International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 30-11-2021, Accepted: 16-12-2021, Published: 31-12-2021
Volume 6, Issue 6, 2021, Page No. 1539-1547

Multivariate analysis of medicinal plant knowledge on the *Salai Taret Complex*, a polyherbal recipe used by Meitei community in North East India

Sanjoy Singh Ningthoujam[1*], Anupam Das Talukdar[2], Kumar Singh Potsangbam[3], Manabendra Dutta Choudhury[4], Suresh Singh Mairembam[5]

[1] Department of Botany, Ghanapriya Women's College, Imphal, Manipur, India
[2] Department of Life Science and Bioinformatics, Assam University, Assam, India
[3] Department of Life Sciences, Manipur University, Canchipur, Manipur, India
[4] Bioinformatics Centre, Assam University, Assam, India
[5] Department of Zoology, Ghanapriya Women's College, Imphal, Manipur, India

Abstract
The *Salai Taret complex* is a traditional polyherbal recipe used by the Meitei community in North East India for the treatment of fever, pneumonia and skin diseases. Practical knowledge of this medicinal complex has disappeared from majority of the Meitei community except a few residing in different parts of North East India. Among these people also, variations were observed in constituents, applications and mode of preparations. An attempt have been made to study *Salai Taret Complex* with multivariate analysis for determination of the core components and applications. Data on component plants, preparations and usage were collected through field studies in Jiribam (Manipur) and Agartala (Tripura) in North East India by using semi-structured questionnaires. Salient indices were calculated by using Smith index and Sutrop index to determine relative preference of the component plants. Principal coordinate analysis and cluster analysis were used to determine the medicinal plant knowledge. In the study, 25 medicinal plants belonging to 20 families were reported as the components of this herbal complex. The complex were categorized into two main groups of formulations. First group contained *Centella asiatica, Zingiber officinale, Hydrocotyle sibthorpioides, Phyllanthus fraternus* and *Oldenlandia diffusa* as main components while the second group was represented by *Andrographis paniculata, Nyctanthes arbor-tristis, Phlogacanthus thyrsiflorus, Magnolia champaca, Clerodendrum glandulosum, Azadirachta indica* and *Momordica charantia* as the main components. Application of multivariate analysis help in identifying the core components in different formulations of the herbal complex and their associated properties.

Keywords: polyherbal recipe; north east India; Meitei; multivariate analysis; bitter medicine

Introduction

Polyherbal formulations are important constituents of traditional medicine system in India, China, Cuba (Cano and Volpato, 2004) [5], South East Asia (Pucot and Demayo, 2021) [24], Middle East (Carmona *et al*., 2005) [6] and Latin America (Bussmann *et al*., 2010; Vandebroek *et al*., 2010) [4, 33]. A particular polyherbal recipe may have different combinations of different herbal components according to basic formulae in the traditional medicine (Kiyohara *et al*., 2004) [13]. Selection pattern of the constituents of these complexes were derived by our ancestors through trial and error methods, which later on developed into specific criteria. There are probabilities of supplementation or substitution of the components in the polyherbal complex. It is because ethnobotanical knowledge is not static but dynamic as it is transferred and acquired by the people who practiced it. During this evolution, selection pattern of newly incorporated plants might not be in random but according to certain criteria specific to the traditional system. Identification of the main constituents are important for understanding the basic properties of the complex with different formulations.

Several approaches of multivariate analysis have been attempted to determine genesis and factors controlling these medicinal plant complex in different cultural context (Bussmann *et al*., 2010; Obon *et al*., 2014; Obón *et al*., 2012; Vandebroek *et al*., 2010) [4, 18, 19, 33]. Each of these studies have their own unique focus that determine the choice of the statistical methods used. Popular tools like principal component analysis, principal coordinate analysis and cluster analysis were used to partition the data into different categories.

Meitei (also known as Manipuri) inhabiting in India, Bangladesh and Myanmar (Hodson, 1908) [10] used different polyherbal complex as part of their traditional medicine system. One of such complex is "*Salai Taret ki hidak*" (hereafter represented as *ST complex*). The origin of this complex is still elusive. This complex was mentioned in a monograph of ethnomedicinal plants of Manipur, which was compiled from many ancient manuscripts and medicinal texts (Mayanglambam, 2005) [14]. The complex was mainly prescribed for the treatment of pneumonia which is known to the Meitei community as *Bhukuti*, *Bhugati* or *Khulai Laihou* (Ningthoujam *et al*., 2013) [17]. Description of this herbal complex in the monograph included some non-Manipuri vernacular terms, thereby indicating possibility of acquisition of external traditional medicine system, probably Ayurveda or vice versa.

Practical knowledge of this medicinal plant complex was practically non-existent among general public in the Imphal valley area where majority of the Meitei community reside. Ethnobotanical field survey in the Imphal valley for the last twenty years by the first and third authors and also by other researchers did not report this complex. This absence might be an indication of the loss of knowledge about this herbal complex from the public domain.

In the year 2012, authors have met some people in Jiribam in Manipur and Agartala in Tripura who are still retaining knowledge of this herbal complex. Those encounters motivated the authors to document the remaining knowledge of this dying tradition of the Meitei community.

Aim of the study was to determine the components of the *Salai Taret complex* by application of multivariate analysis and to demonstrate the dynamic nature of the medicinal plant knowledge. In order to achieve the objectives, the information about the *ST complex* were collected from ethnopharmacological field surveys.

Materials and Methods

Study Site

Ethnopharmacological field study was conducted in the Jiribam, Manipur and Agartala, Tripura in the North-East India between February 2018 and February 2021.

The survey covered whole of the Jiribam District of Manipur and sub-urban pockets of Agartala, Tripura State in North East India.

Jiribam is located on the western side of the Manipur bordering Cachar district of Assam.

Agartala is located on the western part of Tripura near its border with Bangladesh.

Study was confined to the Meitei communities residing in these areas. Interactions were made with either healers still practicing traditional method, who have abandoned the system or persons belonging to healer's family. Informant selection were done with snowball method. Out of the interaction with 87 traditional knowledge holders in these two sites, only 16 persons inhabiting in five villages (Uchathol, Harinagar, Ningshingkhul, Mongbung and Chingdong Leikai) in Jiribam and two localities (Radhanagar and Borjala Mayai Leikai) in Agartala were still retaining this knowledge. Information collected from this limited number of informants formed the basis of this study.

Fig 1: Map showing study sites

The 'Meitei' community

The Meitei or Manipuris belongs to the Mongoloid stock with some traces of Aryan traces (Singh, 2003) [27]. The community was formed by amalgamation of different clans and immigrants (Hodson, 1908) [10]. It is the largest ethnic group in Manipur state in North East India. Meitei community practiced different forms of religions-pre-Hindu Meiteism, synthetic form of Hinduism, and Christianity. People speak Manipuri language which is a branch of Tibeto-Burman linguistic family. Historically and anthropologically, the community traced its origin to the Manipur state, the erstwhile kingdom of the Meiteis. Still today, the state of Manipur is considered as the cultural center of the Meitei community where various cultural elements and ethos are still preserved. Push and pull factors in the political history of the kingdom caused various instances of migration (Singh, 2003) [27]. As the consequences of dispersal, various sections of the community settled in Myanmar, Bangladesh and various states of North East India.

Traditional medicine system of the community also got influenced by neighboring cultures and environment. In the course of time, traditional medicine of the Meitei emerged as the fusion of original indigenous pharmacopeia with Ayurveda, Unani and South-East Asian medicine system. Meitei community in Jiribam area have close cultural relationship with both Imphal valley in Manipur and Barak valley of the Assam. On the other hand, those in Agartala have close affinities with Barak valley and Meitei community in Bangladesh.

Data collection procedures

Semi-structured questionnaire was used for collecting the information. Questionnaire format was developed by taking into account the complexities of the medicinal plant knowledge such as plant constituents, stage, plant parts, dosage, routes of administration, preparation, recommendations and contraindications. Sequences of the plant constituents of the complex was recorded as free lists for each of the informants. Prior informed consents were taken from each of the informants. Plant mentioned in the complex were collected from nearby forests and home gardens of the informants and identified. Voucher specimens were deposited and also cross-checked with the earlier collections in the Life Sciences Department, Manipur University, Imphal. Nomenclature of the generic and specific epithets were standardized through the Plant List version 1.1 (Kalwij, 2012) [11]. Plants are classified according to the APG IV (Chase *et al*., 2016) [8].

Data Preparation and analysis

Formulations reported by each informants are coded and treated separately as R1, R2 and so on. Plants mentioned in each formulation were organized into a matrix with recipe code and plant names as mutually exclusive presence-absence descriptors. Recipe codes are arranged in rows while plant names are arranged in columns. Matrix was developed in the Microsoft Office Excel 365 version. The coding is 0 for absence and 1 for presence. Dissimilarity matrix was computed from the crude matrix by applying Sokal-Sneath index of dissimilarity. This index is selected as it is favorable for binary data of 0 and 1 and also a part of Euclidean distances.

A hierarchical agglomerative tree was also constructed by applying complete linkage criterion. Ward criterion was applied to update dissimilarity during the tree construction to search at each step for a local optimum. Principal coordinate analysis was also performed to determine diversity within the herbal complex (Obón *et al*., 2012) [19]. Close similarities between samples were verified with a weighted neighbour joining trees by using the criterion of relative neighbourhood, weighted average for dissimilarity updating and adjustment to an additive tree distance. Dissimilarity estimation, tree construction and principal coordinate analysis were done in DARwin 6.0.10 (Perrier *et al*., 2003; Perrier and Jacquemoud-Collet, 2006) [21, 22].

Conventional level of the salience are usually embedded in the sign systems and culture and cannot be changed arbitrarily (Obon *et al*., 2014) [18]. Differential level of the salience among the individuals reflect the contrast among items. As such, salience index were used to identify culturally key elements within the polyherbal formulation (Obon *et al*., 2014) [18]. Index was calculated for each medicinal plants in terms of frequency of citations. Salience indices of each of the plants were calculated as Sutrop Index (Bimler and Uusküla, 2021; Sutrop, 2001) [29] and Smith Index (Smith and Borgatti, 1997) [28] as per frequency of the cited items. Two different salience measures were used to provide aggregate result as both measures, sometimes, may provide differential results in one or two cases (Thompson and Juan, 2006) [31].

The Sutrop index was calculated using the formula S = F/ (N*mp), where F is the frequency of the medicinal plants in the free list, N the number of respondents and mP is the mean position of the medicinal plants. Mean position of the medicinal plants was calculated as mP = (Σr1)/F, where Σr1 is the sum of all individual ranks. The Smith index (Smith and Borgatti, 1997) [28] was calculated using the formula S = [Σ(L-R+1)/L]/N, where S is the cultural importance of item, N number of respondents, L is the length of the list and R is the citation rank of the item (medicinal plant). Relative frequency of citation was also expressed as the percentage of citations of medicinal plants in the recipes to the total number of citations. This measure and salience indices were calculated using Flame version 1.1, an add-in for the Microsoft Excel 1997 and later versions (Pennec *et al*., 2012) [20].

On the basis of the results from cluster analysis, recipes were grouped into separate categories. Salience indices and frequencies of the medicinal plant present in each category were again recomputed after removing the absentee data. Salience indices and relative frequency of citation of the medicinal plants were used to determine significant ingredients in each category. Indices with value greater than average value of the indices was considered as salient items (Vainik, 2003) [32].

Results

In the field study, 87 peoples were interviewed-72 in Jiribam and 15 in Agartala. Out of these, only 16 persons (14 in Jiribam and 2 in Agartala) were found to retain this knowledge. Analysis of the age profile of the informants indicated that most of the knowledge holders are above middle age (Table 1).

Table 1: Age profile of the informants

Age Group	Male	Female
Below 40	-	-
40-49	-	2
50-59	1	3
60-69	4	2
70-79	1	1
80-89	1	1
Total	7	9

Two informants in Jiribam provided two formulations each while remaining informants provided only one each, giving a total of 18 recipes. Recipes recorded in the study are presented in the following table (Table 2).

Table 2: Diversity of the recipes reported in the study

Recipe Code	Medicinal Plants (in order of freelisting)	Preparation	Colour	Storage	Organoleptic Property	Uses	Additives	Mode of administration	Overdose
R1	*Centella asiatica, Hydrocotyle sibthorpioides, Momordica charantia, Alocasia macrorhizos, Oldenlandia diffusa*	Boiled	Green	No	Bitter	Prutitis, Pneumonia		Drink, Wash	Strictly prohibited
R2	*Phyllanthus fraternus, Eclipta prostrata, Oldenlandia diffusa, Hydrocotyle sibthorpioides, Alocasia macrorhizos, Zingiber officinale, Centella asiatica*	Crushed	Green	No	Bitter	Measles, Fever, Pneumonia		Drink, Wash	Strictly prohibited

R3	*Hydrocotyle sibthorpioides, Phyllanthus fraternus, Eclipta prostrata, Oldenlandia diffusa, Centella asiatica, Alocasia macrorhizos, Zingiber officinale*	Crushed	Green	No	Bitter	Measles, Fever, Pneumonia	Honey	Drink, Wash	Strictly prohibited
R4	*Andrographis paniculata, Phlogacanthus thyrsiflorus, Nyctanthes arbor-tristis, Momordica charantia, Magnolia champaca, Entada phaseoloides, Azadirachta indica*	Boiled	Green	No	Bitter	Pruritis, Pneumonia	Honey	Drink	Strictly prohibited
R5	*Phyllanthus fraternus, Andrographis paniculata, Oldenlandia diffusa, Zingiber officinale, Piper nigrum*	Crushed	Green	No	Bitter	Pruritis, Pneumonia, Ulcer	Honey, Salt	Drink, Wash	Strictly prohibited
R6	*Phyllanthus fraternus, Magnolia champaca, Nyctanthes arbor-tristis, Andrographis paniculata, Oldenlandia diffusa, Murraya paniculata, Azadirachta indica*	Crushed	Green	Dried and Pellet	Bitter	Pneumonia		Eat	Strictly prohibited
R7	*Phlogacanthus thyrsiflorus, Azadirachta indica, Nyctanthes arbor-tristis, Clerodendrum glandulosum, Andrographis paniculata, Murraya paniculata, Nyctanthes arbor-tristis*	Crushed	Green	No	Bitter	Pruritis, Fever, Pneumonia		Drink, Wash	Strictly prohibited
R8	*Andrographis paniculata, Magnolia champaca, Momordica charantia, Phlogacanthus thyrsiflorus, Scutellaria discolor, Nyctanthes arbor-tristis, Clerodendrum glandulosum*	Boiled	Green	No	Bitter	Pruritis, Malaria, Fever, Pneumonia	Honey	Drink, Wash	Strictly prohibited
R9	*Clerodendrum glandulosum, Phlogacanthus thyrsiflorus, Azadirachta indica, Magnolia champaca, Nyctanthes arbor-tristis, Andrographis paniculata, Momordica charantia*	Crushed	Green	No	Bitter	Pruritis, Pneumonia		Drink, Wash	Strictly prohibited
R10	*Andrographis paniculata, Phlogacanthus thyrsiflorus, Nyctanthes arbor-tristis, Clerodendrum glandulosum, Oldenlandia diffusa, Scutellaria discolor, Momordica charantia*	Crushed	Green	No	Bitter	Pneumonia		Drink, Wash	Strictly prohibited
R11	*Andrographis paniculata, Phlogacanthus thyrsiflorus, Scutellaria discolor, Azadirachta indica, Murraya paniculata, Nyctanthes arbor-tristis*	Crushed	Green	No	Bitter	Prutitis		Wash	
R12	*Centella asiatica, Hydrocotyle sibthorpioides, Piper nigrum, Syzygium aromaticum, Momordica charantia, Dactyloctenium aegyptium, Phlogacanthus thyrsiflorus, Zingiber officinale*	Crushed	Green	No	Bitter	Measles		Wash	
R13	*Nyctanthes arbor-tristis, Clerodendrum glandulosum, Magnolia champaca, Andrographis paniculata, Phlogacanthus thyrsiflorus*	Crushed	Blackish Green	Dried and Pellet	Bitter	Fever, Pneumonia	Honey	Eat	Strictly prohibited
R14	*Magnolia champaca, Clerodendrum glandulosum, Phlogacanthus thyrsiflorus, Andrographis paniculata, Momordica charantia*	Crushed and Boiled	Green	No	Bitter	Prutitis, Pneumonia		Drink, Wash	Strictly prohibited
R15	*Andrographis paniculata, Phlogacanthus thyrsiflorus, Ocimum tenuiflorum, Nyctanthes arbor-tristis, Azadirachta indica, Scutellaria discolor, Momordica charantia*	Boiled	Blackish Green	No	Bitter	Prutitis, Fever, Pneumonia	Honey	Drink, Wash	Strictly prohibited
R16	*Phyllanthus fraternus, Eclipta prostrata, Oldenlandia diffusa, Hydrocotyle sibthorpioides, Alocasia macrorhizos, Zingiber officinale, Centella asiatica, Cyperus corymbosus*	Crushed	Green	No	Bitter	Fever, Pneumonia		Drink, Wash	Strictly prohibited
R17	*Justicia adhatoda, Azadirachta indica, Clerodendrum glandulosum, Andrographis paniculata, Momordica charantia, Centella asiatica, Aganosma heynei*	Crushed	Green	No	Bitter	Fever, Pneumonia		Drink, Wash	Strictly prohibited
R18	*Magnolia champaca, Azadirachta indica, Phlogacanthus thyrsiflorus, Toona ciliata, Dactyloctenium aegyptium, Clerodendrum glandulosum*	Crushed	Green	No	Bitter	Fever, Pneumonia		Drink, Wash	Strictly prohibited

Different recipes of the herbal complex were constituted of 25 medicinal plant species belonging to 20 families. Frequency of citation, relative frequency of citation and salience indices of the medicinal plants in the survey were reflected in the Table 3.

Table 3: Component medicinal plants with indices expressing frequency of citations

Sl No	Plant Name	Family	Vernacular Name (Manipuri)	FC	RFC	Smith Index	Sutrop Index
1	*Andrographis paniculata* (Burm.f.) Nees	Acanthaceae	Chirota, Bhubati	12	67%	0.465	0.235
2	*Phlogacanthus thyrsiflorus* Nees	Acanthaceae	Nongmangkha	11	61%	0.419	0.204
3	*Nyctanthes arbor-tristis* L.	Oleaceae	Singgarei	9	50%	0.292	0.132
4	*Momordica charantia* L.	Cucurbitaceae	Karon Akhabi	9	50%	0.191	0.098
5	*Clerodendrum glandulosum* Lindl.	Lamiaceae	Kuthap	8	44%	0.261	0.123
6	*Azadirachta indica* A.Juss.	Meliaceae	Neem	8	44%	0.247	0.111
7	*Magnolia champaca* (L.) Baill. ex Pierre	Magnoliaceae	Leihao	7	39%	0.295	0.151

8	*Oldenlandia diffusa* (Willd.) Roxb.	Rubiaceae	Linmarei	7	39%	0.205	0.097
9	*Centella asiatica* (L.) Urb.	Apiaceae	Peruk	6	33%	0.173	0.074
10	*Phyllanthus fraternus* G.L.Webster	Phyllanthaceae	Chakpa Heikru	5	28%	0.270	0.231
11	*Hydrocotyle sibthorpioides* Lam.	Araliaceae	Lai Peruk	5	28%	0.215	0.107
12	*Zingiber officinale* Roscoe	Zingiberaceae	Shing	5	28%	0.074	0.045
13	*Alocasia macrorrhizos* (L.) G.Don	Araceae	Yendem Angouba	4	22%	0.090	0.044
14	*Scutellaria discolor* Colebr.	Lamiaceae	Yenakhat	4	22%	0.093	0.044
15	*Eclipta prostrata* (L.) L.	Asteraceae	Uchi Sumbal	3	17%	0.136	0.071
16	*Murraya paniculata* (L.) Jack	Rutaceae	Kamini	3	17%	0.044	0.029
17	*Piper nigrum* L.	Piperaceae	Gun maru	2	11%	0.053	0.028
18	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Pungphai	2	11%	0.039	0.020
19	*Justicia adhatoda* L.	Acanthaceae	Nongmangkha angouba	1	6%	0.056	0.056
20	*Ocimum tenuiflorum* L.	Lamiaceae	Tulsi amuba	1	6%	0.040	0.019
21	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Myrtaceae	Laungpan, Laung	1	6%	0.035	0.014
22	*Toona ciliata* M.Roem.	Meliaceae	Tairen	1	6%	0.028	0.014
23	*Entada phaseoloides* (L.) Merr.	Fabaceae	Kangthro	1	6%	0.016	0.009
24	*Aganosma dichotoma* K.Schum.	Apocynaceae	Malati	1	6%	0.008	0.008
25	*Cyperus corymbosus* Rottb.	Cyperaceae	Chumthang	1	6%	0.007	0.007

Note: FC-frequency of citations, RFC-relative frequency of citations expressed as percentages; SR-summed rank

Highest mention was observed in *Andrographis paniculata*, followed by *Phlogacanthus thrysiflorus*, *Nyctanthes arbor-tristis* and *Momordica charantia*. Seven species of *Aganosma dichotoma*, *Cyperus corymbosus*, *Entada phaseoloides*, *Justicia adhatoda*, *Ocimum tenuiflorum*, *Syzygium aromaticum* and *Toona ciliata* were mentioned only once in the survey.

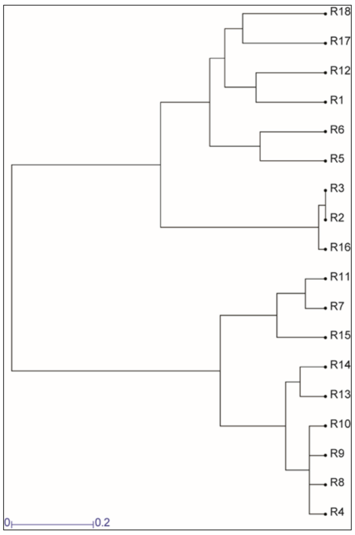

Fig 2: Trees generated by cluster analysis provides two groups of recipes.

Cluster analysis of the binary data matrix by applying ward criterion (Figure 2) provide two groups of recipes. First formulation was represented by the recipes-R1, R2, R3, R5, R6, R12, R16, R17 and R18. The second cluster was represented by the recipes nos. R4, R7, R8, R9, R10, R11, R13, R14 and R15. In the first cluster, four plants possessing highest frequencies were *Centella asiatica*, *Oldenlandia diffusa*, *Hydrocotyle sibthorpioides*, *Phyllanthus fraternus* and *Zingiber officinale and*. Out of these five, *Phyllanthus fraternus* possessed the highest Smith index and Sutrop index (Table 4).

Table 4: Medicinal plant groups present in the recipes of first cluster

Plant Names	F	RF	Smith Index	Sutrop Index
Centella asiatica	6	66.67%	0.345	0.148
Oldenlandia diffusa	6	66.67%	0.363	0.174
Hydrocotyle sibthorpioides	5	55.56%	0.430	0.214
Phyllanthus fraternus	5	55.56%	0.540	0.463
Zingiber officinale	5	55.56%	0.148	0.090
Alocasia macrorhizos	4	44.44%	0.179	0.089
Momordica charantia	3	33.33%	0.170	0.077
Eclipta prostrata	3	33.33%	0.272	0.143
Andrographis paniculata	3	33.33%	0.216	0.100
Azadirachta indica	3	33.33%	0.204	0.091
Piper nigrum	2	22.22%	0.106	0.056
Magnolia champaca	2	22.22%	0.206	0.148
Dactyloctenium aegyptium	2	22.22%	0.079	0.040
Phlogacanthus thrysiflorus	2	22.22%	0.102	0.044

Clerodendrum glandulosum	2	22.22%	0.098	0.049
Nyctanthes arbor-tristis	1	11.11%	0.079	0.037
Murraya paniculata	1	11.11%	0.032	0.019
Syzygium aromaticum	1	11.11%	0.069	0.028
Cyperus corymbosus	1	11.11%	0.014	0.014
Justicia adhatoda	1	11.11%	0.111	0.111
Aganosma heynei	1	11.11%	0.016	0.016
Toona ciliata	1	11.11%	0.056	0.028

Note: FC-frequency of citations, RFC-relative frequency of citations expressed as percentages; SR-summed rank

In the second cluster, *Andrographis paniculata* have the highest frequency of citation, followed by *Phlogocanthus thyrsiflorus*. In this group, *Phlogacanthus thyrsiflorus* have the highest Smith index and Sutrop Index followed by *Andrographis paniculata* (Table 5).

Table 5: Medicinal plant included in the recipes of second cluster

Plant Name	F	RF	Smith Index	Sutrop Index
Andrographis paniculata	9	100.00%	0.713	0.375
Phlogacanthus thrysiflorus	9	100.00%	0.737	0.391
Nyctanthes arbor-tristis	8	88.89%	0.505	0.229
Momordica charantia	6	66.67%	0.213	0.121
Clerodendrum glandulosum	6	66.67%	0.424	0.200
Magnolia champaca	5	55.56%	0.384	0.185
Azadirachta indica	5	55.56%	0.291	0.132
Scutellaria discolor	4	44.44%	0.185	0.089
Murraya paniculata	2	22.22%	0.056	0.040
Entada phaseoloides	1	11.11%	0.032	0.019
Oldenlandia diffusa	1	11.11%	0.048	0.022
Ocimum tenuiflorum	1	11.11%	0.079	0.037

Note: FC-frequency of citations, RFC-relative frequency of citations expressed as percentages; SR-summed rank

There are some plants common to both clusters indicating their importance. *Andrographis paniculata, Nyctanthes arbor-tristis, Phlogacanthus thyrsiflorus, Magnolia champaca, Clerodendrum glandulosum, Azadirachta indica, Momordica charantia, Oldenlandia diffusa, Phyllanthus fraternus* and *Hydrocotyle sibthorpioides* are common to both the clusters. Though some of the medicinal plants are common in both groups of formulations, their relative frequencies in both the formulations are different. Main components in each formulations are identified from medicinal plants having relative frequency of citation greater than 50% in each group.

Scatter diagram from the principal coordinate analysis with axes 1 and 2 segregate medicinal plants with higher relative frequencies into two distinct groups (Figure 3).

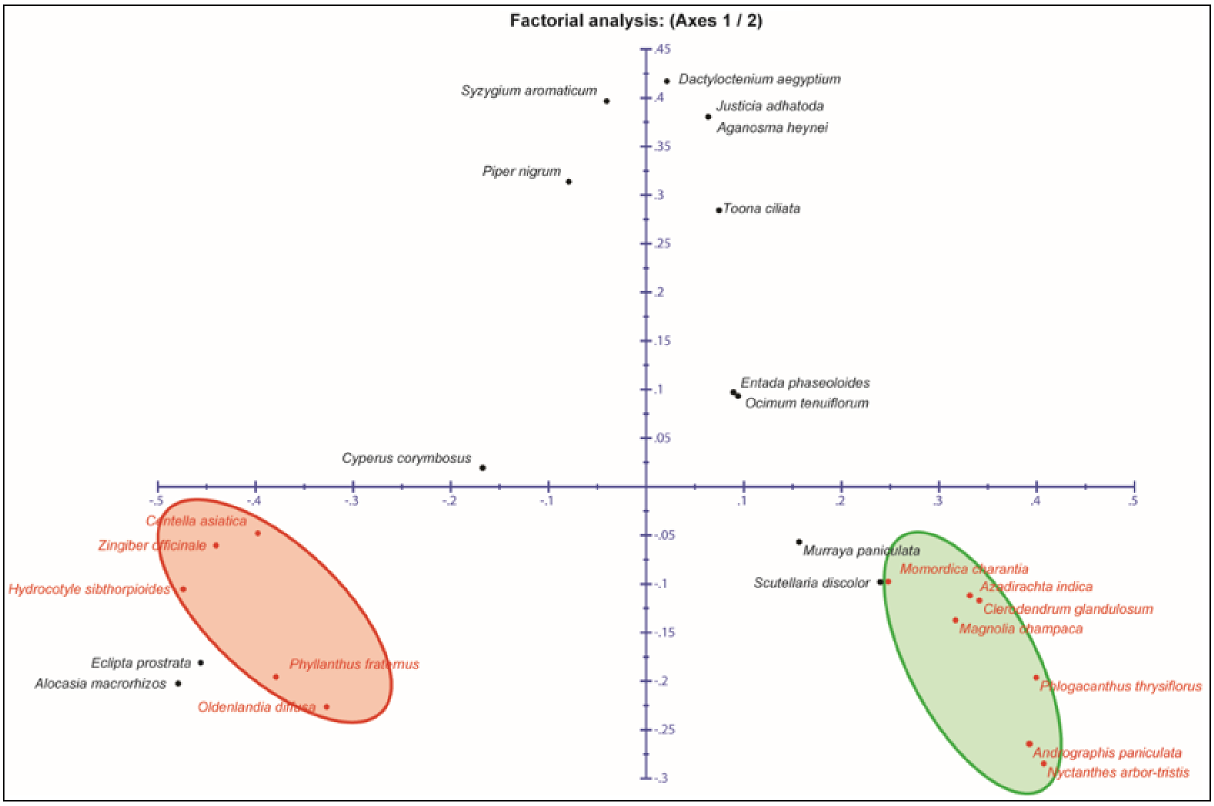

Fig 2: Scatter diagram for the two principal axes of the results of principal coordinate analysis of the *ST complex*

After selecting the plants possessing higher frequency of citations in each category, main components in two groups were determined.

Group #1

- **Main Components:** *Centella asiatica, Zingiber officinale, Hydrocotyle sibthorpioides, Phyllanthus fraternus* and *Oldenlandia diffusa*

Group #2

- **Main Components**: *Andrographis paniculata, Nyctanthes arbor-tristis, Phlogacanthus thyrsiflorus, Magnolia champaca, Clerodendrum glandulosum, Azadirachta indica* and *Momordica charantia*

Apart from their component medicinal plants, there were no distinct differentiation with regard to mode of preparation, uses, routes of administration and organoleptic properties.

Common characteristics

- **Organoleptic Property:** Bitter
- **Use:** Fever, malaria and pruritis
- **Preparation:** Crushed
- **Route of Administration:** Oral administration for diseases associated with fever; washing for skin related diseases
- **Overdose:** Strict prohibited

Discussion

In the study, only 18.40% of the total 87 persons were observed to retain the knowledge of ST complex. Two female informants below 50 years belonged to families of traditional healers and still remembering those practices. Apart from these two, most of the informants are above 50 years and no persons below 40 years have this knowledge. It reflects the regressive trend of this medicinal complex among the community. As expected for a dying knowledge, the number of informants retaining the knowledge of ST complex (16 informants) is low, cluster analysis is performed as the method is not unduly limited by the sample size (Mooi and Sarstedt, 2011) [15]. Moreover, as per the existing situation, increasing the survey size will not directly transform into discovering more persons retaining this knowledge. Cluster analysis and principal coordinate analysis have categorized two groups of formulations of ST complex. Medicinal plants having higher relative frequency are not always salient in the people's knowledge as they have lower values in Smith and Sutrop Indices. In the study, salient indices were used to determine the relative salience of terms within the domain. Smith Index and Sutrop Index have provided more or less similar data, with one or two variations. Salience values higher than their average in each Index are considered as significant. In the first group, *Centella asiatica, Oldenlandia diffusa, Hydrocotyle sibthorpioides, Phyllanthus fraternus, Eclipta prostrata, Andrographis paniculata, Magnolia champaca* and *Justicia adhatoda* were observed to higher salience among the people. In the second group, *Andrographis paniculata, Phlogacanthus thysiflorus, Nyctanthes arbor-tristis, Clerodendrum glandulosum* and *Magnolia champaca* have higher cultural salience among the informants. Items with the higher salient indices are those elements that respondents list most commonly and respondents tend to recall more immediately than other items (Thompson and Juan, 2006). Medicinal plants with higher salient indices are culturally noticed more quickly, probably because of their efficacies or familiarity. Interestingly plants with higher salient values, such as *Andrographis paniculata, Justicia adhatoda, Phyllanthus fraternus* are plants known for their applications in fever as monoherbal and polyherbal recipes (Chandra *et al*., 2010; Gandhi *et al*., 2014) [7, 9]. Even then, their therapeutic roles in this particular polyherbal complex can only be validated through pharmacological experiments.

The term '*salai taret*' literally means seven constituent clans of Meitei community having their own their own principalities in the past (Hodson, 1908) [10]. However, use of the phrase 'seven clan' in the present context seems to reflect the numerous components of the recipe. In spite of its name, number of the components of the recipe may be greater or less than seven. The word '*taret',* used in the present context, may literally means '*several'* instead of numeric seven. It is to be noted that 'several' is another meaning of the Manipuri word '*taret'*. In the present study it was observed that the complex is also known as "*Akhaba machal taret*" which literally means "complex of seven bitter components". As such, the word '*salai'* might be symbolic representation of the various components with their own unique medicinal properties. Though, most of these species shared organoleptic properties of the bitter, this characteristic was not shared by all the components. Therapeutic roles provided by these plants in the complex are yet to be identified.

Linkage of taste-perceptions and traditional herbal recipes may be originated from human physiology but also related to bio-cultural aspects (Pieroni and Torry, 2007) [23]. Importance of bitter taste in human healthcare were reported in many traditional medicine systems such as Traditional Chinese Medicine (Kastner, 2004) [12], Ayurveda (Svoboda, 1996) [30], Western Herbalism (Salguero, 2003) [25]. Use of bitter components in fever and antimalarials were observed in different parts of the world with their own folk beliefs (Salguero, 2003; Willcox and Bodeker, 2004) [25, 34]. For instance, many communities in West African countries favored bitter plants for the treatment of malaria, by considering that bitterness revived appetite and good for healthy body (Aikins *et al*., 1994) [1]. Bitter herbal preparations are also popular in North East India as medicinal food. Herbal mixture of Shuktani or Shukta was used as popular dish in social and religious functions by the Bengali community in Cachar district of Assam (Nath and Maiti, 2012) [16]. In Manipur, another preparation with similar name Shuktani was used by Meitei community by preparing from *Justicia adhatoda* for use as medicinal food for accelerating digestion (Singh and Huidrom, 2013) [26]. However, *Salai Taret complex* was distinct from such common bitter preparations by its use as febrifuge and strict regulations in dosage. In the case of *ST complex*, the recipe was not recommended as medicinal food but restricted only in critical medical conditions. Precautions associated with the overdose might be an indication of the toxicity present in the complex. Application of the recipe in various skin-diseases also indicate probable cytotoxic property of the complex. Variations in the medicinal plant ingredients in the complex may arise from various reasons. One probable reason was the specialization of the concerned herbal practitioner coupled with substitution of the plant constituents (Atherton, 1994) [2]. There were some minor components which may be present in all the recipes. These components might be incorporated later in the evolution of this recipe. Many known bitter medicinal plants did not find their place in this herbal complex characterized by 'bitterness', indicating that selection pattern of new components were not done in random.

Conclusion

In this work, multivariate analysis have been applied to characterize the polyherbal formulations of *Salai Taret* Complex. Application of cluster analysis and principal coordinate analysis could help in characterizing two types of formulations of the same complex from the data collected from ethnopharmacological field study. Polyherbal recipes are complex in that the medicinal plant present might exhibit either synergistic or antagonistic relationships. Study of this polyherbal complex would provide insight into the mechanisms of different bioactive compounds present. It needs further detailed analysis of the existing polyherbal formulation to determine plant selection pattern and the associated synergistic relationships between the constituents.

Acknowledgement

We are indebted to the people of Jiribam, Manipur and Agartala, Tripura for their cooperation and sharing their traditional knowledge, which formed the basis for this study. Authors are also thankful to the Department of Environment and Ecology, Government of Manipur for extending cooperation in the field study at Jiribam. We also express our gratitude to Mr. Khoisnam Mangol Singh and Mr. Rajkumar Tarunjit Singh of Agartala and Nongmaithem Pahari Memorial Trust, Imphal for providing invaluable service during the field study at Agartala.

References

1. Aikins MK, Pickering H, Greenwood B. Attitudes to malaria, traditional pracrices and bednets (mosquito nets) as vector control measures: a comparative. Journal of Tropical Medicine and Hygiene,1994:97:8l-86.
2. Atherton D. Towards the safer use of traditional remedies. BMJ: British Medical Journal,1994:308(6930), 673.
3. Bimler D, Uusküla M. Two Indices Are Better than One: Building on Robbins, Nolan, and Chen,2017:33(1):42-51.
4. Bussmann RW, Glenn A, Meyer K, Kuhlman A, ownesmith A. Herbal mixtures in traditional medicine in Northern Peru. Journal of ethnobiology and ethnomedicine,2010:6:10.
5. Cano JH, Volpato G. Herbal mixtures in the traditional medicine of Eastern Cuba. Journal of ethnopharmacology,2004:90(2-3):293-316.
6. Carmona MD, Llorach R, Obon C, Rivera D. "Zahraa", a Unani multicomponent herbal tea widely consumed in Syria: Components of drug mixtures and alleged medicinal properties. Journal of ethnopharmacology,2005:102(3):344-350.
7. Chandra R, Kumarappan C, Kumar J, Mandal S. Antipyretic activity of JURU-01-a polyherbal formulation. Global J Pharmacol (GJP),2010:4(1):45-47.
8. Chase MW, Christenhusz M, Fay M, Byng J, Judd WS, Soltis D *et al*. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society,2016:181(1):1-20.
9. Gandhi S, Shinde P, Avalaskar A, Rao S. Phytochemical Investigation and Antimicrobial Activity Testing of Phyllanthus fraternus Leaves Webster. Int J Pharmacognosy and Phytochemical Research,2014:6(3):444-448.
10. Hodson TC. The Meitheis. Low Price Publications, Delhi, 1908.
11. Kalwij JM. Review of 'The Plant List, a working list of all plant species'. Journal of Vegetation Science,2012:23(5):998-1002.
12. Kastner J. Chinese nutrition therapy: Dietetics in traditional Chinese medicine (TCM). Thieme, Stuttgart, 2004.
13. Kiyohara H, Matsumoto T, Yamada H. Combination Effects of Herbs in a Multi-herbal Formula: Expression of Juzen-taiho-to's Immuno-modulatory Activity on the Intestinal Immune System. Evid Based Complement Alternat Med,2004:1(1):83-91.
14. Mayanglambam G. Manipurda erat thouniron-ga loinarakpa hidaklon (Monograph on ritual hymns and chants of Manipur as sources of information on medicinal plants). The People's Museum, Kakching, Manipur, 2005.
15. Mooi E, Sarstedt M. Cluster Analysis, A concise guide to market research. Springer-Verlag, Berlin Heidelberg, 2011.
16. Nath A, Maiti G. Shuktani-a new ethno-medico recipe among the Sylheti Bengali community of Barak valley, Southern Assam, India. Indian J Trad Know,2012:11(1):156-160.
17. Ningthoujam SS, Talukdar AD, Potsangbam KS, Choudhury MD. Traditional uses of herbal vapour therapy in Manipur, North East India: an ethnobotanical survey. Journal of ethnopharmacology,2013:147(1):136-147.
18. Obon C, Rivera D, Alcaraz F, Attieh L. Beverage and culture. "Zhourat", a multivariate analysis of the globalization of a herbal tea from the Middle East. Appetite,2014:79:1-10.
19. Obón C, Rivera D, Verde A, Fajardo J, Valdés A, Alcaraz F *et al*. Árnica: A multivariate analysis of the botany and ethnopharmacology of a medicinal plant complex in the Iberian Peninsula and the Balearic Islands. Journal of ethnopharmacology,2012:144(1):44-56.
20. Pennec F, Wencelius J, Garine E, Raimond C, Bohbot H. Flame 1.1: Free-List Analysis under Microsoft Excel. Le Centre national de la recherche scientifique, Paris, 2012.
21. Perrier X, Flori A, Bonnot F. Data analysis methods, in: Hamon, P., Seguin, M., Perrier, X., Glaszmann, J.C. (Eds.), Genetic diversity of cultivated tropical plants. Science Publishers. Montpellier, Enfield, 2003, 43-76.
22. Perrier X, Jacquemoud-Collet JP. DARwin software, 2006.
23. Pieroni A, Torry B. Does the taste matter? Taste and medicinal perceptions associated with five selected herbal drugs among three ethnic groups in West Yorkshire, Northern England. J Ethnobiol Ethnomed,2007:3:21.
24. Pucot J, Demayo CJBJOBD. Polyherbal formulations and other folk medicines used by the healers and locals

of Aurora, Zamboanga del Sur, Philippines. Biodiversitas, 2021, 22(12).
25. Salguero CP. Thai Herbal. Findhorn Press Scotland, 2003.
26. Singh KJ, Huidrom D. Ethnobotanical uses of medicinal plant, Justicia adhatoda L. by Meitei community of Manipur, India. Journal of Coastal Life Medicine,2013:1(4):322-325.
27. Singh NT, The Pan-Manipuris, in: Naorem, S. (Ed.) Manipur, Past and Present: The Heritage and Ordeals of a Civilization, Mittal Publications, New Delhi, 2003, 4.
28. Smith JJ, Borgatti SP. Salience Counts-And So Does Accuracy: Correcting and Updating a Measure for Free-List-Item Salience. Journal of Linguistic Anthropology,1997:7(2):208-209.
29. Sutrop U. List Task and a Cognitive Salience Index. Field Methods,2001:13(3):263-276.
30. Svoboda RE. Prakriti Your Ayurvedic Constitution. Motilal Banarsidass Publ, 1996.
31. Thompson EC, Juan Z. Comparative cultural salience: measures using free-list data. Field Methods,2006:18(4):398-412.
32. Vainik E. Lexical knowledge of emotions: the structure, variability and semantics of the Estonian emotion vocabulary, Department of Lexicology, Institute of the Estonian Language. University of Tartu., Tartu, 2003.
33. Vandebroek I, Balick MJ, Ososki A, Kronenberg F, Yukes J, Wade C *et al*. The importance of botellas and other plant mixtures in Dominican traditional medicine. Journal of ethnopharmacology,2010:128(1):20-41.
34. Willcox ML, Bodeker G. Traditional herbal medicines for malaria. BMJ: British Medical Journal,2004:329(7475):1156-1159.