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ORIGINAL RESEARCH ARTICLE

Quantitative Ethnobotanical Study of Medicinal Plants Used by the People of Bandhakhola Village, Gazipur, Bangladesh

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Abstract: **The rural people of Bangladesh still depend on the use of medicinal plants to treat simple health problems. These uses are more common in countryside areas of Bangladesh, where advanced medical facilities are sparse. This practice also proliferates in areas that are rich in plant species diversity. An ethnobotanical survey was conducted in the Bandhakhola village of Gazipur. This study aimed to identify the most important medicinal plants in this region. The collected data was analyzed with two different quantitative tools, namely Factor informant consensus (Fic) and Fidelity level (Fl). With the fic and number of informants, the main categories of diseases were detected and scored. Among the disease categories, Respiratory disease (Fic-0.82), First aid (Fic-0.76), and Gastrointestinal diseases (Fic-0.58) were found to be the most important. Using the second tool, Fl, and the number of informants, the most important species from these categories were selected. The results showed *Justicia adhatoda*, *Aerva sanguinolenta*, and *Litsea glutinosa* as the most used medicinal plants in the Respiratory disease, First aid, and Gastrointestinal diseases categories, respectively. When two factors are considered, it was shown that the five most important medicinal plants of this area are *Justicia adhatoda*, *Azadirachta indica*, *Centella asiatica*, *Ocimum sanctum*, and *Cynodon dactylon*. The results of this study can help scientists to carry out advanced ethnopharmacological studies in this region.**

Keywords: Ethnomedicinal plants; Informant consensus factor; Fidelity level; Gazipur.

From ancient times people of Asia are familiar with the use of medicinal plants. The famous alternate medical system used throughout the world- "Ayurveda", has originated from this subcontinent. The use of medicinal plants to treat diseases is a cultural practice in this region (1). This particular cultural practice of this territory makes it a suitable candidate for conducting an ethno-pharmacological field study. Several ethno-pharmacological studies have been conducted in Bangladesh to expand our understanding about endogenous knowledge. Most of these researches were focused on endogenous ethnic groups. Studies have been conducted on the ethnobotanical knowledge of the Chakma, Rakhain, Marma, Tanchayanga communities of Bangladesh (2–5). Few studies were also targeted at the ethnobotanical understanding of the people of the flat plain, e.g., Barishal, Jessore, etc. (6,7). Such ethnobotanical studies not only facilitated ethnobotany research, but it also enhanced the conservation of endangered medicinal plants and even contributed on the preservation of important natural cites. These explorations carry profound importance not only because of their scientific value, but also due to their role in preserving the endogenous knowledge of a community. Preservation of endogenous knowledge is considered to be one of the factors for the sustainable development of rural communities (8).

The main resource of the rural Bangladesh is its lustrous, green, diversified plant community. This plant diversity is comprised of about 6500 species belonging to various plant families (9). Among all these plants, about 500 species are known to have significant medicinal values (10). Study of these medicinal plants are crucial as the understanding of the traditional use of these herbs as medicines can lead us to understand the rational exploitation and their development as phytomedicines. The gradual increase of medicinal plants use worldwide has led to a disastrous state for these species. According to one study now about 15000 medicinal plant species are at the risk of extinction. Habitat destruction and over-exploitation of these plant species are responsible for this situation (11).

Special conservation methods must be undertaken to preserve these valuable plants. One of the best

conservation methods includes community-based conservation. It has been reported that when an endogenous community gets involved in the conservation plan that yields the long-term success (12). Ethnobotanical studies are such fields of biology that can enhance and nurture the relationship between a community and its surrounding medicinal plants (13,14). Because medicinal plants are culturally suitable as treatments for several diseases, it is important to document their uses and to perform studies about their pharmacological activities to assure their efficacy and safety. The endogenous knowledge of medicinal plants reveals non-conventional treatments. Such non-conventional use of medicinal plants often gets ignored by the current scientific literature. However, it is of immense importance that this knowledge is recorded and preserved as this information could open up a new area of research in the near future.

The aim of this work is to present the results of an ethnopharmacological field survey conducted in the village, named- "Bandhakhola", Gazipur, Bangladesh. This small village, although very close to town, lacks an efficient health service. Due to the lack of such facilities, only a small number of people received an official health service, that is, if they are able to reach the town. To treat common ailments, the inhabitants entirely depend on their knowledge of medicinal plant use. The data were collected through direct interviews with the residents of the village. The data collected from the interviewees were analyzed using two different quantitative tools. The purpose of using these tools was to select the most important medicinal plant species used as a traditional medicine in this community. This data was also helpful to list the important medicinal plants of this area which could probably help to explore the flora of this region.

MATERIALS AND METHOD

Data collection site

The data collection area was a village of Bangladesh, named "Bandhakhola"; under- Nagori post office, Kaligonj Thana, Gazipur district, and Dhaka division. The population of this village was about 1 to 2 thousand. The demography is mainly Christian and Hindu in religion. This small village is located at 23˚55'39.28''N and 90˚31'21.27''E, at about 6 meter above sea level. The weather is humid with an annual mean temperature of 26.1˚C, having an annual mean rain precipitation of 2376 mm. In terms of structural capacity, the village has only one primary school, and no established hospitals. During this study about 7% of the population of the village was covered. The resource map and the households that were visited are shown in Figure 1.

Data collection

Direct interviews with the people were performed in some short visits using a questionnaire. The questionnaire contained an open and a semi-structured question. Different houses of the village were visited in a random order. The open question was: "Name some of the plants you generally use to treat diseases". Then on the basis of their answer, the semi structured question was about the (i) use, (ii) parts used, and (iii) manner of use for each plant mentioned. Then with the help of the informants, the botanical material was collected (if needed). With the help of different books and websites, the binomial plant names were revised, and listed.

Figure 1. The resource map and the households (yellow circles) covered during the interview session.

Quantitative analysis

(i) Factor informant consensus (Fic)

The results of the direct interviews were analyzed using two quantitative tools. For the analysis of the general use of plants, the factor informant consensus (Fic) were used (15). The factors were used to highlight the agreement in the use of that particular plant. To use this tool, the mentioned diseases were classified into broad disease categories (several diseases were placed in one category on the basis of organ). e.g., (1) gastrointestinal, (2) respiratory, (3) dermatological etc. As a result of this analysis, it was possible to see if there was an agreement in the use of plants in the disease categories between the populations. The Fic was calculated using the following equation:

$$FIC = \frac{nur - nt}{nur - 1}$$

Here, *nur* = number of use citations in each category,

nt = number of species used.

(ii) Fidelity level (Fl)

The fidelity level (Fl) is the ratio between the number of informants who independently suggested the use of a species for the same major purpose and the total number of informants who mentioned the plant for any use (16). The following equation was used to calculate Fl:

$$FI(\%) = \frac{NP}{N} \times 100$$

Where, Np = number of informants that claimed a use of a plant species to treat a particular disease.

N = number of informants that used the plants as a medicine to treat any given disease.

(iii) Use-mentions (Um)

Use-mentions (Um) refers to the mentions for one plant given by all the informants for a specific disease.

RESULTS AND DISCUSSION

Plant identification and documentation

The current study aims to determine and explore the most important medicinal plants used by the local inhabitants of "Bandhakhola" village, Gazipur, Bangladesh. To investigate, direct interview was taken of 70 peoples of the village. Which covers about 7% of the total village population. The interviewees mentioned about 64 plants which they use in their regular life for medicinal purposes. In addition, they also provided the following information: parts of the plant used for medicinal purpose, preparation of the medication, disease treated, and other identifying characters of the plant. The data obtained from all the interviewees were analyzed, categorized, and listed. Using the identification information, photographs, and herbarium specimen, the scientific binomial names of all the medicinal plant specimen were listed on Table 1.

Selection of plants with highest use-mention number

Through the analysis of this data, it was evident that the use of medicinal plants is a normal practice for the people of this village. All the informants (100%), use medicinal plants to treat at least some simple ailments. However, all the informants did mention to visit physicians for complicated illnesses. People collect the plants from area surrounding their home, gardens, forests, etc. At home garden they usually collect plants like *Tagetes erecta*, *Ocimum sanctum*, etc. From their surroundings they gather, *Azadirachta indica*, *Coccinia cordifolia*, etc. plants. The plants with the major number of use-mentions for any disease are shown in Figure 2, only top eight has been selected for representation. Based on the participants data, both *Justicia adhatoda* and *Azadirachta indica* are the plants that were mentioned by highest number of informants (40), followed by both *Centella asiatica* and *Ocimum sanctum*, where 37 informants mentioned about them. Similar ethnobotanical study was carried out in the Batiaghata, Khulna region of Bangladesh where author found *Mangifera indica* as the highest used plant (17).

Disease categorization and fidelity level (Fl) analysis

Based on the participants data regarding the diseases, all the diseases were categorized into 14 categories (Table 2). Then the most important plants for each disease category were identified using the fidelity level (Fl). For fidelity level (Fl) analysis, the plants only mentioned once were not considered. The Fl percentage of all 64 plants were presented in Table 1. It was observed that, for the respiratory category, the most important species, according to their fidelity and number of informants are: *Justicia adhatoda* (Fl-100), *Ocimum sanctum* (Fl-97.3), and *Clerodendrum viscosum* (Fl-50). For the first aid category: *Aerva sanguinolenta* (Fl-100), *Tagetes erecta* (Fl-100), and *Cynodon dactylon* (Fl-86.96). For the gastrointestinal category, the most important plants are: *Litsea glutinosa* (Fl-61.53), *Achyranthes aspera* (Fl-60), *Centella asiatica* (Fl-35.14). An ethnobotanical study conducted in the Noakhali region of Bangladesh also carried out similar analysis and determined that in that region *Aegle marmelos* has the highest Fl value followed by *Azadirachta indica* (18).

Factor informant consensus (Fic) analysis

The other tool that was used is this study was the factor informant consensus (Fic). The results of the Fic showed that the cardiovascular category (Fic-1) had the greatest agreement, followed by macro parasitic diseases (Fic-0.92) and skeletal (Fic-0.89). But considering the number of informants (nur), the most important categories were, as follows: 1. Respiratory (Fic-0.82; nur-50), 2. First aid (Fic-0.76; nur-43), and 3. Gastrointestinal (Fic-0.58; nur-57). The least agreement between the informants was observed in the hair diseases and muscular inflammation (the results were in minus), followed by diabetes (Fic-0.11) and liver disease (Fic-0.25) (Figure 3). Interestingly, a similar study that was carried out in Rangamati district of Bangladesh where they found gastrointestinal or digestive system disorders with highest Fic value (19). This change might indicate that profound influence of environment in public health (20). It has been reported

that in Bangladesh, Gazipur district has one of the worst air quality due to the presence of numerous industrial factories (21). This suggest that the overwhelming respiratory disease occurrence in this area is due to its bad air quality.

The goal of this ethnopharmacological study was to find out the leading medicinal plants used in this region.

By considering two factors (Fic and Fl) it can be concluded that the five topmost important plants for medicinal purpose, of the village "Bandhakhola" are: 1. *Justicia adhatoda*, 2. *Azadirachta indica*, 3. *Centella asiatica*, 4. *Ocimum sanctum*, and 5. *Cynodon dactylon*. The plants listed above should be further explored for future ethnopharmacological studies.

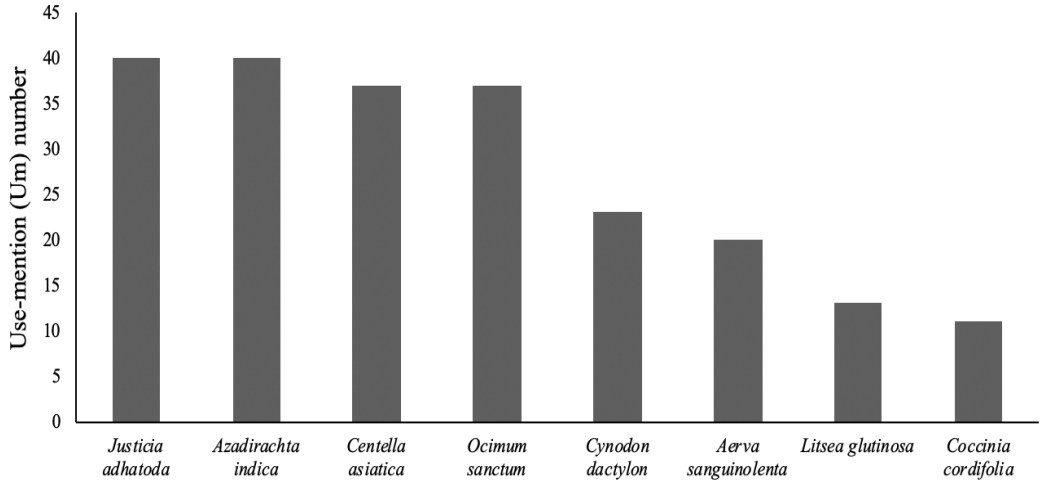

Figure 2. Medicinal plants with the highest number of use-mentions (Um).

Table 1. List of medicinal plants, their use, use-mention, and fidelity percentage.

Sl.	Scientific name	Local name	Used part	Disease	Um	Preparation	Application	Fl (%)	Category
1	*Justicia adhatoda*	Basak	Leaf	Cough	40	Juice	Oral	100	2
2	*Centella asiatica*	Thankuni	Leaf stem	Stomachache	13	Paste	Oral	35.14	1
			Leaf	Gastritis	3	As vegetable	Oral	8.11	1
			Leaf	Dysentery	13	Juice	Oral	35.14	1
			Leaf	Memory tonic	2	Juice	Oral	5.41	14
			Leaf	Cold	5	Juice	Oral	13.51	2
			Leaf	Diabetes	2	Juice	Oral	5.41	6
			Leaf	Gynecological disease	1	Juice	Oral	2.7	14
			Leaf	Leukoderma	3	Juice	Oral	8.11	3
3	*Ocimum sanctum*	Tulsi	Leaf	Cold, cough	36	Juice	Oral	97.3	2
			Leaf	Hoarseness	1	Juice	Oral	2.7	2
			Leaf	Ringworm	2	Juice	External	5.41	3
4	*Azadirachta indica*	Neem	Leaf	Skin disease	11	Paste + turmeric	External	27.5	3

			stem	Tooth care	3	As toothbrush	Oral	7.5	9
			Leaf	Pox	3	Paste	Exter-nal	7.5	3
			Leaf	Diabetes	2	As vegetable (dried)	Oral	5	6
			Leaf	Dysentery	2	As vegetable (dried)	Oral	5	1
			Leaf	Helminthiasis	11	As vegetable (dried)	Oral	27.5	12
			Leaf	Stomachache	6	As vegetable (dried)	Oral	15	1
			Leaf	Scab/itch	2	Paste	Exter-nal	5	3
			Leaf	Low appetite	2	As vegetable (dried)	Oral	5	1
			Leaf	Diarrhea	2	As vegetable (dried)	Oral	5	1
			Leaf	Gastritis	2	As vegetable (dried)	Oral	5	1
5	*Crataeva religiosa*	Boinna pata	Leaf	Gout	4	Paste	Exter-nal	100	8
6	*Terminalia arjuna*	Arjun	Stem bark	Heart disease	5	Powder, Paste	Oral	100	5
7	*Cissus quadrangularis*	Harbhanga	Whole plant	Bone fracture	9	Fractured area is wrapped with this vine	Exter-nal	100	10
8	*Momordica charantia*	Korolla	Fruit	Diabetes	2	Juice, as vegetable	Oral	100	6
9	*Syzygium cumini*	Jam	Fruit	Diabetes	1	Juice	Oral	-----	6
10	*Mangifera indica*	Aam	stem bark	Chronic dysentery	1	Juice	Oral	-----	1
11	*Achyranthes aspera*	Nengra, Habra	Leaf	Jaundice	1	Juice	Oral	10	11
			Leaf	Constipation	6	Juice	Oral	60	1
			Leaf	Gastritis	2	Paste	Oral	20	1
			Leaf	Sunstroke/dehydration	1	Paste	Oral	10	14
			Leaf	Dysentery	1	Paste	Oral	10	1
			Leaf	Stomachache	1	Paste	Oral	10	1
12	*Coccinia indica*	Telakuch, kuchila	Leaf	Diabetes	4	Juice	Oral	33.33	6
			Leaf	Cough	1	Paste	Oral	8.33	2
			Leaf	Weakness	1	As vegetable	Oral	8.33	14
			Leaf	Gastritis	1	Juice	Oral	8.33	1
			Leaf	Jaundice	2	Juice	Oral	16.67	11

			Leaf	Wound	1	Paste	External	8.33	13
			Stem base	Dysentery	1	Juice	Oral	8.33	1
			Leaf	Stomachache	1	Juice	Oral	8.33	1
13	*Cuscuta reflexa*	Shunnolota	whole plant	Cold	1	Paste, Juice	Oral	25	2
			whole plant	Hair tonic	1	Paste, Juice	External	25	4
			whole plant	Wound	2	Paste, Juice	External	50	13
14	*Moringa oleifera*	Shajna	bark	Body pain	3	Paste, Juice	Oral	100	7
15	*Basella alba*	Pui shak	Leaf	Weakness	1	As vegetable	Oral	-----	14
16	*Ipomoea aquatica*	Kolmi shak	Leaf, stem	Weak eye sight	2	As vegetable	Oral	50	14
			Leaf, stem	Weakness	2	As vegetable	Oral	50	14
17	*Enhydra fluctuans*	Helencha	Leaf	Weak eyesight	1	As vegetable	Oral	50	14
			Leaf	Weakness	1	As vegetable	Oral	50	14
18	*Colocasia esculenta*	Kochu	Leaf	Dysentery	1	As vegetable	Oral	20	1
			Young Leaf	Wound	2	Paste	External	40	13
			Leaf, stem	Anemia	1	As vegetable	Oral	20	14
			Leaf	Gout	1	As vegetable	Oral	20	8
19	*Alocasia macrorrhizos*	Mankochu, fenkochu	Leaf, stem	Severe pain	1	As vegetable	Oral	50	7
			Leaf, stem	Weakness	1	As vegetable	Oral	50	14
20	*Kalanchoe pinnata*	Pathorchuni	Leaf	Dysentery	2	Paste, Juice	Oral	100	1
21	*Andrographis paniculata*	Kalomegh, kolponati	Leaf	Helminthiasis	4	Juice	Oral	50	12
			Leaf	Diabetes	1	Juice	Oral	12.5	6
			Leaf	Stomachache	2	Juice	Oral	25	1
			Leaf	Constipation	1	Juice	Oral	12.5	1
			Leaf	Cold	2	Juice or as vegetable	Oral	25	2
22	*Calotropis gigantea*	Apon pata	Leaf	Gout	1	Fomentation	External	-----	8
23	*Aerva sanguinolenta*	Lal pata	Leaf	Wound	20	Paste, Juice	External	100	13

24	*Cynodon dactylon*	Durba ghash	Leaf, stem	Wound	20	Paste	External	86.96	13
			Leaf	Gynecological disease	1	Juice	Oral	4.35	14
			Leaf	Stomachache	1	Juice + turmeric	Oral	4.35	1
			Leaf	Mouth sore	1	Chewed	Oral	4.35	3
			Leaf	Hair tonic	1	Soaked in coconut oil	External	4.35	4
25	*Tagetes erecta*	Genda phul	Leaf	Wound	9	Paste	External	100	13
26	*Aegle marmelos*	Bel	Fruit	Stomachache	2	Juice	Oral	66.67	1
			Fruit	Constipation	1	Juice	Oral	33.33	1
27	*Clerodendrum viscosum*	Bhait	Young Leaf	Cough of baby	1	Paste + ginger	Oral	50	2
			Young Leaf	Dysentery	1	Paste	Oral	50	1
28	*Leucas aspera*	Dondo-kolosh	Leaf	Cough	1	Juice	Oral	1.43	2
				Dysentery	1	Juice	Oral	1.43	1
29	*Litsea glutinosa*	Karjoli, karjolti, bijlamonda	Leaf	Dysentery	4	Paste/Juice + sugar	Oral	30.77	1
			Leaf	Severe constipation	8	Juice	Oral	61.54	1
			Leaf	constipation	1	Juice	Oral	7.69	1
30	*Punica granatum*	Dalim	Leaf	Diarrhea	1	Juice	Oral	50	1
			Leaf	Burn injury	1	Dried, then thrashed delicately and then applied	External	50	13
31	*Mikania cordata*	Sagor pata	Leaf	Wound	1	Paste, Juice	External	------	13
32	*Hibiscus rosa-sinensis*	Roktojoba	Leaf	Wound	1	Juice	External	------	13
33	*Citrus* sp.	Lebu	Fruit	Hair falls problem	1	Juice	External	-----	4
34	*Lens esculenta*	Mosur dal	Seed	Hair falls problem	1	Paste	External	-----	4
35	*Zingiber officinale*	Ada	Rhizome	Stomachache	3	Paste + salt	Oral	60	1
				Nausea	2	Pieces are chewed + salt	Oral	40	1
36	*Brassica napus*	Sorisha	Seed	Body pain	1	Oil + garlic	External	----	7
37	*Justicia gendarussa*	Bishjaron	Leaf	Gout	1	Paste	External	----	8
38	*Cyperus rotundus*	Bhadla ghash	Rhizome	Bone fracture	1	Thrashed and mixed with mustard oil,	External	-----	10

						then applied on the fractured area			
39	*Cajanus cajan*	Arhar	Leaf	Jaundice	1	Powder + turmeric + coconut oil	Oral	----	11
40	*Borassus flabellifer*	Taal	Young Leaf	Cold	1	Burnt then taken as Juice	Oral	-----	2
41	*Citrus sinensis*	Komola	Peel	Jaundice	1	Dried then soaked with water + *Coccinia cordifolia*	Oral	-----	11
42	*Ficus hispida*	Dumur	Leaf	Body pain	1	Juice	Oral	33.33	7
			Fruit	Dysentery	1	As vegetable	Oral	33.33	1
			Fruit	Stomachache	1	Fried in oil then eaten	Oral	33.33	1
43	*Typhonium trilobatum*	Kharkan	Leaf	Gout	2	As vegetable with *Colocasia* sp.	Oral	100	8
44	*Allium cepa*	Piyaz	Bulb	Skin problem	1	Paste	External	50	3
			Bulb	Hair problem	1	Juice applied on skull skin	External	50	4
45	*Phyllanthus emblica*	Amloki	Fruit	Constipation	1	Soaked in water and then drink it	Oral	20	1
			Fruit	Hair problem	1	Juice	External	20	4
			Fruit	Low appetite	3	Dried, then chewed/directly chewed/Juice	Oral	60	1
46	*Eupatorium triplinerve*	Bisholla-koroni	Leaf	Wound	1	Paste	External	-----	13
47	*Cocos nucifera*	Narikel	Young fruit	Diarrhea	3	Coconut milk	Oral	60	1
			Young fruit	Jaundice	1	Coconut milk	Oral	20	11
			Root	Tooth gum pain	1	Paste	External	20	9
48	*Swietenia mahagoni*	Mehogoni	Seed	Diabetes	1	Paste	Oral	-----	6
49	*Xanthosoma violaceum*	Dudh kochu	Leaf	Body pain	1	Paste	External	-----	7
50	*Alocasia cucullata*	Bish kochu	Leaf	Body pain	1	Paste	External	-----	7
51	*Mentha arvensis*	Pudina	Leaf	Stomachache	1	Juice	Oral	----	1
52	*Saccharum officinarum*	Aakh	Stem	Jaundice	1	Juice	Oral	----	11
53	*Psidium guajava*	Peyara	Young leaf	Toothache	3	Juice/Paste	External	100	9
54	*Curcuma longa*	Holud	Rhizome	Skin disease	2	Paste	External	100	3

55	*Lawsonia inermis*	Mehedi	Leaf	Nail disease	2	Paste	Exter-nal	100	3
56	*Vinca rosea*	Noyontara	Leaf	Diabetes	1	chewed	Oral	-----	6
57	*Corchorus* sp.	Pat shak	Leaf	Low appetite	2	As vegetable	Oral	100	1
58	*Curcuma zedoaria*	Shothi	Rhizome	Dysentery	1	Paste	Oral	----	1
59	*Tinospora cordifolia*	Gulanchi	Leaf	Scab/itch	1	The opposite side of the Leaf applied on the diseased area	Exter-nal	----	3
60	*Phyllanthus reticulatus*	Chitki	Leaf	Diarrhea	1	Juice	Oral	----	1
				Dysentery		Juice	Oral		1
61	*Glycosmis pentaphylla*	Motkila	Leaf	Dysentery	1	Paste + turmeric	Oral	----	1
62	*Zizipus mauritiana*	Boroi	Leaf	Cold	1	Paste/directly eaten	Oral	-----	2
63	*Elettaria cordamomum*	Elachi	Seed	Hoarseness	1	Mixed with tea + *Cinnamomum verum* bark	Oral	----	2
64	*Musa* sp.	Kachkola	Fruit	Anemia	1	As vegetable	Oral	-----	14

Table 2. Category of diseases based on informant's data.

Sl.	Category	Disease
1	Gastrointestinal	Gastritis
		Dysentery
		Stomachache
		Diarrhea
		Severe constipation
		Vomiting
		Low appetite
		Constipation
2	Respiratory	Cough
		Cold
		Hoarseness
3	Dermatological	Skin disease
		Ring worm
		Leukoderma
		Nail disease
		Pox
		Mouth sore

		Conjunctivitis of eye
4	Hair diseases	Hair fall
		Blackening hair
		Hair care
5	Cardiovascular	Heart disease
6	Diabetes	Diabetes
7	Muscular inflammation	Body pain
8	Arthritis	Gout
9	Dental	Tooth ache
		Tooth care
		Tooth gum pain
10	Skeletal	Bone fracture
11	Liver disease	Jaundice
12	Macro parasitic diseases	Helminthiasis
13	First aid	Wound
		Blood clotting
		Burn
14	Others	Weakness
		Weak eyesight
		Dehydration
		Memory tonic
		Gynecological disease

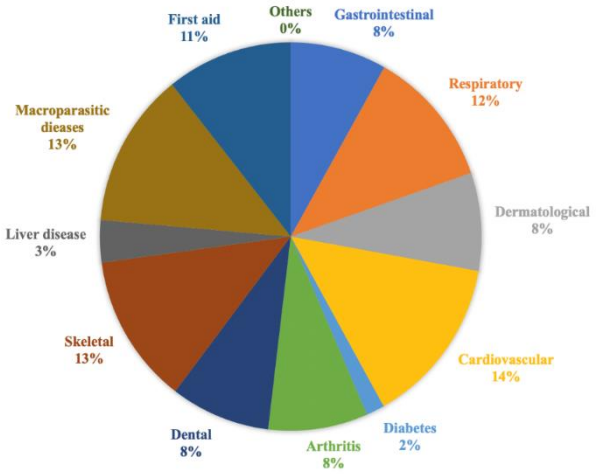

Figure 3. Factor informant consensus (Fic) of different disease categories shown in percentage.

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CONFLICT OF INTEREST

This article has no conflict of interest.

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