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Ethnomedicinal Practices of the Santal Tribe Living Around Biharinath Hill in the District of Bankura, West Bengal, India

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ABSTRACT

The present investigation encompasses the ethnomedicinal uses of plants utilized by the Santal people living adjacent to Biharinath hill in the district of Bankura, West Bengal. Ethnomedicinal data were obtained from the Santal informants (medicine men and knowledgeable persons) through semi-structured interviews. Before collection of the data Free, Prior Informed Consent (FPIC) was taken from each informant to ensure their intellectual property rights. The collected data have been evaluated using suitable statistical indices, viz. Informant Consensus Factor (Fic) and Cultural Value Index (CV) to recognize the most significant ethnomedicinal plant species used in the surveyed region. In total, 78 plant species have been recorded and they are utilized in the area for treatment of 37 health disorders. The root (31.6%) is the most recurrently used plant part in the recorded formulations. The Birth/Puerperium Disorders and Sensory System Disorders obtained the highest Fic value, i.e., 1. Based on the values of the CV index, the top ranked 25 taxa have been identified, namely *Asparagus racemosus* Willd., *Soymida febrifuga* (Roxb.) A. Juss., *Byttneria herbacea* Roxb., etc. The documentation of such ethnomedicinal knowledge will enrich the data base of the district as well as the country, but scientific validation of the documented ethnomedicinal claims is needed.

Key words: Ethnomedicinal uses, Biharinath hill, Informant consensus factor, Cultural value index

Ethnomedicine is the study of human health, related illnesses and healing systems traditionally practiced in a particular culture. This practice is based on the beliefs and experiences of ethnic people. Ethnomedicinal knowledge is passed on orally from competent peers to the next generation. Over time, the flow of such ethnic knowledge has been gradually diminished due to cultural erosion, modernization and lack of interest of the younger generation in learning such age-old cultural tradition. Thus, documentation of such knowledge is gaining more and more priority around the world in order to conserve ancient cultural practices. Like other parts of the world, Ethnobotanists from all over India are engaged in documenting ethnobotanical information. Similarly, in West Bengal, a good number of ethnobotanists are working in this field. But a few scattered ethnobotanical works have been performed [1-5] till date in the Bankura district. But no such type of research work has been carried out in the tribal-infested villages surrounding Biharinath Hill in Bankura. In this background, the present research programme was planned to document the traditional knowledge regarding the therapeutic uses of medicinal plants in treating various disorders of human

beings. This study will also help in preparation of the district's ethnomedicinal database.

MATERIALS AND METHODS

The district Bankura is one of the five districts of the Medinipur administrative division of West Bengal. It is located between 22°46' to 22°38' N and 86°36' to 87°46' E. The geographical area of the district is 6882 km² and its total forest area is 1482 km² (21.53% of the entire land area of the district). Total population of the district is 3596674 and district's scheduled tribe population is 368690 (10.25% of overall population of the district) [6]. Bankura district is designated as a minor ethnobotanical hotspot or traditional knowledge hot spot based on forest cover and scheduled tribe population of the district [7]. The district lies between the plains of West Bengal and the Chhota Nagpur plateau. The district's physiography is divided into 3 parts, viz. the hilly areas on the west, the central undulating zone and the alluvial plains on the east. The remarkable hills of the district are Susunia and Biharinath. Biharinath hill is the tallest hill (448 m) in Bankura district. It is situated at Saltora block in the northern part of Bankura district. The forest of the hill is tropical dry deciduous type. The hill is rich in a variety of plant resources especially medicinal plants. Thirty different types of tribal communities live in Bankura district like Santal, Bhumij, Kora, Savar, Lodha, etc. [8]. The Santal represents the dominant tribe among the different tribal communities. The total Santal population of the

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district is 298992 (81.10% of the total ST people of the district) [8]. The seven tribal villages (7 in number) selected for this study are also dominated by the Santal tribe. The study villages are situated within a 10 km radius surrounding Biharinath hill (Fig 1).

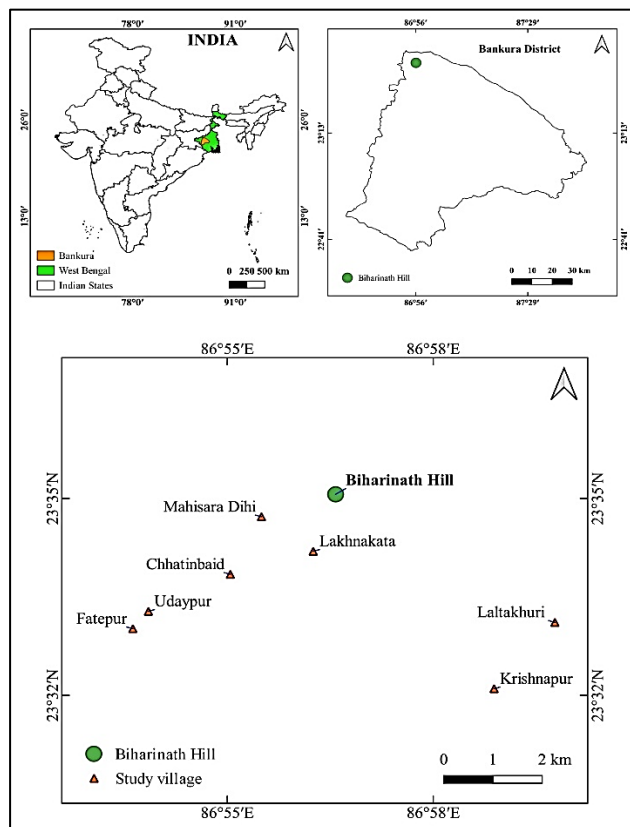


Fig 1 Map of the study area

Data collection

Information about ethnomedicine has been gathered from the study area by interviewing the Santal informants employing semi-structured questionnaire during 2016 to 2017. Free, Prior Informed Consent (FPIC) was taken from each informant prior to the beginning of an interview. Altogether, 11 informants (10 male and 1 female) were interviewed. The age of these informants ranges from 40 to 80 years. Informants were selected using the purposive sampling method [9]. Informants were categorized into two groups, i.e., medicine men and knowledgeable persons. During the interview, information on the local name, plant part(s) utilized, methods of crude drug preparation, route of administration, dose, and diseases treated were noted. Along with the data collection, plant species having medicinal value were collected from the field in presence of the informants. Collected plant species were identified using different Floras. [10-15]. Voucher specimens have been prepared following the standard ethnobotanical methods [16] and deposited in the Herbarium, Department of Botany, Visa-Bharati, Santiniketan. the data collection, plant species having medicinal value were collected from the field in presence of the informants. Collected plant species were identified using different Floras. [10-15]. Voucher specimens have been prepared following the standard ethnobotanical methods [16] and deposited in the Herbarium, Department of Botany, Visa-Bharati, Santiniketan.

Data analysis

Two quantitative indices like Informant Consensus Factor (F_{ic}) [17] and Cultural Value Index (CV) [18] have been used to analyze the collected ethnomedicinal data.

F_{ic} is calculated to identify the most likely efficacious ethnomedicinal plants in the culture of the Santal tribe. It is calculated by a formula:

$$F_{ic} = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

Where, N_{ur} = the number of use reports recorded in each usage category; N_t = the number of taxa used in each usage category. It has a value that ranges from 0 to 1, where a high value indicates a high level of informant agreement and a low value indicating informant disagreement.

The Cultural Value Index (CV) is a measurement of the cultural relevance of ethnomedicinal plants in a given society. It has three parts

$$CV_s = \left[\frac{NU_s}{NC} \right] \times \left[\frac{FC_s}{N} \right] \times \left[\sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} \frac{UR_{ui}}{N} \right]$$

Where, first part (NU_s divided by NC): NU_s = Number of ethnomedicinal uses recorded for the species (s) and NC = Total number of use categories reported in the study. The second part (FC_s divided by N): FC_s = Frequency of citation of the species (s) and N = total number of informants who participated in the study. The third part is the sum of all the use reports of the species (s) divided by the total number of the informants interviewed. Finally, the CVs are calculated by multiplying three components together.

RESULTS AND DISCUSSION

The collected ethnomedicinal information have been organized into a table. All the recorded taxa have been enumerated along with their scientific name, family name and voucher number, Santal name, plant parts used, disorders cured, methods of preparation, dosage regimen and route of administration (Table 2).

Ethnomedicinal plants recorded

Altogether, 78 ethnomedicinal plant species have been recorded from the study area. The studied plant taxa are spread over 50 families, 74 genera and 78 species (Table 1). Among the reported 50 families, Fabaceae has been represented by the highest number of species (7 species, 13.5%) followed by Apocynaceae (5 species, 9.6%), Asparagaceae, Asteraceae, Malvaceae and Piperaceae (3 species each, 5.8%). The ten families (Anacardiaceae, Apiaceae, Lamiaceae, etc.) have been represented by 2 species each (3.8%). The rest of the 34 families (Acanthaceae, Amaranthaceae, Amaryllidaceae, etc.) have been represented by single species only (1.9%) (Fig 2). The probable reason behind the highest number of leguminous plants used in making the ethnomedicine may be due to their efficacy in curing different types of disorders or diseases. The healing properties of these legume plants are also supported by the reported presence of various bioactive phytochemical groups such as tannins, flavonoids, alkaloids and triterpene saponins in quite a large number of species of the Fabaceae family [19].

Table 1 Number of families, genera and species recorded during ethnomedicinal study

	No. of families	No. of genera	No. of species
Dicotyledons	41	63	67
Monocotyledons	7	9	9
Pteridophytes	2	2	2
Total	50	74	78

Based on plant habit the recorded taxa are categorized into four groups namely Trees, Shrubs, Herbs, Climbers. The number of plant species in each group and their respective percentages are Trees - 27 (34.62%), Shrubs - 09 (11.54%), Herbs - 27 (34.62%), Climbers-15 (19.23%) (Fig 3). Therefore, it is very clear that the Santals in the study area use trees and herbs species most commonly to prepare their crude medicine.

Formulations and disorders cured

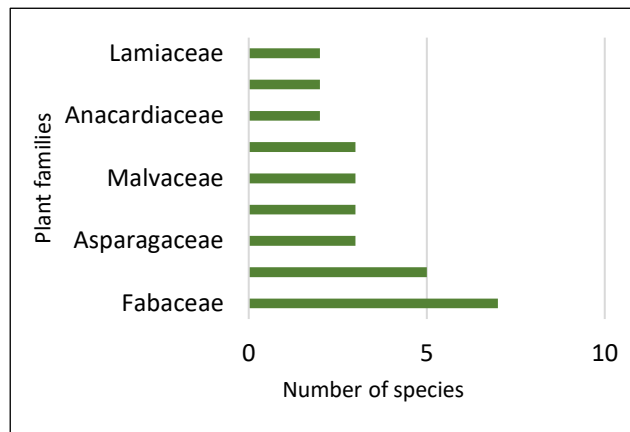


Fig 2 The most cited medicinal plant families along with their respective number of species in the study area

The reported 78 ethnomedicinal plants are regularly used by the tribal informants in preparation of 59 ethnomedicinal formulations for curing 37 types of disorders. A total of 35 preparations are grouped into monoherbal formulation where only a single plant material is used for the preparation of the crude drug. The 24 preparations are grouped into polyherbal formulation which is prepared using more than one plant material. A total of 37 types of disorders are grouped into 11 disease categories.

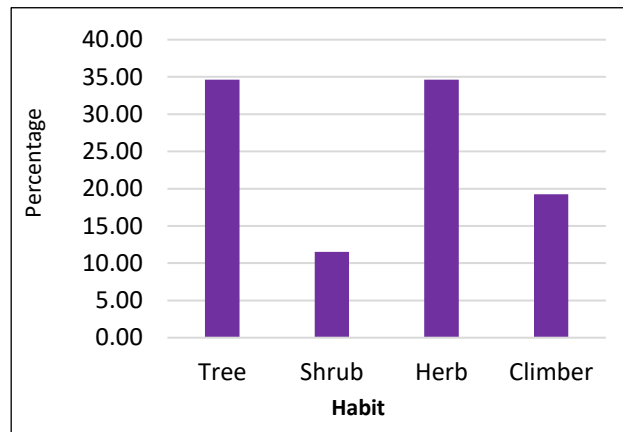


Fig 3 Habits of the recorded taxa

Plant parts used

Ethnomedicinal formulations are prepared using fresh as well as dried plant parts. The root (31.6%) is the most frequently cited plant part followed by stem bark (21.8%), leaf (11.3%) and fruit (10.5%), etc. (Fig 4). The possible reason for using the root part mostly in making crude drugs could be due to the efficacy of chemical constituents present in roots in curing various health conditions. Roots are also reported as notable phytochemical factories due to its capacity to produce

as well as store a vast range of secondary metabolites [20-21]. The frequent collection of underground plant parts such as roots, bulbs and tubers poses a higher risk to the survival of plants in comparison to the collection of other parts like stem bark, leaves and flowers [22]. Therefore, present study indicates a higher collection pressure on the root drug plants than other medicinal plants used and it could be interpreted as a threat of certain degree to the future progeny of this particular group of ethnomedicinal plants in the surveyed area.

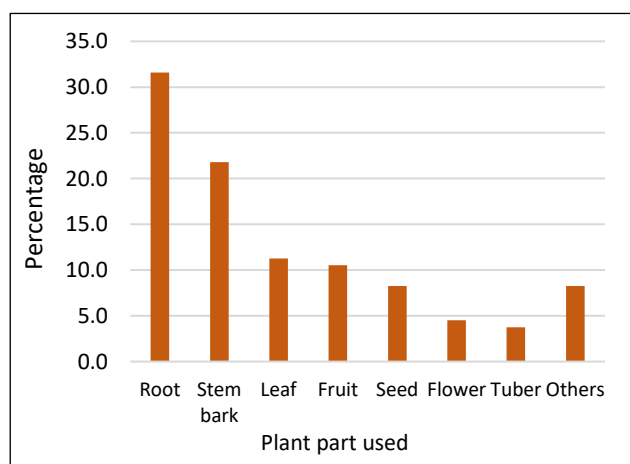


Fig 4 Plant parts used in ethnomedicinal formulations

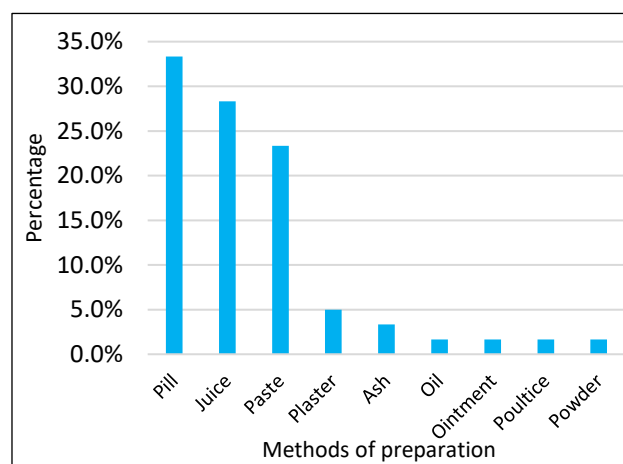


Fig 5 Recorded methods of preparation of ethnomedicine

Methods of preparation, forms and routes of administration of medicines

Ethnomedicinal formulations were prepared in different ways by the Santal informants according to their needs. The most common methods of remedy preparation and forms of administration are pills (33.3%) followed by juice (28.3%), paste (23.3%), plaster (5%), ash (3.3%), oil, ointment, poultice and powder (1.7%) (Fig 5). The pill is the most frequently used method of preparation and form of administration of drugs in

the study region. The possible justification for utilizing the pills in most elevated recurrence is that pills are easy to use, transport and store, and decrease wastage during preparations compared to other forms of medicine [23]. The ethnomedicinal formulations have been administered by the tribal people in two ways, viz. oral mode (70%) and topical mode (30%). In oral application, different forms of crude medicine have been used namely pills, juice, paste and powder. For the topical application, drugs are applied as plaster, ointment, poultice ash, and oil.

Table 2 List of ethnomedicinal plants used by the Santal people living around Biharinath hill, Bankura
[Monoherbal formulations (S. No. 1-35) and Polyherbal formulations (S. No. 36-59)]

S. No.	Scientific name of the plant (s)/Family name/Voucher number	Santal name	Plant parts used	Disorders cured	Method of preparation	Dosage regimen	Mode of administration
1	<i>Andrographis paniculata</i> (Burm.f.) Nees/Acanthaceae/SK 15	Kalmegh	Leaf	Itch	Pills are made from the leaf paste	One pill per day for seven days	Oral
2	<i>Aristolochia indica</i> L./Aristolochiaceae/SK 246	Jhunkagand	Root	Stomach ache	The root paste is made into pills	Two pills a day	Oral
3	<i>Baccharoides anthelmintica</i> (L.) Moench/Asteraceae/SK 22	Shaonrai	Seed	Indigestion	The fried seeds are ground into powder	Half teaspoonful every day	Oral
4	<i>Byttneria herbacea</i> Roxb./Sterculiaceae/SK 34	Kamraj	Root	Leucorrhoea	The root paste is made into pills	One pill twice a day for seven days	Oral
5	<i>Byttneria herbacea</i> Roxb./Sterculiaceae/SK 34	Kamraj	Root	Stomach ache	The juice is extracted from the root	One teaspoonful two times a day	Oral
6	<i>Cajanus cajan</i> (L.) Huth/Fabaceae/SK 59	Raher	Leaf	Jaundice	Juice is made from the leaves	Two teaspoonsful twice a day for fifteen days	Oral
7	<i>Capparis zeylanica</i> L./Capparaceae/SK 85	Asaria	Stem bark	Body ache	Paste is made from the stem bark	Once a day	Topical
8	<i>Cissampelos pareira</i> L./Menispermaceae/SK 176	Tejo mala	Root	Stomach ache	The root (about 3 cm long) is crushed into paste and a pinch of black salt is added to it	Once a day for three days	Oral
9	<i>Clerodendrum phlomidis</i> L.f./Lamiaceae/SK 331	Panjot	Leaf	Headache	Either leaf juice or paste is made	Two times a day	Topical
10	<i>Clerodendrum phlomidis</i> L.f./Lamiaceae/SK 331	Panjot	Leaf	Biliousness	Leaf juice is prepared	Once a day	Oral
11	<i>Combretum roxburghii</i> Spreng./Combretaceae/SK 209	Aten	Stem bark	Chicken pox	Juice is made by crushing the stem bark	Two times a day for seven days	Oral
12	<i>Combretum roxburghii</i> Spreng./Combretaceae/SK 209	Aten	Leaf	Athlete's foot	Juice is prepared by crushing the leaves	Three times a day for seven days	Topical
13	<i>Combretum roxburghii</i> Spreng./Combretaceae/SK 209	Aten	Leaf or root	Bone fracture	The leaf or root paste is applied as plaster	The plaster is kept for seven days and then fresh paste is given for the next seven days	Topical
14	<i>Crinum asiaticum</i> L./Amaryllidaceae/SK 305	Bonpeyan j	Bulb	Body ache	The paste of bulb is boiled in mustard oil till a thick ointment is made	Once a day	Topical
15	<i>Elaeodendron glaucum</i> (Rottb.) Pers./Celastraceae/SK 58	Neuri	Stem bark	Leucorrhoea	The stem bark (5 gm) is made into paste	Once a day for seven days	Oral
16	<i>Elaeodendron glaucum</i> (Rottb.) Pers./Celastraceae/SK 58	Neuri	Stem bark	Arthritis	The bark is made into juice and applied on the affected part	Twice a day	Topical
17	<i>Emilia sonchifolia</i> (L.) DC./Asteraceae/SK 290	Kulai lutur	Leaf	Ear discharge and earache	The juice is extracted from the leaves and applied to the affected ears	Once a day	Topical
18	<i>Holarrhena pubescens</i> Wall. ex G.Don/Apocynaceae/SK 227	Hart	Stem bark	Indigestion and stomach ache	The stem bark (5 gm) is made into paste and mixed with common salt (one pinch)	Twice a day for two days	Oral
19	<i>Holarrhena pubescens</i> Wall. ex G.Don/Apocynaceae/SK 227	Hart	Fruit	Boil and abscess	The ash is made by burning the fruits and mixed with coconut oil.	Twice a day till cure	Topical
20	<i>Ipomoea carnea</i> subsp. <i>fistulosa</i> (Mart. Ex Choisy) D.F.Austin/Convolvulaceae/SK 384	Bera	Leaf	Bone fracture and joint dislocation	The leaves are made into paste. Luke warmed paste is applied as plaster	The paste is kept for fifteen days	Topical
21	<i>Litsea glutinosa</i> (Lour.) C.B.Rob./Lauraceae/SK 365	Leda	Stem bark	Body ache and Myalgia	Luke warmed paste of stem bark is applied as poultice	Twice a day for three days	Topical
22	<i>Morinda citrifolia</i> L./Rubiaceae/SK 242	Chaili	Leaf or fruit or stem bark	Boil and abscess	The paste is made from the respective plant part	Twice a day for three days	Topical
23	<i>Mucuna pruriens</i> (L.) DC./Fabaceae/SK 207	Etkar	Root	Headache	The juice is extracted from the root	Once a day	Topical
24	<i>Oroxylum indicum</i> (L.) Kurz/Bignoniaceae/SK 93	Banahata	Stem bark	Low back pain and headache	The juice is made from the stem bark	One teaspoonful once a day for seven days	Oral
25	<i>Plumbago zeylanica</i> L./Plumbaginaceae/SK 269	Kitari	Root	Flatulence	The root (5 gm) is made into paste and taken with boiled egg of wild hen	Once a week	Oral
26	<i>Pueraria tuberosa</i> (Roxb. ex Willd.) DC./Fabaceae/SK 212	Bhuinkumra	Tuber	Gastritis	The pills are made from the paste of tuber and taken along with goat's milk (100 ml)	One pill per day for ten days	Oral
27	<i>Scoparia dulcis</i> L./Plantaginaceae/SK 123	Bodjira	Leaf	Stomach ache	The juice is made from the leaves	One teaspoonful juice twice a day	Oral
28	<i>Soyimida febrifuga</i> (Roxb.) A.Juss./Meliaceae/SK 83	Rahin	Stem bark	Myalgia and sprain	The juice is extracted and the paste is also prepared from the stem bark	Juice: Two teaspoonfuls two times a day Paste: Once a day for three days	Oral and topical
29	<i>Soyimida febrifuga</i> (Roxb.) A.Juss./Meliaceae/SK 83	Rahin	Root	Chicken pox and measles	The pills are made from the root	Once a day for three days	Oral

30	<i>Soymida febrifuga</i> (Roxb.) A.Juss./Meliaceae/SK 83	Rahin	Stem bark	Lochia	The juice is extracted from the stem bark	Two teaspoonfuls two times a day for fifteen days	Oral
31	<i>Soymida febrifuga</i> (Roxb.) A.Juss./Meliaceae/SK 83	Rahin	Stem bark	Stomach ache	The juice is made from the stem bark	One teaspoonful two times a day	Oral
32	<i>Streblus asper</i> Lour./Moraceae/SK 41	Sarha	Stem bark	Stomach ache	The juice is made from the stem bark	One teaspoonful two times a day	Oral
33	<i>Tamilnadia uliginosa</i> (Retz.) Tirveng. & Sastre/Rubiaceae/SK 328	Pindra	Flower	Leucorrhoea	The flower is made into paste	Once a day for seven days	Oral
34	<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb./Fabaceae /SK 289	Babla	Leaf	Athlete's foot	The leaves are made into paste	Twice a day	Topical
35	<i>Vitex negundo</i> L./Lamiaceae/SK 46	Sinduari	Leaf	Headache	The leaves are made into paste	Once a day	Topical
36	<i>Abutilon indicum</i> (L.) Sweet/Malvaceae/SK 337	Mirubaha	Root	Diarrhoea	The root of <i>A. indicum</i> (5 gm) is made into paste along with the seven fruits of <i>P. nigrum</i>	One pill per day for two days	Oral
37	<i>Piper nigrum</i> L./Piperaceae <i>Adiantum philippense</i> L./Pteridaceae/SK 299	Rabin Kalijhap	Fruit Leaf	Bone fracture	Plant parts (1:1:1:1) are made into paste. The paste is used as plaster	The plaster is kept for 15 days	Topical
	<i>Geodorum densiflorum</i> (Lam.) Schltr./Orchidaceae/SK 106	Bir kala	Tuber				
	<i>Asparagus racemosus</i> Willd./Asparagaceae/SK 126	Satamuli	Root				
	<i>Byttneria herbacea</i> Roxb./Sterculiaceae/SK 34	Kamraj	Root				
38	<i>Asparagus racemosus</i> Willd. Asparagaceae/SK 126	Satamuli	Root	Asthma	The roots (50 gm each) of <i>A. racemosus</i> and <i>S. zeylanica</i> are made into paste along with the seeds of <i>N. sativa</i> , <i>C. cyminum</i> (1/2 teaspoon), <i>M. fragrans</i> (1/2), fruits (1/2 teaspoon) of <i>P. cubeba</i> , <i>P. longum</i> , flower buds (7) of <i>S. aromaticum</i> and the stem bark (5 gm) <i>C. verum</i> . Finally, pills are prepared from it	One pill per day for twenty-one days	Oral
	<i>Smilax zeylanica</i> L./Smilacaceae/SK 152	Atkir	Root				
	<i>Nigella sativa</i> L./Ranunculaceae	Kalajira	Seed				
	<i>Cuminum cyminum</i> L./Apiaceae	Jira	Seed				
	<i>Myristica fragrans</i> Houtt./Myristicaceae	Jaifal	Seed				
	<i>Piper cubeba</i> L.f./Piperaceae	Kabab chini	Fruit				
	<i>Piper longum</i> L./Piperaceae	Rali	Fruit				
	<i>Syzygium aromaticum</i> (L.) Merr. & L.M.Perry/Myrtaceae	Lavanga	Flower bud				
	<i>Cinnamomum verum</i> J.Presl/Lauraceae	Daruchini	Stem bark				
39	<i>Byttneria herbacea</i> Roxb./Sterculiaceae/SK 34	Kamraj	Root	Leucorrhoea and Spermatorrhoea	The (5 gm) of <i>B. herbacea</i> is made into paste along with the seed husks of <i>P. ovata</i> seeds of <i>L. sativum</i> (one teaspoonful) and the latex of <i>F. benghalensis</i> (one teaspoonful). The paste is dissolved in cow's milk (100 ml).	Once a day for seven days.	Oral
	<i>Plantago ovata</i> Forssk./Plantaginaceae	Isabgul	Seed husk				
	<i>Lepidium sativum</i> L./Brassicaceae	Halim	Seed				
	<i>Ficus benghalensis</i> L./Moraceae/SK 197	Bare	Latex				
40	<i>Chlorophytum arundinaceum</i> Baker/Asparagaceae/SK 112	Dura	Root	Spermatorrhoea and leucorrhoea	The roots of these plants are taken in equal amount and made into paste. The pills are made from the paste.	Thrice a day for fifteen days	Oral
	<i>Hemidesmus indicus</i> (L.) R.Br./Apocynaceae/SK 180	Nanha dudhi nari	Root				
	<i>Byttneria herbacea</i> Roxb./Sterculiaceae/SK 34	Kamraj	Root				
	<i>Elephantopus scaber</i> L./Asteraceae/SK 60	Menjurjhuti	Root				
	<i>Morinda citrifolia</i> L./Rubiaceae/SK 242	Chaili	Root				
	<i>Leea asiatica</i> (L.) Ridsdale/Vitaceae/SK 151	Duri hatkam	Root				
41	<i>Cyperus corymbosus</i> Rottb./Cyperaceae/SK 352	Sura ghas	Root	Body ache and lower back pain (lumbago)	The roots both plants are taken in equal amounts and made into paste and the pills are made from it.	One pill two times a day for one month	Oral
	<i>Imperata cylindrica</i> (L.) P.Beav./Poaceae/SK 141	Chera ghas	Root				
42	<i>Hemidesmus indicus</i> (L.) R.Br./Apocynaceae/SK 180	Nanha dudhi nari	Root	Leucorrhoea	The roots (25 gm) of <i>H. indicus</i> , <i>S. zeylanica</i> , <i>A. racemosus</i> , <i>B. herbacea</i> and the flower (1:1:1) of <i>C. gigantea</i> , <i>H. rosa-sinensis</i> , <i>N. nucifera</i> are made into paste and pills are prepared from it.	One pill per day for fifteen days.	Oral
	<i>Smilax zeylanica</i> L./Smilacaceae/SK 152	Atkir	Root				
	<i>Asparagus racemosus</i> Willd./Asparagaceae/SK 126	Satamuli	Root				
	<i>Byttneria herbacea</i> Roxb./Sterculiaceae/SK 34	Kamraj	Root				

	<i>Calotropis gigantea</i> (L.) W.T.Aiton/Apocynaceae/SK 65	Pod Akaona	Flower				
	<i>Hibiscus rosa-sinensis</i> L./Malvaceae/SK 89	Jaba	Flower				
	<i>Nelumbo nucifera</i> Gaertn./Nelumbonaceae/SK 30	Padma	Flower				
43	<i>Hemidesmus indicus</i> (L.) R.Br./Apocynaceae/SK 180	Nanha dudhi nari	Root	Spermatorrhoea	The roots of these plants are made into paste and finally pills are prepared	One pill per day for one month	Oral
	<i>Solanum virginianum</i> L./Solanaceae/SK 17	Rangaini janum	Root				
	<i>Asparagus racemosus</i> Willd./Asparagaceae/SK 126	Satamuli	Root				
44	<i>Hibiscus rosa-sinensis</i> L./Malvaceae/SK 89	Jaba	Flower	Irregular menstruation	The flowers (2:1) of <i>H. rosa-sinensis</i> , <i>N. nouchali</i> , the leaflets (6) of <i>A. marmelos</i> , the roots (10 gm each) of <i>H. indicus</i> , <i>A. racemosus</i> , <i>S. zeylanica</i> , the root (5 gm) of <i>P. crotalarioides</i> and the stem bark (10 gm) of <i>S. febrifuga</i> are made into paste and pills are made from it	One pill per day for three days	Oral
	<i>Nymphaea nouchali</i> Burm.f./Nymphaeaceae/SK 257	Upal baha	Flower				
	<i>Aegle marmelos</i> (L.) Corrêa/Rutaceae/SK 333	Sinjo	Leaf				
	<i>Hemidesmus indicus</i> (L.) R.Br./Apocynaceae/SK 180	Nanha dudhi nari	Root				
	<i>Polygala crotalarioides</i> Buch.-Ham. ex DC./Polygalaceae/SK 355	Lil kathi	Root				
	<i>Asparagus racemosus</i> Willd./Asparagaceae/SK 126	Satamuli	Root				
	<i>Smilax zeylanica</i> L./Smilacaceae/SK 152	Atkir	Root				
	<i>Soymida febrifuga</i> (Roxb.) A.Juss./Meliaceae/SK 83	Rahin	Stem bark				
	<i>Phyllanthus emblica</i> L. Phyllanthaceae/SK 52	Meral	Fruit				
45	<i>Ichnocarpus frutescens</i> (L.) W.T.Aiton/Apocynaceae/SK 181	Dudhinari	Root	Ring worm	The ashes are made from the root of <i>I. frutescens</i> (25 gm), the stem bark of <i>L. parviflora</i> (25 gm) and one seed of <i>S. nux-vomica</i> and mixed with coconut oil	Twice a day till cure	Topical
	<i>Lagerstroemia parviflora</i> Roxb./Lythraceae/SK 231	Sekreji dare	Stem bark				
	<i>Strychnos nux-vomica</i> L. Loganiaceae/SK 300	Kuchla	Seed				
46	<i>Lannea coromandelica</i> (Houtt.) Merr. Anacardiaceae/SK 19	Doka	Stem bark	Diarrhoea	The juice is extracted from the stem barks (1:1:1) of these plants	One teaspoonful juice per day for three days	Oral
	<i>Syzygium cumini</i> (L.) Skeels/Myrtaceae/SK 49	Kodo	Stem bark				
	<i>Mangifera indica</i> L./Anacardiaceae/SK 44	Ul	Stem bark				
47	<i>Lannea coromandelica</i> (Houtt.) Merr./Anacardiaceae/SK 19	Doka	Stem bark	Diarrhoea and Dysentery	The juice is extracted from the stem barks (1:1:1:1) of these plants	One teaspoonful per day for seven days	Oral
	<i>Butea monosperma</i> (Lam.) Kuntze/Fabaceae/SK 54	Murut	Stem bark				
	<i>Streblus asper</i> Lour./Moraceae/SK 41	Sarha	Stem bark				
	<i>Madhuca longifolia</i> var. <i>latifolia</i> (Roxb.) A.Chev./Sapotaceae/SK 80	Matkom	Stem bark				
	<i>Ziziphus mauritiana</i> Lam./Rhamnaceae/SK 336	Jom Janum	Stem bark				
48	<i>Ledebouria revoluta</i> (L.f.) Jessop/Asparagaceae/SK 324	Birpeyanj	Tuber	Piles	The tuber of <i>L. revoluta</i> (50 gm) is made into paste along with the half seed of <i>M. fragrans</i> , three flower buds of <i>S. aromaticum</i> and the stem bark of <i>C. verum</i> (10 gm), three fruits of <i>E. cardamomum</i> and the tail of <i>Chelonia</i> (10 gm). Pills are prepared from the paste.	One pill twice a day for one month	Oral
	<i>Myristica fragrans</i> Houtt./Myristicaceae	Jaifal	Seed				
	<i>Syzygium aromaticum</i> (L.) Merr. & L.M.Perry/Myrtaceae	Lavanga	Flower bud				
	<i>Cinnamomum verum</i> /Lauraceae	Daruchini	Stem bark				
	<i>Elettaria cardamomum</i> (L.) Maton/Zingiberaceae	Elach	Fruit				
49	<i>Lycoperdon</i> sp./Agaricaceae/SK 4	Tumba ot	Spore	Hydrocoele	The stem bark of <i>C. verum</i> (5 gm) and the three fruits of <i>E. cardamomum</i> are made into paste. The paste is mixed with the spores of <i>Lycoperdon</i> sp. (1/2 teaspoonful). Finally, pills are prepared from the paste	One pill per day for fifteen days	Oral
	<i>Cinnamomum verum</i> J.Presl/Lauraceae	Daruchini	Stem bark				
	<i>Elettaria cardamomum</i> (L.) Maton/Zingiberaceae	Elach	Fruit				

50	<i>Marsilea minuta</i> L./Marsileaceae/SK 206	Dak chatom ara	Leaf	Headache, stomach ache and gastric problems	The leaves of <i>M. quadrifolia</i> (5 gm) and root or stem bark (20 gm) of <i>C. spinarum</i> are made into paste and pills are prepared from it	One pill per day for seven days	Oral
	<i>Carissa spinarum</i> L./Apocynaceae/SK 302	Karwat	Root or stem bark				
51	<i>Plumbago zeylanica</i> L./Plumbaginaceae/SK 269	Kitari	Root	Inguinal hernia	The roots (1:1) of <i>P. zeylanica</i> and <i>S. caesia</i> are made into paste	One pill twice a day for one month	Oral
	<i>Senegalia caesia</i> (L.) Maslin, Seigler & Ebinger/Fabaceae/SK 319	Kondro janum	Root				
52	<i>Plumbago zeylanica</i> L./Plumbaginaceae/SK 269	Kitari	Root	Chest pain	The roots (1:1) of <i>P. zeylanica</i> , <i>A. aspera</i> are made into paste along with the seven fruits of <i>P. nigrum</i>	Once a day for seven days	Oral
	<i>Achyranthes aspera</i> L. /Amaranthaceae/SK 198	Chirchiri	Root				
53	<i>Piper nigrum</i> L./Piperaceae	Rabin	Fruit	Tendinitis	The seed oil of these plants is taken in equal amounts and mixed together.	Two times a day for seven days	Topical
	<i>Pongamia pinnata</i> (L.) Pierre/Fabaceae/SK 37	Karaj	Seed				
	<i>Ricinus communis</i> L./Euphorbiaceae/SK 39	Erdom	Seed				
54	<i>Sesamum indicum</i> L./ Pedaliaceae	Til	Seed				
	<i>Pueraria tuberosa</i> (Roxb. ex Willd.) DC./Fabaceae/SK 212	Bhuinkumra	Tuber	Epilepsy	The tuber <i>P. tuberosa</i> (100 gm) is made into paste along with the two fruits of <i>P. emblica</i> L. and pills are made from it	One pill per day for twenty-one days	Oral
	<i>Phyllanthus emblica</i> L. /Phyllanthaceae/SK 52	Meral	Fruit				
55	<i>Senegalia caesia</i> (L.) Maslin, Seigler & Ebinger/Fabaceae/SK 319	Kondro janum	Stem bark	Chicken pox	The Stem bark of <i>S. caesia</i> (10 gm), three spines of <i>B. ceiba</i> , root of <i>Z. oenoplia</i> (10 gm) and seven stipes of <i>Termitomyces</i> sp. are made into paste and pills are prepared from it.	One pill twice a day for fifteen days	Oral
	<i>Bombax ceiba</i> L./Malvaceae/SK 57	Edel	Spine				
	<i>Ziziphus oenoplia</i> (L.) Mill./Rhamnaceae/SK 335	Shiakul	Root				
56	<i>Termitomyces</i> sp./Lyophyllaceae/SK 125	Porbichatu	Stipe				
	<i>Tamilnadia uliginosa</i> (Retz.) Tirveng. & Sastre/Rubiaceae/SK 328	Pindra	Stem bark	Indigestion and Stomach ache	The stem barks (1:1) of <i>T. uliginosa</i> , <i>S. febrifuga</i> and the roots (1:1) of <i>B. herbacea</i> , <i>A. racemosus</i> are made into paste and pills are prepared from it	One pill twice a day	Oral
	<i>Soymida febrifuga</i> (Roxb.) A.Juss. Meliaceae/SK 83	Rahin	Stem bark				
	<i>Byttneria herbacea</i> Roxb. Sterculiaceae/SK 34	Kamraj	Root				
	<i>Asparagus racemosus</i> Willd. Asparagaceae/SK 126	Satamuli	Root				
57	<i>Tinospora cordifolia</i> (Willd.) Hook.f. & Thomson / Menispermaceae/SK 98	Gulancha	Aerial root	Arthritis	The root is made into paste along with the fruits of <i>T. amni</i> (5 gm) and pills are made from it.	One pill twice a day for twenty-one days	Oral
	<i>Trachyspermum ammi</i> (L.) Sprague Apiaceae/SK 216	Jowan	Fruit				
58	<i>Tinospora cordifolia</i> (Willd.) Hook.f. & Thomson / Menispermaceae/SK 98	Gulancha	Stem	Gastritis	The stem of <i>T. cordifolia</i> (50 gm), tuber of <i>P. tuberosa</i> (10 gm) and the seeds of <i>T. amni</i> (5 gm) are made into paste. Finally, pills are made from it.	One pill twice a day for fifteen days	Oral
	<i>Pueraria tuberosa</i> (Roxb. ex Willd.) DC. Fabaceae/SK 212	Bhuinkumra	Tuber				
	<i>Trachyspermum ammi</i> (L.) Sprague Apiaceae/SK 216	Jowan	Fruit				
59	<i>Vitex negundo</i> L./Lamiaceae/SK 46	Sinduari	Leafy twig	Filariasis (early stage)	The leafy twig of <i>V. negundo</i> is made into paste along with the fruits (5 gm) of <i>P. nirgum</i> (5 gm), <i>T. amni</i> and <i>N. sativa</i> (1/2 teaspoonful). The pills are made from the paste	One pill twice a day for one month	Oral
	<i>Piper nigrum</i> L. / Piperaceae	Rabin	Fruit				
	<i>Trachyspermum ammi</i> (L.) Sprague Apiaceae/SK 216	Jowan	Fruit				
	<i>Nigella sativa</i> L. / Ranunculaceae	Kalojira	Seed				

Other ingredients used in ethnomedicinal formulations

During the preparation of ethnomedicinal formulations, different adjuvants like black salt, common salt, mustard oil and coconut oil have been added to the main ingredients of plant origin. Adjuvants are known to help and accelerate the healing activity of crude drugs in order to improve the efficacy of the drugs. Besides, parts of animals and its products like the tail of tortoise, egg of wild hen, milk of goat and cow, have frequently been used to prepare formulations. Moreover, spores and stipes

of the fungal fruit bodies are occasionally employed in preparation of ethnomedicine.

Quantitative analysis

The recorded data have been examined employing two indices, viz. F_{ic} (Informant Consensus Factor) and CV (Cultural Value Index). The F_{ic} values have been calculated for the eleven disease categories and values ranged from 0.5 to 1 (Table 3). The disease category with a high value specifies that there is a

high level of agreement on the use of ethnomedicinal plants in the treatment of disorders or diseases under that category. The highest F_{ic} value, i.e., 1 has been scored by the disease categories namely Birth/Puerperium Disorders and Sensory System Disorders. Then F_{ic} value of 1 was followed by Digestive System Disorders (0.66), Genitourinary System Disorders (0.65), Muscular-Skeletal System Disorders (0.65), etc., F_{ic} scores of different disease categories show very clearly that the ethnomedicinal plant species against these use

categories are highly effective and popularly used by the tribal informants in present study zone in curing a wide range of health disorders. These plant species are considered as high consensus species, i.e., culturally most important plant resource to the Santal people of this surveyed area. In bioprospecting research, statistically determined such type of popular plant species are preferred by the scientists as promising candidates for future exploration of bioactive compounds and natural product research [24].

Table 3 Information consensus factor (F_{ic}) for each disease category

Serial Number	Disease categories	Number of taxa (N_t)	Use reports (N_{ur})	F_{ic}
1	Birth/Puerperium Disorders	1	5	1.00
2	Sensory system disorders	1	6	1.00
3	Digestive System Disorders	25	71	0.66
4	Genitourinary System Disorders	20	56	0.65
5	Muscular-Skeletal System Disorders	18	50	0.65
6	Circulatory System Disorders	3	6	0.60
7	Culture Bound Syndrome	8	18	0.59
8	Skin/Subcutaneous Cellular Tissue Disorders	8	18	0.59
9	Nervous System Disorders	8	16	0.53
10	Infections/Infestations	12	24	0.52
11	Respiratory System Disorders	2	3	0.50

Table 4 List of the first 25 ethnomedicinal plant species based on their CV index value

S. No.	Name of taxa	Basic values			Index
		FC	UR	NU	CV
1.	<i>Asparagus racemosus</i> Willd.	7	19	5	0.4996
2.	<i>Soymida febrifuga</i> (Roxb.) A.Juss.	6	20	5	0.4508
3.	<i>Byttneria herbacea</i> Roxb.	6	15	4	0.2705
4.	<i>Combretum roxburghii</i> Spreng.	4	7	3	0.0631
5.	<i>Hemidesmus indicus</i> (L.) R.Br.	5	8	2	0.0601
6.	<i>Morinda citrifolia</i> L.	3	6	3	0.0406
7.	<i>Plumbago zeylanica</i> L.	4	6	2	0.0361
8.	<i>Smilax zeylanica</i> L.	4	6	2	0.0361
9.	<i>Holarrhena pubescens</i> Wall. ex G.Don	3	7	2	0.0316
10.	<i>Streblus asper</i> Lour.	3	7	2	0.0316
11.	<i>Lannea coromandelica</i> (Houtt.) Merr.	4	5	2	0.0301
12.	<i>Carissa spinarum</i> L.	3	6	2	0.0270
13.	<i>Marsilea minuta</i> L.	3	6	2	0.0270
14.	<i>Tamilnadia uliginosa</i> (Retz.) Tirveng. & Sastre	3	6	2	0.0270
15.	<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	5	6	1	0.0225
16.	<i>Elaeodendron glaucum</i> (Rottb.) Pers.	3	5	2	0.0225
17.	<i>Butea monosperma</i> (Lam.) Kuntze	3	4	2	0.0180
18.	<i>Madhuca longifolia</i> var. <i>latifolia</i> (Roxb.) A.Chev.	3	4	2	0.0180
19.	<i>Phyllanthus emblica</i> L.	3	4	2	0.0180
20.	<i>Vitex negundo</i> L.	3	4	2	0.0180
21.	<i>Elephantopus scaber</i> L.	2	4	2	0.0150
22.	<i>Emilia sonchifolia</i> (L.) DC.	3	6	1	0.0135
23.	<i>Chlorophytum arundinaceum</i> Baker	2	4	2	0.0120
24.	<i>Clerodendrum phlomidis</i> L.f.	2	4	2	0.0120
25.	<i>Ficus benghalensis</i> L.	2	4	2	0.0120

The Cultural value index in the study sample ranged from 0.0008 to 0.4996. Plant species having greater cultural value play a larger role in a particular culture. Based on the cultural values, the top ranked most useful 25 ethnomedicinal plant species have been presented here (Table 4).

The highest cultural value has been observed in case of *Asparagus racemosus* Willd. (0.4996) followed by *Soymida*

febrifuga (Roxb.) A. Juss. (0.4508), *Byttneria herbacea* Roxb. (0.2705), *Combretum roxburghii* Spreng. (0.0631), etc. The top ranked 25 ethnomedicinal species could be measured as culturally most important in respect of their medicinal efficacy. The plants with high cultural value could also be targeted as ethnomedicinal leads for future phytochemical and pharmacological research.

CONCLUSION

The documentation of ethnomedicinal knowledge of Santal communities in the study area will add more information to the ethnomedicinal database for the district of Bankura. Present investigation will also play important role in protecting the Intellectual Property Rights (IPR) of the knowledge providers in the surveyed areas as the ethnomedicinal data were collected after taking Free, Prior Informed Consent (FPIC) from the informants. Quantitative indices like Consensus factor (F_{ic}) and Cultural Value (CV) have been employed here to identify the culturally most important ethnomedicinal plants in the Santal society and values of these indices highlight the very reliable ethno-taxa which are confidently used by the Santal community of the area in successful treatment of their many health disorders. Statistically analyzed such culturally

important medicinal plant species would act as promising candidates for future bioprospecting research. Documentation of ethnomedicinal knowledge related to the plant resources also illustrates the use pattern and collection pressure exerted by the tribal community to the medicinal plants grown in the studied zone. So, ethnobotanical study throws some light on conservation aspects of medicinal plant resources in a particular area. As a result, conservation study in the research area is desirable for the long-term usage of medicinal plants.

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