, treat wind-damp arthralgia, treat paralysis, treat bruises and injuries, treat measles in children	0.1290	YY240516013
Trema cannabina var. *dielsiana* (Handel-Mazzetti) C. J. Chen	Po ma	Cannabaceae	Herb	Wild	Clear heat and detoxify, relieve pain, stop bleeding, treat boils	0.0860	YY240515018

This inventory is arranged in descending order based on RFC values.

Table 3 Analysis of families and genera of medicinal plants in *Laji-He*

Category	Number of families (Genera)	Proportion of total families (Genera) (%)	Number of species	Proportion of total species (%)
Multiple-species families (≥ 5 species)	2	5.56	11	17.46
Few-species families (2–4 species)	13	36.11	31	49.21
Single-species families (1 species)	21	58.33	21	33.33
Total	36	100	63	100
Few-species genera (2–4 species)	7	12.96	16	25.4
Single-species genera (1 species)	47	87.04	47	74.6
Total	54	100	63	100

overall distribution of genera is balanced, with no single genus dominating the formulation of making *Laji-He*. The genera with 2–4 species account for 12.96% of the total genera, contributing 25.40% of the species, while single-species genera make up 87.04% of the total genera, representing 74.60% of the species (Table 3). This distribution indicates that most genera in *Laji-He* contain only one species, reflecting a broad utilization of plant species.

Analysis of life forms and resource types

The life forms of the plants used in *Laji-He* show a clear distribution pattern, with herbaceous plants making up 49.21% of the total, indicating their important role in the formulation. Shrubs account for 22.22% and trees for 19.05%, reflecting the common use of both in the plant composition. Vines represent 9.52%, and while fewer in number, they add to the diversity of life forms. This distribution highlights the diverse utilization of plants in *Laji-He*, with various life forms being widely applied, demonstrating the close connection between this traditional food and local natural resources.

The use of plant resources in *Laji-He* primarily relies on wild plants. According to the data, 51 wild species account for 80.95% of the total, indicating a strong dependence on natural plant resources by the local people. Cultivated plants and those that can be both cultivated and found in the wild each account for 9.52%, showing that cultivated plants are not the primary source in the formulation of *Laji-He*, but rather serve as a supplement to wild resources. This reliance on wild resources reflects the richness of the local natural ecosystem. As a traditional food, most of the plants used in *Laji-He* are not artificially cultivated but are directly gathered from the wild. Due to their infrequent use, this practice does not place significant pressure on the resources. This approach may be closely linked to the local people's long-standing traditions of foraging and ecological knowledge, ensuring the sustainable use of natural resources for the production of *Laji-He*.

The small proportion of cultivated plants, as well as those that can grow both in the wild and through cultivation, indicates that these species are commonly used in daily life, where cultivation is more convenient and resource-efficient than wild collections. For example, *Piper sarmentosum* is highly valued for its distinctive aroma and is widely used as both a medicinal and edible plant in local communities. In addition to its role in *Laji-He*, it is also consumed as a wild vegetable or seasoning.

Notably, none of the plants used in *Laji-He* are protected or endangered species, which suggests that the production of this traditional food does not burden rare plant resources, allowing for the preservation of cultural traditions while demonstrating a high degree of environmental sustainability. This feature provides a solid foundation for the continued production and cultural transmission of *Laji-He*.

Medicinal properties of plants used in *Laji-He*

The analysis of the medicinal properties of the raw plant materials used in *Laji-He* reveals that the predominant therapeutic categories include heat-clearing and detoxification, expelling wind-dampness, treating traumatic injuries, and hemostasis (Table 4). These therapeutic

Table 4 Medicinal properties of the plant ingredients used in *Laji-He*

Efficacy category	Frequency	Proportion (%)
Clearing heat and detoxification	46	73
Dispelling wind and dampness	27	42.9
Treating traumatic injuries	26	41.3
Hemostasis (stopping bleeding)	22	36.7
Treating abscesses and ulcers	14	22.2
Relieving cough and phlegm	14	22.2
Calming the mind	13	20.6
Treating dysentery	13	20.6
Treating eczema	9	14.3
Treating cold symptoms	9	14.3

properties are closely associated with the hot and humid climatic conditions of the Beibu Gulf region, reflecting the local inhabitants' traditional strategies for using plants to regulate bodily conditions, as well as prevent and treat common ailments.

Among the medicinal properties identified, heat-clearing and detoxifying plants are the most prevalent, accounting for approximately 70% of the total medicinal uses. The Beibu Gulf region is characterized by a hot and humid climate, making the human body prone to damp-heat invasion, which can lead to the accumulation of internal heat toxins, resulting in symptoms such as fever and skin disorders. The use of heat-clearing and detoxifying plants effectively helps the locals eliminate internal heat and maintain health. These plants play an essential role in the daily diets of local communities, helping to regulate the internal environment and alleviate discomfort caused by the damp-heat climate. In the Lingnan region, traditional herbal teas and soups are common components of daily health practices, with heat-clearing and detoxification serving as their primary therapeutic functions [5, 11].

According to the inventory we recorded, the use of plants with wind-dampness-dispelling properties (treating Rheumatic diseases) is similarly widespread, representing nearly half of the total medicinal uses. The prolonged exposure to humid conditions in this region has contributed to the high prevalence of rheumatism and related conditions, particularly among coastal residents engaged in activities such as fishing and shrimp harvesting, which increase the risk of joint pain and muscle stiffness. Plants with wind-dampness-dispelling properties are thus crucial for their ability to dispel cold and dampness, alleviating joint issues caused by the accumulation of moisture in the body. Their therapeutic role extends beyond rheumatism management to the broader prevention of climate-induced chronic ailments.

Plants used to treat traumatic injuries are also widely represented, comprising approximately 40% of the total medicinal uses. This trend is strongly linked to the local labor-intensive lifestyle. Residents of the Beibu Gulf, especially those in rural areas, are frequently engaged in physically demanding activities, which increase the incidence of sprains and other minor injuries. Plants with properties such as promoting blood circulation, reducing swelling, and alleviating pain are, therefore, essential components of external injury management. These plants not only provide effective pain relief but also facilitate the rapid recovery of damaged tissues, making them indispensable in local healthcare practices.

Hemostatic plants also account for a considerable proportion, representing approximately 37% of the total medicinal uses. Although this therapeutic function appears to be unrelated to the direct preparation of *Laji-He*, it carries significant supplementary value in the daily lives of residents in the Beibu Gulf region. The hot and humid environment often leads to skin injuries and hemorrhagic wounds, especially for individuals engaged in outdoor labor or rural activities. Plants with hemostatic properties are frequently employed to treat minor wounds, facilitating rapid blood coagulation and reducing the risk of infection.

However, it is noteworthy that some of these medicinal plants contain potentially toxic compounds. While traditionally used for routine health maintenance and treatment, modern studies have indicated that certain plants may pose health risks when consumed in excess or over extended periods. Some of these plant constituents have been found to exhibit hepatotoxic or nephrotoxic effects, which necessitates caution in their use. Therefore, in addition to evaluating their therapeutic efficacy, it is critical to assess their safety profile. Although these plants have long been incorporated into local dietary and medicinal practices, further toxicological research is warranted in a contemporary context to ensure their safe application in modern society. The analysis of these medicinal properties demonstrates how residents in the Beibu Gulf region have skillfully utilized local natural resources to address health challenges associated with the damp-heat climate. These plants not only aid in regulating internal moisture and heat, but also play an irreplaceable role in managing traumatic injuries, stopping bleeding, and alleviating rheumatic conditions. Their use reflects the deep interaction between humans and their natural environment and embodies the concept of "food and medicine homology" in traditional wisdom.

Key medicinal plants with high RFC values in *Laji-He* preparation

The relative frequency of citation (RFC) is an effective measure to evaluate the popularity and frequency of use of specific plants within local communities [7]. A higher RFC value indicates a closer association of the plant with the daily lives of local residents and a higher utilization frequency [7]. In the preparation of *Laji-He*, certain plants are widely favored due to their medicinal properties, cultural significance, and ease of access. The top five most commonly used plants in *Laji-He* preparation (Fig. 4), along with their respective RFC values, are as follows: *Paederia scandens* (RFC = 0.8817), *Piper sarmentosum* (RFC = 0.7742), *Houttuynia cordata* (RFC = 0.7312), *Centella asiatica* (RFC = 0.7204), and *Morus alba* (RFC = 0.7097). These high RFC values suggest that these plants hold a prominent role in the daily lives of the local residents and are indispensable in the preparation of *Laji-He*.

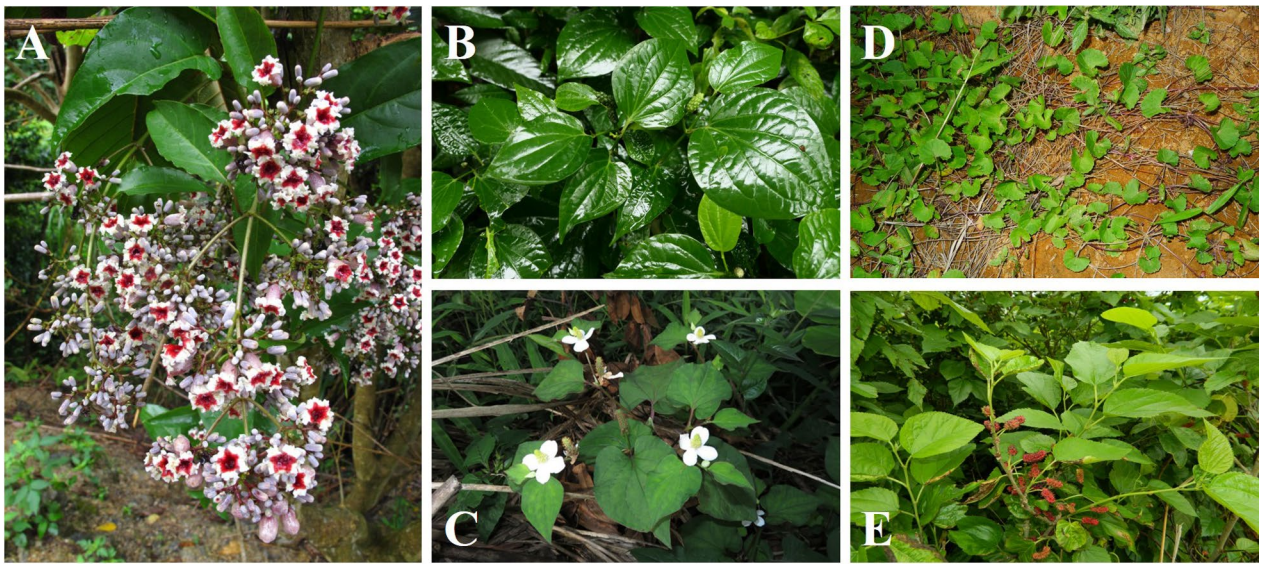

Fig. 4 Key medicinal plants with high RFC values in *Laji-He* preparation. **A** *Paederia scandens*, **B** *Piper sarmentosum*, **C** *Houttuynia cordata*, **D** *Centella asiatica*, **E** *Morus alba*

Paederia foetida is one of the most widely used plants in the preparation of *Laji-He*, with the highest RFC value (0.8817) among all documented plant species, indicating its high utilization frequency and widespread application within the local community. As a wild climbing vine of the Rubiaceae family, *P. foetida* is primarily utilized for its leaves, which are traditionally employed to treat various ailments, including rheumatism, indigestion, heat clearance, detoxification, and abdominal pain relief. The plant is extensively used during the traditional Lunar April 8th festival for the preparation of *Laji-He* and is also commonly found in the production of medicinal glutinous rice cakes in daily life. This dual role, combining cultural significance and medicinal value, highlights the importance of *P. foetida* in the daily lives of local residents. Not only does it serve as a symbolic component in festival cuisine, but its consistent medicinal efficacy also makes it a popular ingredient for daily food therapy and healthcare.

In recent years, research on *P. foetida* has expanded significantly, and its phytochemical composition and pharmacological properties have been systematically documented and received increasing attention [12, 13]. According to the latest reviews, *P. foetida* is rich in a variety of bioactive phytochemicals, including iridoid glycosides, flavonoid glycosides, anthraquinones, and various terpenoids [12, 13]. These compounds have been shown to possess a range of pharmacological activities, such as anti-inflammatory, antioxidant, antidiabetic, and anticancer effects, in both in vitro and in vivo studies [12, 13]. Among these components, iridoid glycosides are considered the primary bioactive constituents, with paederoside and paederosidic acid being the most notable [12, 13]. These compounds have demonstrated significant analgesic, anti-inflammatory, and antimicrobial effects in various disease models, making them of particular interest for further pharmacological research [12, 13].

Although other species of the same genus, such as *Paederia lanuginosa* and *Paederia pertomentosa*, contain similar chemical constituents and exhibit comparable medicinal properties, their RFC values are relatively low due to limited availability and scattered distribution in the region. In contrast, *P. foetida*, owing to its widespread distribution and easy accessibility in natural habitats, has become the preferred plant material for the preparation of *Laji-He* and other traditional foods, as well as an essential ingredient in daily dietary therapy within the local community.

In comparison with *Paederia foetida*, *Piper sarmentosum* also plays a crucial role in the preparation of *Laji-He*. As a herbaceous plant belonging to the Piperaceae family, *P. sarmentosum,* can be cultivated or grown wild, and its leaves are primarily used for medicinal purposes. It is widely distributed in Southeast Asia and the southeastern coastal regions of China, including Fujian, Guangdong, and Guizhou [14]. With a long-standing history in traditional medicine, *P. sarmentosum* has been utilized for the treatment of wind-cold cough, fever, rheumatism, arthralgia, diarrhea, dysentery, postpartum foot swelling, stomachache, toothache, diabetes, and traumatic injuries [14].

Therefore, in the preparation of *Laji-He*, *P. sarmentosum* not only enhances the dish's unique aroma but also contributes to its medicinal efficacy by clearing heat, detoxifying, and dispelling dampness, thus helping to prevent heat-dampness-related disorders. In recent years, the chemical composition and pharmacological activities of *P. sarmentosum* have been extensively studied. The literature indicates that *P. sarmentosum* is rich in essential oils, alkaloids, flavonoids, lignans, and steroids, which have been demonstrated to exhibit various pharmacological properties, such as anti-inflammatory, antitumor, antipyretic, anti-osteoporosis, antibacterial, antidepressant, anti-atherosclerotic, and hypoglycemic activities [14].

The use of *P. sarmentosum* in *Laji-He* not only reflects its unique flavor and medicinal properties but also extends to its presence in other traditional local dishes, such as stir-fried *P. sarmentosum* with field snails, *P. sarmentosum* cakes, and stir-fried dog meat with *P. sarmentosum*. Additionally, local residents often crush the leaves for external application to treat traumatic injuries, showing significant therapeutic effects. The versatile applications of *P. sarmentosum* demonstrate its multi-purpose utility and cultural value within the local community, while its medicinal properties lay a solid foundation for further research into its bioactive components and potential drug development.

In addition to *Paederia foetida* and *Piper sarmentosum*, three other plants play equally significant roles in the preparation of *Laji-He*: *Houttuynia cordata*, *Centella asiatica*, and *Morus alba*. These plants are not only considered integral components of traditional medicinal food due to their respective pharmacological properties but have also gradually gained recognition through modern pharmacological research.

Houttuynia cordata, commonly known as fish mint, is a wild herbaceous plant belonging to the Saururaceae family. Its leaves possess multiple therapeutic properties, such as clearing heat and detoxification, promoting diuresis, relieving dysentery, and treating abscesses and ulcers. It has long been used in traditional medicine to alleviate heat-induced dysentery, rhinitis, and constipation [15]. In the preparation of *Laji-He*, the incorporation of *H. cordata* not only enhances the flavor of the dish but also contributes to the balance of internal damp-heat conditions, a particularly vital function in the local hot and humid climate [15]. Recent studies have shown that chemical constituents in *H. cordata*, such as essential oils, flavonoids, and chlorogenic acid, exhibit anti-inflammatory, antiviral, and immunomodulatory activities, thereby providing scientific evidence supporting its traditional usage [16].

Centella asiatica, a wild herbaceous plant of the Apiaceae family, is traditionally used for its medicinal properties, such as clearing heat and detoxification, alleviating toothache and dysmenorrhea, and promoting scar healing [17]. It holds an important position in *Laji-He*, mainly due to its strong heat-clearing effect, which is particularly beneficial during the hot season. Furthermore, its triterpenoid components have been extensively studied in recent years, demonstrating significant antioxidant, anti-inflammatory, and wound-healing properties, which extend its potential applications beyond traditional medicinal food use [18, 19].

Morus alba, a cultivated tree species in the Moraceae family, is predominantly used for its leaves in the preparation of *Laji-He*, due to its properties of clearing heat and detoxification, dispelling wind-dampness, and relieving cough and phlegm [20]. The leaves are rich in various alkaloids and flavonoids, which have been reported to possess antidiabetic, lipid-lowering, and anti-obesity effects, making them valuable in the development of modern functional foods and pharmaceuticals [20, 21]. Although the fruits of *M. alba* are also widely consumed in the daily diet of local residents, the leaves are more extensively utilized in *Laji-He* preparation, playing a crucial role in balancing internal damp-heat conditions, especially during the hot summer months.

The analysis of the RFC values for these plants indicates that *Paederia foetida*, *Piper sarmentosum*, *Houttuynia cordata*, *Centella asiatica*, and *Morus alba* all occupy significant roles in the preparation of *Laji-He*. In particular, *Paederia foetida*, with its high RFC value, not only features prominently during traditional festivals but also finds application in daily life. The usage frequency and popularity of these plants not only reflect the local community's strong reliance on their medicinal value but also demonstrate their deep connection with the local natural environment and climate. The incorporation of these plants in *Laji-He* is more than just a culinary tradition; it serves as an essential tool for local residents to cope with the hot and humid climate and to maintain overall health.

Discussion

The multifaceted social functions of *Laji-He*

According to our survey, *Laji-He* is not just a traditional food in the Beibu Gulf region but also plays a profound social role. From the perspective of cultural transmission, *Laji-He* serves not only as a representation of dietary culture but also as a medium for the preservation and transmission of knowledge related to the local natural environment and medicinal plants. Based on the theory of collective memory, cultural memory is preserved and passed on through shared practices (e.g., the making of *Laji-He* and traditional festival celebrations) across

generations [22]. Thus, when family or community members gather to prepare *Laji-He*, it is not only a transmission of culinary skills but also a continuation of cultural meanings and ecological knowledge. Moreover, research on cultural food practices has indicated that the production of traditional foods can sustain cultural continuity through generational transmission and reinforce collective identity [23].

Regarding community cohesion, the collective preparation of *Laji-He* often takes place during significant social events such as festivals and weddings. These activities are not merely food production processes but are crucial moments for communication and emotional connection among community members. Through shared participation and food sharing, community members strengthen their social ties, thereby forming a more cohesive social network and reinforcing collective identity. For example, research has indicated that communal preparation and sharing of food can enhance mutual trust and cooperation among group members and, through collaborative labor and interaction, contribute to improved community resilience and collective identity [24, 25]. Despite the gradual transformation of traditional community lifestyles due to urbanization, the collective making of *Laji-He* continues to play a role in fostering social relationships. The shared preparation and consumption of this traditional food enable local residents to maintain social and cultural continuity and a sense of community belonging, even amidst the rapidly changing societal landscape.

Enhancing cultural identity is also one of the key social functions of *Laji-He*. As a unique traditional food of the Beibu Gulf region, it not only reflects the dietary habits of local residents but also serves as a significant symbol of their cultural identity. Traditional foods like Laji-He play an important role in creating a sense of belonging among local people and also strengthen cultural identity as they are shared and enjoyed within migrant communities [26]. Thus, whether in the context of daily life in the homeland or as part of cultural exchanges in external communities, *Laji-He* has become a symbolic representation of regional culture, acting as a bridge that connects local residents to their native cultural roots.

In addition to its cultural and social significance, *Laji-He* also serves an important role in health management. The ingredients used in its preparation are primarily medicinal plants, reflecting the local residents' wisdom in utilizing food for health maintenance. Given the hot and humid climate of the Beibu Gulf region, the local populace frequently suffers from conditions associated with damp-heat syndromes. The medicinal plants used in *Laji-He* help to clear heat, detoxify, dispel dampness, and promote diuresis, thus aiding in the regulation of internal damp-heat balance. This dietary tradition not only embodies the concept of "medicine and food homology" but also contributes to the prevention and treatment of climate-related ailments through regular consumption. In this sense, *Laji-He* is not merely a delicacy but also a practical tool for maintaining health.

Laji-He not only holds significant cultural importance but also plays a crucial role in both economic and ecological functions. Its production and sale foster the development of a comprehensive supply chain encompassing harvesting, processing, preparation, and marketing, thereby generating a source of income for numerous local families. With the advancement of cultural tourism in the region, *Laji-He*, as a representative local specialty, attracts a considerable number of tourists, which stimulates local economic growth. Furthermore, the preparation of *Laji-He* involves extensive use of local plant resources, promoting their sustainable utilization. By efficiently leveraging these native botanical resources, the production of *Laji-He* strengthens local self-sufficiency and reduces dependence on external food supplies, thus supporting a more sustainable local economy and ecosystem. In this way, *Laji-He* not only contributes to the economic development of the region but also aids in ecological preservation, demonstrating how traditional foods can foster both social and environmental sustainability through the responsible use of natural resources.

From a comprehensive perspective, *Laji-He*, as a traditional food, extends far beyond its role in daily dietary consumption. It plays a significant role in cultural transmission, community cohesion, identity reinforcement, health management, and economic and ecological sustainability. The complex social functions embedded in this food reflect the intricate interaction between Beibu Gulf residents and their natural environment, as well as their strategies for preserving and innovating traditional culture in the face of modern societal changes. *Laji-He* not only serves as a vessel for traditional culture but also exemplifies the residents' wisdom in utilizing and adapting to local natural resources.

Formation of rice-based cuisine in Lingnan

The rice-based food culture in the Lingnan region has a long-standing history, characterized by various local names and preparation methods that have developed over time. Whether it is *He* (粄) from Western Guangdong and Beibu Gulf, *Guo*(粿) from Chaoshan (a cultural region in eastern Guangdong known for its distinct dialect and culinary traditions), or *Ban* (粄) from the Hakka areas, these rice-based foods, although named differently, are all primarily made from rice and profoundly reflect the unique lifestyles and cultural traditions of the Lingnan people [1, 27, 28].

From a historical perspective, during the Eastern Han Dynasty (25 CE to 220 CE), migrants from the Central Plains of ancient China brought northern dumpling culture to the Lingnan region. However, due to the lack of wheat production in Lingnan, these migrants utilized the abundant rice resources available to invent similar rice-based foods, such as rice dumplings [29, 30]. This rice-based food not only alleviated the feelings of homesickness among the migrants but also adapted and developed further under the humid and hot climate conditions of Lingnan. To enhance food preservation, they gradually began using glutinous rice to make the wrappers, enclosing the fillings before steaming them. This evolution of technique led to the widespread popularity of this type of food in Guangdong, Guangxi, Fujian and Hainan of China, resulting in the development of various local flavors [27, 28].

"Food–medicine" practices in Lingnan culture

Laji-He is a folk functional food with both nutritional and medicinal benefits; however, plants used in preparation of *Laji-He* overlap both the food and medicinal value, which refer to food–medicine/medicinal foods [31].

The rice-based food culture in the Lingnan region embodies the concept of TCM concept of "food and medicine sharing the same origin" (药食同源) [32]. This principle is particularly evident in various parts of Lingnan, where different types of rice-based dishes often incorporate medicinal plants such as mugwort (*Artemisia argyi*) and *Paederia foetida*. These ingredients not only enhance the flavor but also provide certain health benefits. The tradition of integrating medicinal herbs into daily diets is widely practiced throughout the region, as seen in the preparation of herbal teas and medicinal soups, reflecting the cultural emphasis on health maintenance through dietary practices [3, 4, 11]. This dual-use philosophy remains deeply ingrained in the lives of the Lingnan people, forming an essential part of their intangible cultural heritage.

However, with the rapid pace of urbanization and changes in modern lifestyles, this traditional dietary culture that merges medicinal and culinary practices is gradually at risk of being forgotten and marginalized. Consequently, in recent years, local governments and cultural organizations have implemented a variety of measures to preserve and promote this cultural heritage. These initiatives include the establishment of cultural preservation projects, the organization of traditional food preparation training programs, and the recording and dissemination of traditional recipes and cooking techniques through digital media. Through these efforts, the traditional rice-based food culture of the Lingnan region is not only preserved on a material level but also promoted on a cultural and spiritual level, thus serving as a bridge between history and modernity, continuing to strengthen community cohesion and cultural transmission.

Furthermore, as food security and health issues become increasingly important in modern society, the traditional concept of "food and medicine sharing the same origin" holds significant implications for public health. By exploring the medicinal and dietary value of these traditional foods, especially in addressing common modern health issues such as chronic diseases and declining immunity, the concept of "food and medicine sharing the same origin" offers new insights into contemporary health [33]. By integrating traditional practices with modern approaches, the food–medicine culture in the Lingnan region not only has a profound impact on human health but also promotes food sovereignty, food security, and ecological sustainability, serving as a dual bridge for local culture and ecological conservation.

Limitations of the study

This study employed a snowball sampling method, primarily focusing on Han respondents, to gather comprehensive information about Laji-He preparation, its cultural significance, and the medicinal plants used in its production. However, the study did not randomly include knowledge of *Laji-He* from diverse groups, such as different age groups, occupations, or ethnicities. This limitation hinders a broader understanding of the patterns and trends in knowledge transfer and conservation across various societies. Additionally, as the study is based on social surveys and observations, it cannot fully demonstrate the precise medicinal effects of the plants used in *Laji-He* for specific ailments. Nonetheless, this research provides a foundation for future studies to explore the pharmacological properties of these food–medicine plants through laboratory-based investigations.

Conclusion

This study explores the traditional preparation methods and medicinal plant use in *Laji-He*, highlighting its multifaceted role beyond just traditional snacks. Our analysis shows that the recipe's rich botanical diversity is prevalent in medicine, such as in heat-clearing and detoxifying the body. The findings also emphasize the cultural and ecological significance of *Laji-He* as a medium for cultural transmission, community cohesion, and sustainable resource use. Overall, *Laji-He* exemplifies the deep connection between Beibu Gulf residents and their natural environment, showcasing the integration of food, health, and culture in a rapidly changing society.

Author contributions
B.L. conceptualized the study and acquired funding. R.H. and B.L. wrote the original draft of the manuscript. R.H., Q.W., and K.L. conducted field investigations and performed specimen identification and validation. Z.D., Y.H. and H.C. organized and supplemented the plant inventory and analyzed first-hand data. Y.P., R.H. and B.L. reviewed the manuscript and revised it.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This ethnobotanical study was approved by the concerned bodies of Lushan Botanical Garden. During the field trip, all informants in the study area and all authors willingly agreed to participate, use the data related to their knowledge and publish the results.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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