

## Traditional culinary uses of aromatic plants as spice by the Meitei ethnic group: ethnobotanical evidence from Manipur, Northeast India

Elizabeth Huidrom<sup>a,b</sup>, Ngairangbam Yaipharembi<sup>a,b</sup> & Huidrom Birkumar Singh<sup>a,b,\*</sup>

<sup>a</sup>CSIR- North East Institute of Science & Technology, Branch Laboratory, Lamphelpat, Imphal 795 004, Manipur, India

<sup>b</sup>Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201 002, Uttar Pradesh, India

\*E-mail: hbirkumars@yahoo.com

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Rich traditional knowledge is observed in high biodiversity areas inhabited by numerous ethnic groups, such as the state of Manipur in Northeast India. Our study identifies and evaluates the cultural significance of plants used by the indigenous Meitei community of Manipur as spice in their traditional food system through a survey. Altogether 30 plant species were identified as spice in both wild and cultivated habitat. Use value, informant consensus factor and cultural food significance index was used for data analysis. Data visualization using principal component analysis biplot revealed three distinct clusters of species. Species such as *Zanthoxylum armatum*, *Litsea cubeba*, *Houttuynia cordata*, *Zingiber officinale*, *Allium odorum*, etc. are the most culturally and highly significant as seen in high UV, CFSI, FMRI, and AI scores. These species may be prioritised for conservation or the development of value-added products such as herbal teas, condiments, and nutraceuticals. Species such as *Zingiber montanum*, *Hedychium marginatum*, *Zanthoxylum rhetsa*, *Ocimum basilicum*, *Hedychium spicatum* have niche and specialized uses. Although these species may be under-recognised, they hold potential for exploration in areas such as pharmacology. The traditional food system is a pool of knowledge with potential applications in food and nutritional security, with sound scientific validation of the plants involved.

**Keywords:** Cultural significance, Food plant, Meitei community, Spice, Traditional knowledge

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Traditional knowledge systems all over the world are founded on elements of food, medicine and livelihood interacting with one another through culture of the people. Incorporation of food plants in traditional cuisines is seen in many cultures. Ethnobotany of food plants offers novel ways to evaluate and preserve traditional knowledge and agrobiodiversity<sup>1</sup>. As India is a country with a wide diversity of traditional cuisines; wild gathered vegetables, herbs and spices for colouring, flavouring, seasoning and preservation of food play an important role in the food system<sup>2</sup>. The foundation of culturally significant indices of quantitative ethnobotanical data is based on the documentation of plants traditionally consumed within a certain geographical and cultural environment<sup>3</sup>. Pieroni in 2001 proposed the Cultural Food Significance Index to evaluate the cultural significance of traditionally consumed wild food botanicals, claiming that it is necessary in linking food acceptance in a culture with examination of

phytochemical constituents that could influence general appreciation of food.

Spices and aromatic herbs are largely used to enhance food palatability and taste. Spices are strongly flavoured or aromatic substance of vegetable origin, commonly used as condiment<sup>4</sup>. Spices and herbs can be classified into various groups based on flavour/taste, taxonomy or part of the plant where they come from<sup>5</sup>. However, in the context of ethnobotanical literature, the definition of 'spice' is built on a broad view where - it is an edible plant material used to add flavour and aroma in cooking<sup>6</sup>; it has a pungent flavour or colouring action or increases appetite and aids in digestion<sup>7</sup>. Essentially, the classification of spice comes from its mode of use in food preparation. In this study, the plants used as 'spice' encompasses the aromatic plants and their parts which are used in preparation of folk dishes for their pungent flavour and aroma and have at least one of the following qualities to lend to the food - flavouring, seasoning, masking, preservative and colouring.

The study is concentrated on the use of plants as spice in traditional cuisine of the indigenous Meitei

\*Corresponding author

community which mainly reside in the Imphal Valley of Manipur, North East India. Since centuries ago, the Meiteis have shared a close relationship with its diverse bio-resource system for livelihood, religious rituals, food and medicine. They have rich traditional knowledge built upon a substantial diversity of plant species available in the state<sup>8</sup>. The traditional gastronomy of the Meitei population of Manipur is based on rice as the staple food, varied seasonal herbs, leafy vegetables and fish in their diet. The practice of eating fresh raw parts of plants or herbs with traditional dishes is prevalent among the Meiteis<sup>9</sup>. Ethnobotanical studies carried out in Manipur have mostly focused on wild plants as vegetables and medicinal plants<sup>10-12</sup> and specific studies on use of food plants specifically as spice along with their quantitative ethnobotanical evaluation are lacking. The aims of this study are 1) identify and highlight the plants used as spices by the Meitei community of Manipur in North East India and 2) evaluate the cultural significance of the plants as spice in traditional food and identify high value plants.

**Materials and Methods**

**Study area**

Manipur, a state in North Eastern India has coordinates 23°47' to 25°41'N and 93°61' to 94°48' E

and a geographical area of 22,327 km<sup>2</sup>. The state capital, Imphal lies in an oval-shaped valley of approximately 700 square miles at 790 metres above sea level surrounded by hills<sup>13</sup>. Manipur with a population of roughly 2.8 million is located within the Indo-Burma centre of biodiversity hotspot. It harbours diverse 33 ethnic communities, the most dominant being the Meiteis which constitute 53% of the total population of the state and mostly live in the valley areas. The study was conducted in four villages inhabited by the Meiteis— Wakha and Andro of Imphal East district and Phayeng and Konthoujam of Imphal West district (Fig. 1). The Figure 1 is a map of Manipur showing the study areas drawn using Figma software.

**Field survey and data collection**

Semi-structured interviews, following standard ethnobotanical methods<sup>14</sup>, were conducted in the above mentioned villages from February to November 2022. Using snowball sampling and free listing, 110 informants (67 female, 43 male; aged 35-76) knowledgeable about local food culture were randomly interviewed in Manipuri language. Prior informed consent (PIC) was obtained in accordance with the ISE Code of Ethics<sup>15</sup>. Participants were asked to spontaneously mention from memory, the aromatic plants that are used indigenously as spice in cooking

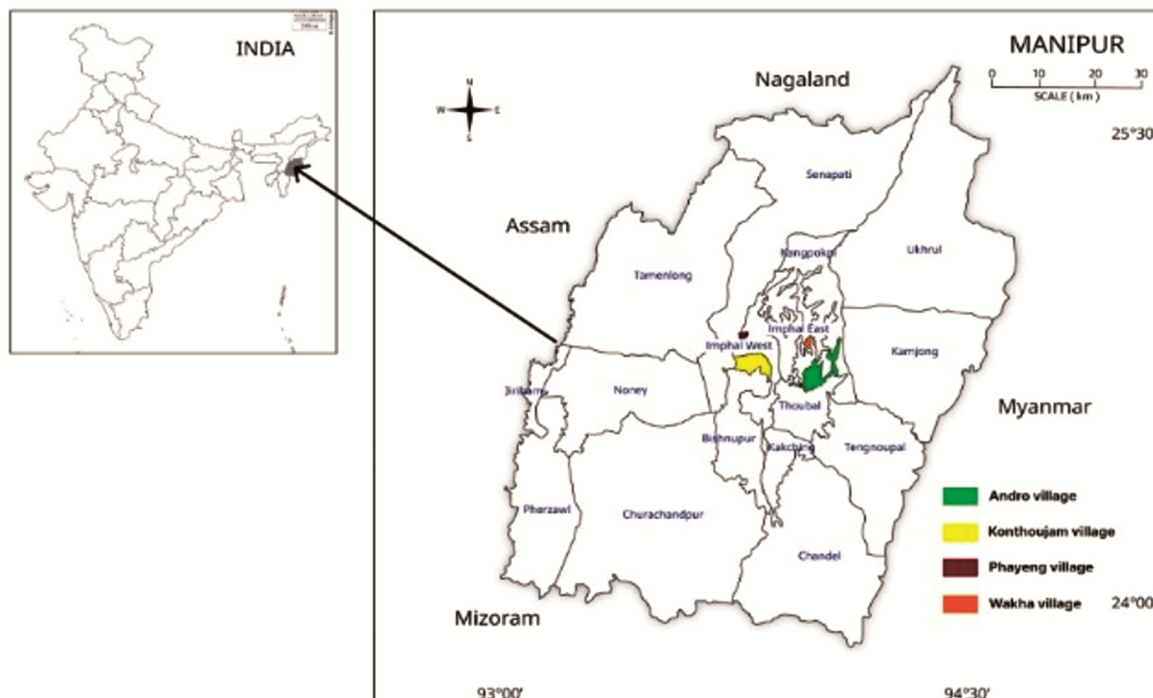


Fig. 1 — Map of Manipur showing the study areas. (Map source – manipur.gov.in)

traditional cuisines. It was emphasized that, in this study, the concept of plant as a 'spice' refers to any plant/part of plant that give a specific pungent or aromatic flavour to heighten the taste or aroma of the food. For each plant, data were collected on usage frequency, parts used, preparation methods, form (fresh/dried), and other ethnobotanical uses. Spices were categorized by function: flavouring, seasoning, masking, preservative, or colouring. Observations included availability, localisation, multifunctional food uses, taste, and medicinal value. Photographs were used for verification. Common cosmopolitan spices (e.g., onion, garlic, coriander, chilli) were excluded.

#### Plant identification

Taxa were collected during field trips and herbarium specimens were prepared. Identification was based on literature<sup>16,17</sup> and verified at BSI, Shillong, where voucher specimens were deposited. World Flora Online<sup>18</sup> (<http://www.worldfloraonline.org/>) was used for identification, nomenclature, and plant characteristics.

#### Data analysis

Indices used for analysis are-

- Use Value (UV):

The Use Value Index (UV) reflects the relative importance of a species based on use reports from informants<sup>19</sup>:

$UV = \sum U_i / N$ , where  $U_i$  is the number of uses reported by each informant  $i$  and  $N$  is the total number of informants citing the species.

- Informant Consensus Factor (ICF):

ICF measures agreement among informants on plant use within a category<sup>3</sup>

$ICF = (Nur - Ns) / (Nur - 1)$ , where  $Nur$  is the number of use reports and  $Ns$  is the number of species used in that category. Values range from 0 (no consensus) to 1 (high consensus).

- Cultural Food Significance Index (CFSI):

CFSI assesses the cultural relevance of food plants<sup>2,20</sup>. Species with fewer than two use reports were excluded.

$CFSI = QI \times AI \times FUI \times PUI \times MFFI \times TSAI \times FMRI \times 10^{-2}$ ,

where:

$QI$  = Quotation Index,  $AI$  = Availability Index,  $FUI$  = Frequency of Use Index,  $PUI$  = Parts used Index,  $MFFI$  = Multifunctional Food Use Index,  $TSAI$  = Taste Score Appreciation Index,  $FMRI$  = Food Medicinal Role Index (Supplementary Table S1)

Pieroni<sup>20</sup> classified the values of this index into six categories to study their relevance; Species with very high significance (CFSI =  $\geq 300$ ), high significance (CFSI= 100-299), moderate significance (CFSI= 20-99), low significance (CFSI = 5-19), very low significance (CFSI =1-4) and negligible significance (CFSI <1).

Data were analyzed using MS Excel and presented through charts. Data visualization and multivariate analysis were performed using anaconda (v24.x) with python (v3.x). A heatmap was generated to visualize patterns of plant use across informants using the *seaborn* and *matplotlib* libraries. Principal component analysis (PCA) was conducted from data values given in to identify major axes of variation in plant use data, using the *scikit-learn* library. Data preprocessing and management were carried out using *pandas*.

## Results








#### Diversity of plants used as spice

The study identified and documented 30 plant species used as spices by the Meitei community, along with associated ethnobotanical uses (Supplementary Table S2). These species represent 8 families and 17 genera, with Zingiberaceae being the most represented (40%), followed by Lamiaceae (20%), and Amaryllidaceae and Rutaceae (10% each). Herbs were the dominant growth form, followed by shrubs and trees. Few species (3) are found in wild habitat, while most species (20) were found in both wild and cultivated habitats, indicating their semi-domesticated status and importance in traditional knowledge systems.

#### Ethnobotanical use reports and ICF








Table 1 shows the parts of the plants used along with their ethnobotanical uses, and the mode of use of each species as given by the informants. Indigenous dishes of the Meitei community mentioned in Table 1 are listed in Supplementary Table S3. The maximum plant parts used as spice include leaf, rhizome and inflorescence (Fig. 2). The ethnobotanical use categories considered here in this study includes spices, vegetables, medicine, herbal drinks, and others (Table 2). As the informants were exclusively asked about plant species used as spice, the highest number of use reports is seen in spice category, followed by medicine, vegetable and others. The ICF is high in all categories, but highest factor (0.98) is seen in spice category.

Table 1 — Ethnobotanical uses along with parts used and use form of plant species as spice in food in Meitei community

Botanical name	Local name	Part used & use form	Ethnobotanical uses			Photograph
			In traditional food (as spice, vegetable) * = use category as spice	Medicine	Others	
<i>Allium ascalonicum</i>	Meitei tilhou macha	Leaf, bulb	Tempering and garnish; <i>kangsoi, eronba, curry, ametpa</i>	Bulb and leaf concoction used to treat high fever and sores; given to mothers post-natal	-	
		Fresh, dried	*Flavoring, seasoning			
<i>Allium hookeri</i>	Maroi napakpi	Leaf, root	Tempering fish curry; leaves added in <i>paknam, kangsoi, curry</i> . Crushed roots added in curry *Flavoring, masking	Leaf chewed against mouth ulcers	-	
		Fresh				
<i>Allium odorum</i>	Maroi nakuppi	Leaf	Tempering oil-based curry and <i>kanghou, ametpa, singju, kelichana, bora, curry (Maroi thongba)</i> *Flavoring, seasoning	Leaf and honey concoction consumed to cure urinary problem and fever	-	
		Fresh				
<i>Alpinia galanga</i>	Kanghou	Rhizome, young inflorescence	Rhizome added in <i>ametpa, singju, eronba, chagempomba</i> . Inflorescence eaten as <i>ametpa</i> *Flavoring, seasoning	Rhizome controls high blood pressure and fever	-	
		Fresh, dried				
<i>Alpinia nigra</i>	Pullei	Tender stem, young rhizome	Pith of the stem and rhizome eaten as <i>eronba, curry, kangsoi</i> *Flavoring	-	-	
		Fresh				
<i>Alpinia officinarum</i>	Pullei manbi	Rhizome	Rhizome added in meat and fish curry, <i>eronba, ametpa</i> *Flavoring, masking	Rhizome chewed to cure mouth sores and bad breath	-	
		Fresh, dried				
<i>Amomum aromaticum</i>	Namara	Tender stem, young rhizome	Tender stem pith and rhizome eaten as <i>eronba, curry</i> with leaves of <i>Senegalia pennata</i> and <i>kanghou</i> *Flavoring	-	-	
		Fresh				








... Contd.

Table 1 — Ethnobotanical uses along with parts used and use form of plant species as spice in food in Meitei community (Contd.)

Botanical name	Local name	Part used & use form	Ethnobotanical uses				Photograph
			In traditional food (as spice, vegetable) * = use category as spice	Medicine	Others		
<i>Amomum</i> sp.	Sarei	Tender stem, young rhizome Fresh	Tender stem eaten as <i>eronba</i> , added in snail curry, <i>ametpa</i> . *Flavoring, masking	-	-		
<i>Cinnamomum verum</i>	Ushingsha	Bark  Fresh, dried	Bark added in fish, meat curry; pickles  *Flavoring, preservative, masking	Carminative, cures bad breath, cold	-		
<i>Citrus latipes</i>	Heiribob	Fruit  Fresh, dried	Fruit peel added in fish, meat curry; lentil and other curries; pickles *Flavoring, masking, preservative	Fruit peel eaten to treat urinary stone cases and piles.	Fruit without the peel used to clean brass utensils		
<i>Curcuma angustifolia</i>	Yaipan	Flower  Fresh	Flower eaten as <i>bora</i> (fritters), curry, <i>eronba</i> and <i>ametpa</i> . *Flavoring	Flower eaten to cure diarrhoea.	-		
<i>Curcuma longa</i>	Yaingang	Rhizome, leaf  Fresh, dried	Rhizome as food colorant in curry; leaf used to wrap for steaming of <i>paknam</i> . *Flavoring, seasoning, coloring, preservative	Rhizome used to treat flu.	Used in auspicious rituals; planted in new home-gardens as a good omen		
<i>Elsholtzia blanda</i>	Kanghuman	Leaf, Tender shoot, young inflorescence Fresh	Garnish for <i>singju</i> , <i>ametpa</i> , <i>eronba</i> . *Flavoring, seasoning	-	-		
<i>Elsholtzia griffithii</i>	Lomba	Inflorescence  Fresh, dried	Garnish for <i>singju</i> , <i>eronba</i> , added in meat curry, taro curry *Flavoring, seasoning	Inflorescence boiled in water with ginger and consumed in cold and cough; treats menstrual disorder	-		

... Contd.

Table 1 — Ethnobotanical uses along with parts used and use form of plant species as spice in food in Meitei community (Contd.)

Botanical name	Local name	Part used & use form	Ethnobotanical uses			Photograph
			In traditional food (as spice, vegetable) * = use category as spice	Medicine	Others	
<i>Elsholtzia stachyodes</i>	Tekta	Leaf, tender shoot  Fresh	Added in <i>chagempomba</i> , curry *Flavoring	-	-	
<i>Eryngium foetidum</i>	Awafadigom	Leaf  Fresh	Leaf added in fish, meat curry, <i>ametpa</i> , lentil, taro curry *Flavoring, seasoning, masking	Cures cold and fever	-	
<i>Foeniculum vulgare</i>	Pakhon	Leaf, tender shoot  Fresh	Leaf and tender shoots added in taro curry, <i>chagempomba</i> , <i>chamthong</i> *Flavoring, seasoning	-	-	
<i>Hedychium coronarium</i>	Loklei	Rhizome  Fresh	Rhizome in <i>eronba</i> , snail curry, <i>kangsoi</i> , <i>ametpa</i> *Flavoring	Rhizome boiled and eaten to cure cold and cough	-	
<i>Hedychium marginatum</i>	Takhellei angangba	Rhizome Fresh, dried	Rhizome eaten as <i>eronba</i> *Flavoring	Crushed rhizome juice with <i>sitamishri</i> (rock sugar) consumed to treat urinary tract problems	Flowers are ornamental	
<i>Hedychium spicatum</i>	Takhellei	Rhizome  Fresh	Rhizome eaten as <i>eronba</i> *Flavoring	-	Flowers used in ' <i>nachom</i> ': traditional flowers worn at the ear by Meitei women	
<i>Houttuynia cordata</i>	Toningkhok	Leaf, root  Fresh	Root, leaf eaten in <i>ametpa</i> , <i>singju</i> , garnish for <i>eronba</i> and <i>kelichana</i> ; root in fish curry; leaf eaten in curry with prawn *Flavoring, seasoning	Cures muscular pain, diarrhoea	-	

... Contd.

Table 1 — Ethnobotanical uses along with parts used and use form of plant species as spice in food in Meitei community (Contd.)

Botanical name	Local name	Part used & use form	Ethnobotanical uses			Photograph
			In traditional food (as spice, vegetable) * = use category as spice	Medicine	Others	
<i>Litsea cubeba</i>	Usingsa/ Ngairong	Fruit, young inflorescence  Fresh, dried	Eaten with <i>ametpa</i> , curry (fish, meat, and lentil), <i>eronba</i> , <i>kanghou</i> and as pickles *Flavoring, seasoning, preservative, masking	Fruits used to cure cold, cough, flatulence, congestion, sore throat, and headache	Wood used as firewood.	
<i>Ocimum americanum</i>	Mayangton	Leaf, tender shoot, young inflorescence  Fresh	Added in curry (pumpkin, lentil), <i>eronba</i> , <i>ametpa</i> ; fried as <i>bora</i> . *Flavoring, seasoning	Controls fever	-	
<i>Ocimum basilicum</i>	Naoshek-lei	Leaf, tender shoot, young inflorescence  Fresh, dried	Eaten with <i>ametpa</i> , garnish for curry, <i>eronba</i> . *Flavoring, seasoning	Young shoots and leaves eaten to cure piles	Dried leaf used in making beedi (local cigarette); Leaf brewed for herbal tea	
<i>Perilla frutescens</i>	Thoiding	Seed  Dried	Roasted seed powder added in <i>singju</i> , pickles, <i>chamthong</i> ; made into <i>thoiding asuba</i> and an ingredient in <i>thoiding kabok</i> *Flavoring, seasoning, preservative	Seed oil used in treating aches, joint pain and skin burns	Seed oil used in skincare; Leaf used as an underlying wrap in preparing omelette	
<i>Persicaria posumbu</i>	Phakpai	Leaf, tender shoot  Fresh	Garnish for <i>eronba</i> , <i>ametpa</i> . *Flavoring, seasoning	Leaf decoction used against fever and cold; applied to stop bleeding	Leaf brewed for herbal tea	
<i>Zanthoxylum armatum</i>	Mukthruhi	Leaf, fruit  Fresh	Essential ingredient in traditional snail and meat curry, <i>ametpa</i> , <i>singju</i> , <i>eronba</i> , <i>chasubi</i> , <i>bora</i> *Flavoring, seasoning, masking	Decoction of leaf, fruits treats cold, cough, congestion and sore throat	-	

... Contd.

Table 1 — Ethnobotanical uses along with parts used and use form of plant species as spice in food in Meitei community (Contd.)




Botanical name	Local name	Part used & use form	Ethnobotanical uses			
			In traditional food (as spice, vegetable) * = use category as spice	Medicine	Others	Photograph
<i>Zanthoxylum rhetsa</i>	Ngang	Fruit	Fruit rind eaten with <i>ametpa</i> ; added in fish and meat curry *Flavoring, seasoning, masking	Leaf decoction used to control fever and cold	Trunk Spines used in making rosaries. Wood is used for making tools	
		Fresh, dried		Bark powder in treatment of toothache		
<i>Zingiber montanum</i>	Tekhao yaikhu	Rhizome	Rhizome in <i>eronba</i> and <i>ooti</i> *Flavoring	Rhizome used to treat respiratory tract infections, skin infections and carminative. Fruit controls diabetes	-	
		Fresh, dried				
<i>Zingiber officinale</i>	Shing	Rhizome, leaf, Floral bud	Rhizome in tempering curry, <i>thoiding</i> balls, soup, <i>chamthong</i> . Young leaf added in pumpkin curry, floral buds in <i>ametpa</i> *Flavoring, seasoning, preservative, masking	Rhizome taken with honey to treat cold and sore throat	Leaf is brewed for herbal tea	
		Fresh, dried				

Table 2 — Ethnobotanical use reports, use categories and their ICF

Use categories	No. of use reports (N <sub>ur</sub> )	No. of species (N <sub>s</sub> )	Informant Consensus Factor (ICF)
Spices	1754	30	0.98
Vegetable	330	10	0.97
Medicine	698	23	0.96
Herbal drinks	53	3	0.96
Others	103	8	0.93

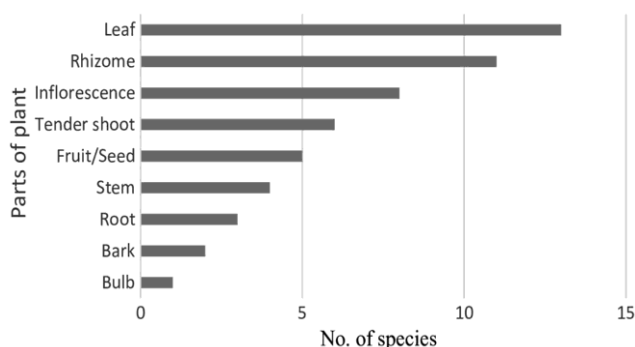


Fig. 2 — Plant parts used as spice by Meitei community of Manipur

On the basis of ethnobotanical knowledge of the local people, five different functions for spice-flavoring, seasoning, masking, preservative and

coloring are considered<sup>21</sup>. These categories are based on the fact that they are the main qualities of being a spice and at least one of them should be possessed by each species, to be regarded as a spice. *Curcuma longa*, *Litsea cubeba* and *Zingiber officinale* have the widest range of use, being placed in four categories each. Maximum species are used for flavouring, followed by seasoning, masking, preservative and colouring (Table 1 & Fig. 3).

Most plants are used fresh, followed by both fresh and dried forms (Table 1, Fig. 4). *Perilla frutescens* seeds are the only ones used exclusively in dried form. Dried rhizomes of *Zingiber montanum*, *Alpinia officinarum*, and grated *Alpinia galanga* are commonly used and sold in local markets. Local vegetable markets in Manipur are predominantly community-driven, seasonal, and self-sustained, though their degree of commercialization remains uneven<sup>22</sup>. Other dried plant parts used as spices include the inflorescence of *Elsholtzia griffithii*, bark of *Cinnamomum verum*, fruit peels of *Zanthoxylum rhetsa* and *Citrus latipes*, and leaves of *C. longa*. Herbs and leaf of plants are preferably used fresh in cooking due to their culinary appeal as well as easy availability.

**UV and CFSI**

The results of UV and CFSI along with the total Use Reports (UR) of each species are given in Table 3. The Use Values (UV) ranges from 1-2.4. The highest use value is seen in *Z. montanum* (2.4), *O. basilicum* (2.3) and *H. spicatum* (2.3).

The values of Cultural food significance index varies significantly between 1.9 as the minimum and

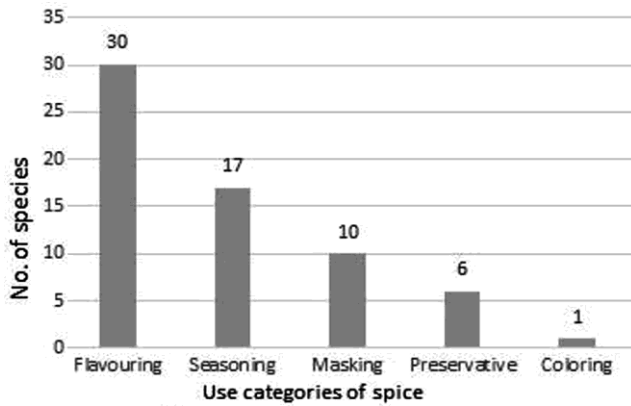


Fig. 3 — Ethnobotanical use categories of plants as spice

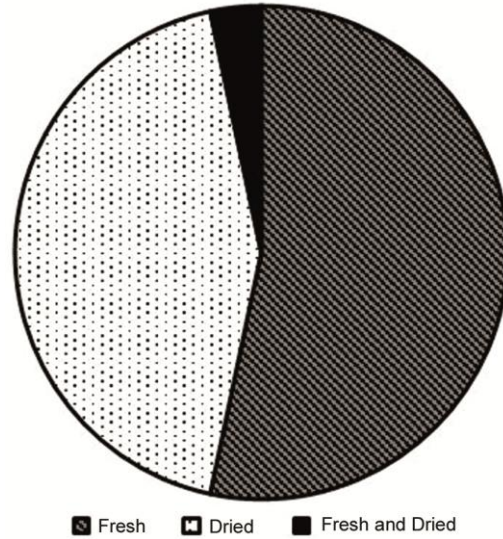


Fig. 4 — Use form category and no. of species in each category

Table 3 — UV and CFSI values for plant species used as spice by Meitei community

Botanical Name	UR	UV	QI	AI	UFI	PUI	MFFI	TSAI	FMRI	CFSI
<i>Allium ascalonicum</i>	117	1.4	81	1.7	2.8	1.5	4.5	8	4.5	936.9
<i>Allium hookeri</i>	109	1.1	97	4	4.9	1.5	3.5	9	3.5	3144
<i>Allium odorum</i>	175	1.7	98	4	4.9	3	6	9	2.5	7779
<i>Alpinia galanga</i>	88	1.3	67	2.2	4	1	5	8	4	943.3
<i>Alpinia nigra</i>	58	1.2	48	2.8	4.3	1	4	6.5	1	150
<i>Alpinia officinarum</i>	72	1.4	49	1.5	3.5	1	4.5	7	3	243.1
<i>Amomum aromaticum</i>	90	1.7	52	2.2	3.9	1	5	8.5	1	189.6
<i>Amomum sp.</i>	62	1.3	46	0.6	2.6	1	4.5	8	1	25.8
<i>Cinnamomum verum</i>	99	1.5	65	2.6	3	1	3.5	8	3	425.8
<i>Citrus latipes</i>	136	1.5	91	3.9	4.5	1.5	1.5	9	2	646.8
<i>Curcuma angustifolia</i>	89	1.8	48	2.6	3.8	0.75	4	7	1.5	149.3
<i>Curcuma longa</i>	145	1.4	101	3.9	4.8	1	2	7	4.5	1191
<i>Elsholtzia blanda</i>	42	1	42	1.5	3.4	2	4	7	1	119.9
<i>Elsholtzia griffithii</i>	103	1.1	86	2.8	4.1	0.75	3.5	8	3.5	725.6
<i>Elsholtzia stachyodes</i>	52	1.2	43	1.6	2.7	2	1	7	1	26
<i>Eryngium foetidum</i>	141	1.3	107	3.8	4.8	3	3	9.5	3.5	5840
<i>Foeniculum vulgare</i>	71	1	71	2.7	3.8	1	3.5	7.5	1	191.2
<i>Hedychium coronarium</i>	110	1.6	67	3.8	4	1	5	7.5	1.5	572.8
<i>Hedychium marginatum</i>	69	2	34	0.5	1.3	1	1	5.5	4.5	5.4
<i>Hedychium spicatum</i>	50	2.3	21	0.7	2.2	1	1	6	1	1.9
<i>Houttuynia cordata</i>	109	1.1	97	3.6	4.3	1.5	5	8.5	3	2871.7
<i>Litsea cubeba</i>	130	1.4	92	2.8	4.4	1.5	5.5	9	4	3366.3
<i>Ocimum basilicum</i>	53	2.3	23	0.6	0.8	0.75	4.75	6	1.5	3.5
<i>Ocimum americanum</i>	84	1.1	76	2.7	3.8	0.75	3.5	7.5	2	307
<i>Perilla frutescens</i>	124	1.5	82	3.8	4.3	1	4	8.5	2	911
<i>Persicaria posumbu</i>	112	1.6	69	2.2	4	1.5	4	7.5	3	819.7
<i>Zanthoxylum armatum</i>	136	1.3	104	3.7	4.1	1.5	7.5	9	4.5	7188
<i>Zanthoxylum rhetsa</i>	34	1.8	18	0.8	1.3	1.5	3	7	2	11.7
<i>Zingiber montanum</i>	109	2.4	45	1.1	1.8	1	3	6	4.5	72.1
<i>Zingiber officinale</i>	213	2	106	3.9	4.8	1.75	3.75	9	4.5	5273.9

\*RFC= Relative frequency of citation; UR =Use report; UV=Use value; QI= Quotation index; AI= Availability index; UFI= Use frequency index; PUI=Parts used index; MFFI= Multifunctional food use index; TSAI= Taste score appreciation index; FMRI= Food medicinal role index; CFSI= Cultural food significance index

7779 as the maximum (Table 3). The CFSI values from this study has revealed a majority of the species belonging to the very high significance group. (Fig. 5). Species in this group have a high taste score of  $\geq 7$ , which contribute to their high significance index in cultural food system. The widest range of uses in food as well as medicinal properties are seen among the species in this category. *Allium odorum*, with the highest CFSI value holds an integral position in the traditional food cuisine of the Meitei community. This is supported by the fact that it is a common abundant herb found throughout the year, with varied usage in different traditional dishes, along with medicinal value. *Zanthoxylum armatum* has the second highest CFSI value, being widely used by the Meiteis to season traditional snail curry and has a high local medicinal value consensus among the people. Other species belonging to this category such as *L. cubeba* and *Houttuynia cordata* have their uses in multiple cuisines, bear a high-to-common availability index with medicinal properties as described by the informants. Commonly used spices – *Z. officinale*, *C. longa* and *C. verum* are included in this category.

*Foeniculum vulgare*, though used in other areas of the world commonly, has a special role in preparation of traditional dishes such as *chagempomba*, and taro curry cooked with fermented soybean. *Z. montanum* has very high FMRI value and nearly all of the informants described it as a medicine which can also eaten as food. All these three species are also eaten as vegetables. *Amomum* sp., is added as a delicacy in snail curry and *Elsholtzia stachyodes* is used in *chagempomba* dish.

Two species – *Z. rhetsa* and *H. marginatum* are included in the low significance category. Like *Z. montanum*, *H. marginatum* is consumed more as a

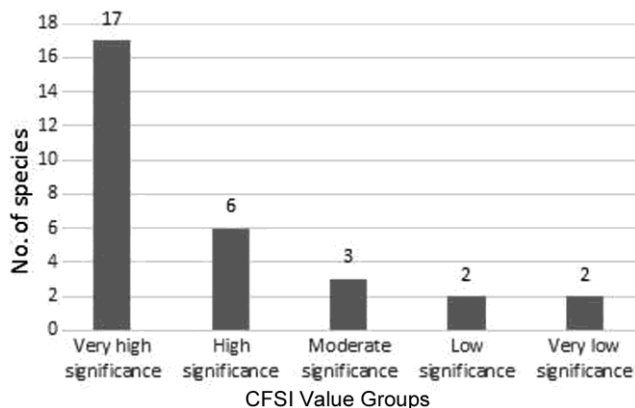


Fig. 5 — CFSI Value groups and number of species for each group

medicine than as food, with high FRMI index of 4.5. The MFFI of *O. basilicum* is high as it is used in a variety of dishes as well as consumed as herbal tea. *H. spicatum* has the lowest CFSI value in the study. The rhizome is used in *eronba* and has very low medicinal consensus among the people. Low FMRI, MFFI and PUI value of the species cements this observation. However, the UV of both these species are high due to consideration of their other ethnobotanical uses as given in Table 1.

A Pearson correlation heatmap of data from CFSI values given in Table (Fig. 6) indicate a strong positive correlation between the QI, AI and FUI, with coefficients ranging from 0.83 to 0.90. The TSAI also shows strong correlations with QI and FUI. It highlights the relation between the factors of availability, knowledge of the plant, frequency of its use and taste. It might mean that plants that are easily accessible and with ‘good taste’ are eaten more frequently in a traditional food system, which is logical. However, UV displays negative correlations with FUI, QI and TSAI, which indicates that a plant with high use value, might not necessarily influence its taste and frequency of use in food.

A Principal Component Analysis (PCA) was conducted to explore the ethnobotanical variation among 30 plant species based on multiple quantitative indices (Fig. 7). The first two principal components of the PCA biplot explained 68.3% of the total variance, with PC1 accounting for 53.6% and PC2 for 14.7%. The biplot revealed three distinct clusters of species, labeled as Cluster 0, Cluster 1, and Cluster 2. Cluster 0 comprised species such as *Z. montanum*, *Hedychium marginatum*, and *O. basilicum*. Cluster 1 included *Zingiber officinale*, *L. cubeba*, and *H. cordata*. These species showed positive associations with PC1 but relatively low alignment with the primary loading vectors, indicating distinct usage patterns or less overlap with the central indices. Cluster 2, the most densely populated group near the origin, included species such as *Curcuma longa*, *A. galanga*, *A. officinarum*, etc. These taxa shared moderate to high scores on several ethnobotanical indices and formed the core of culturally important and commonly used plants. Red vectors representing variable loadings—such as Use Value (UV), Cultural Food Significance Index (CFSI), Relative Frequency of Citation (RFC), and Frequency of Use Index (FUI)—showed strong associations with species like *C. longa* and *Persicaria posumbu*.

**Discussion**

**Plant diversity and traditional knowledge**

The study shows that use of plants as spice in local food system is spread across a considerably wide multiplicity of taxonomic families, genera, growth form and habitat. The concept of ‘both cultivated and wild’ habitat as mentioned in this paper refers to wild plants that are grown and managed through cultivation in homestead gardens. Preference for spice plants in Meitei community is seen for fresh parts of the plant, usually in herbs, as seen in (Fig. 4). Leaf and inflorescence are the most used parts due to this inclination. Since almost all the parts which are used in dried form are also used in fresh form, the practice of using dried parts as spice or any other use can be attributed to convenience more than preference - dried parts of plants that do not lose their flavour, aroma or medicinal value are stored to enable easy availability throughout the year.

Plants used for flavouring (from Table 1) are mostly added to give its particular taste to the dish. Examples are *Zanthoxylum armatum* in traditional

snail curry, *Eryngium foetidum* in fish and meat curry and *Ocimum americanum* in pumpkin curry. The leaf of *Curcuma longa* wraps the ingredients of *Paknam* dish after which it is steamed or baked to enhance the aroma and taste of the dish. Plants eaten as dish toppings are used in seasoning as they are added to improve the taste of the dish, usually at the end. In this study, only one plant *i.e.*, turmeric was used to impart color to food. The plants used as preservative are mostly added in preparation of pickles. Plants like *Alpinia officinarum* and *Citrus latipes* are used for their masking action as well, especially in preparation of fish and meat curry. Their aroma and flavor helps to balance the dish by eliminating the unpleasant smell of raw fish and meat. *Allium ascalonicum*, *Allium hookeri* and *Allium odorum* are herbs mostly used as substituents of onion and garlic by the Meiteis.

Such practices followed by the Meitei is typical of a community that does not solely depend on conventional spices in their cultural food system, but rather thrives on using diverse plants as spices preferably in fresh form.

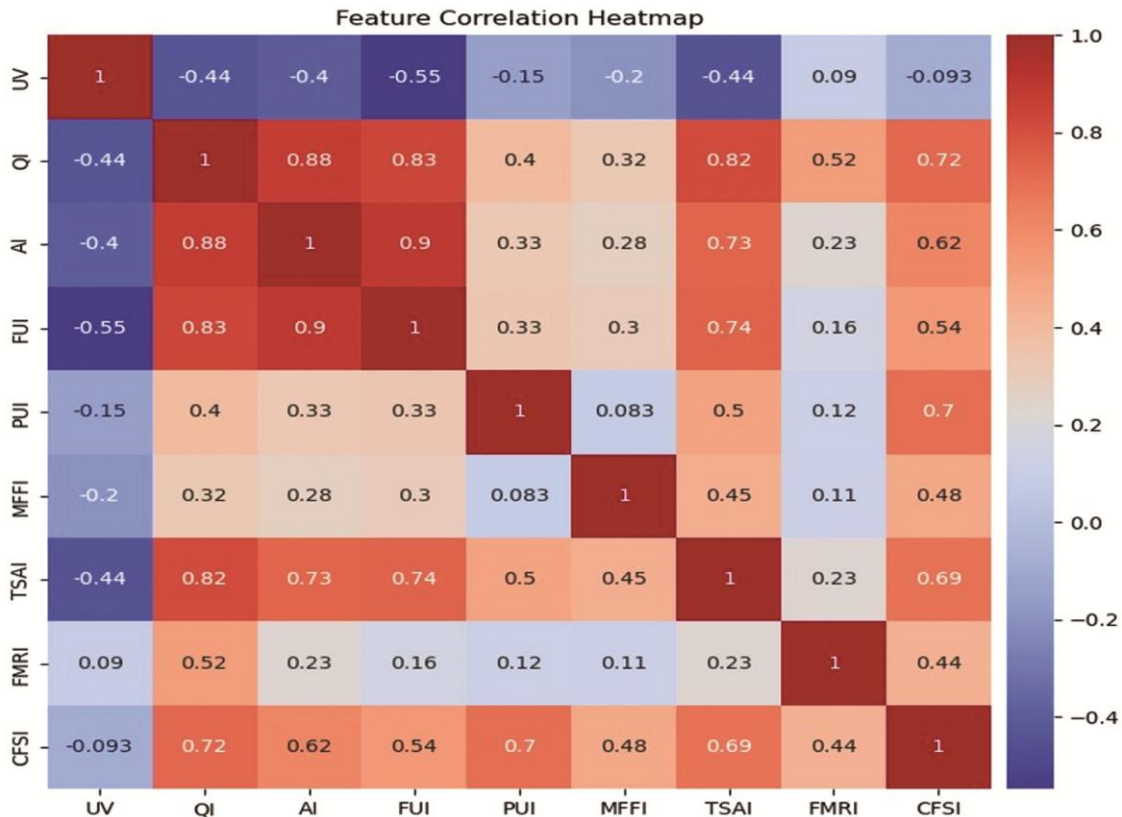


Fig. 6 — Feature correlation heatmap showing Pearson correlation coefficients among ethnobotanical indices used in the study. Colour gradient indicates the strength and direction of correlation (red: positive, blue: negative)

**Cultural significance of plants**

Among the use report categories in Table 2, highest use report and ICF seen for spices category indicates the primary use of the plant species as spices in traditional food context, which corroborates the main objective of the study. The use of some species as vegetables as well as spice can be considered as a middle ground of ‘aromatic vegetables’.

The low availability index of most species of low CFSI score as seen in Table 3 has shown that availability is an important factor in influencing food choice in the Meitei community, like other communities<sup>3,20</sup>. Majority of the plants have high taste score appreciation index, suggesting that taste is an extremely important factor in accommodating plants in traditional food system. High CFSI values of most of the plants in the study establishes the community’s high level of dependence on these plants as spice in their food system.

From the PCA biplot study (Fig. 7), we can identify the species of differing ethnobotanical importance and suggest the potential role of each group of species in traditional food system according to their relevance in this study.

Cluster 0 plants: *Zingiber montanum*, *Hedychium marginatum*, *Zanthoxylum rhetsa*, *Ocimum basilicum*, *Hedychium spicatum* occupy a peripheral position in the biplot. They are niche or specialized use plants. These species exhibit low to moderate UV, AI, and CFSI scores, meaning they are less commonly used or are known mostly for localized uses (e.g., ceremonial, niche culinary, or wild-sourced foods).

The present-day use of such plants seems limited due to constraints by seasonal availability, habitat specificity, or reduced cultural preference. They may have lower visibility in ethnobotanical surveys but remain locally significant in indigenous pharmacopoeias. They are candidates for further study, especially if their use is fading. The decline in

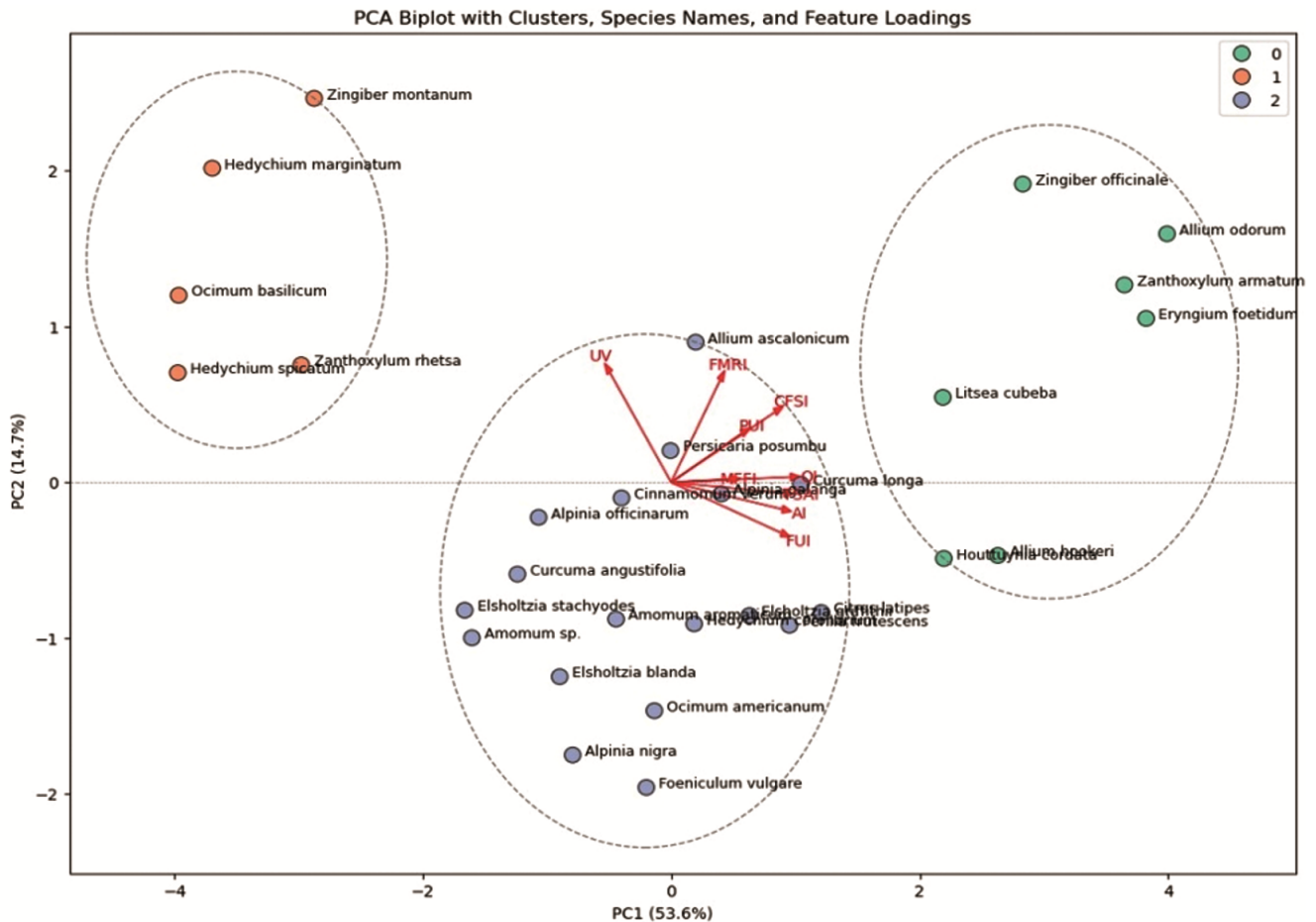


Fig. 7 — Principal Component Analysis (PCA) biplot showing clustering of spice plants based on use indices, with loadings of key variables (UV, CFSI, FMRI, etc.) represented as red arrows

knowledge and practice related to these plants highlights the ongoing processes of cultural change and knowledge erosion.

Cluster 1 plants: *Zanthoxylum armatum*, *Litsea cubeba*, *Houttuynia cordata*, *Zingiber officinale*, *Allium odorum*, etc. This cluster includes the most culturally and medicinally versatile species, reflected in high UV, CFSI, FMRI, and AI scores. These are "cultural keystone species," widely recognized in the community and used in both food and health contexts. These species should be prioritized for conservation, domestication, or value-added product development (e.g., teas, condiments and nutraceuticals).

Cluster 2 plants: *Curcuma longa*, *Alpinia officinarum*, *Foeniculum vulgare*, *Persicaria posumbu*, etc. show balanced usage across several indices. They have moderate UV, QI, and AI, indicating relevance in both food and health systems. They bridge the gap between culinary and medicinal domains. These are "continuum plants" along the food-medicine spectrum and are ideal for programs that promote functional foods, community herbal gardens, or education in traditional diets.

#### Study limitation

The study is based on ethnobotanical knowledge collected through surveys and interviews, which largely depends on the continuity of knowledge transmission within the community. This might be subject to participants' recall or selective knowledge transmission. Seasonal variations in plant availability and the possible loss of traditional knowledge due to cultural erosion or modernisation were also limiting factors that may have affected the comprehensiveness of the data collected. Despite these limitations, the findings offer valuable baseline insights into the community dependence on aromatic plants among the Meitei ethnic group in Manipur and provide important directions for future research and conservation initiatives.

#### Conclusion

The cultural significance of the documented food plants highlights their integral role in Meitei traditional knowledge. Indigenous knowledge of nutraceutical and culturally important foods holds potential for industrial and market applications. Domesticated species like *Allium odorum* and *Allium hookeri* already support local economies in parts of Manipur. However, large-scale cultivation of most spice plants remains limited due to altitude-specific

growth, poor market access, and lack of incentives and planning. As interest in traditional foods grows, ethnobotanical studies can guide the development of functional foods and nutraceuticals. Promoting traditional food systems can enhance food and nutritional security through sustainable, culturally rooted diets.

#### Supplementary Data

Supplementary data associated with this article is available in the electronic form at [https://nopr.niscpr.res.in/jinfo/ijtk/IJTK\\_24\(11\)\(2025\)1020-1033\\_SupplData.pdf](https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_24(11)(2025)1020-1033_SupplData.pdf)

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#### Conflict of Interest

The Authors declare that there is no conflict of interest.

#### Author Contributions

The paper was conceptualized by EH; collection of data, data analysis and writing original draft was done by EH & NY; Review and editing of the draft was done by EH & HBS.

#### Prior Informed Consent

Prior Informed Consent were sought from participants of the community prior to the survey.

#### Ethics Statement

Prior approval was taken from community knowledge holders prior to the survey.

#### Data Availability

Ethnobotanical data will be automatically made available to public domain once published.

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