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Ethnomedicinal Plants Used by Santhal Community of India

Sujata Pradhan [1]*, J. N. Mohanty [1*], and S. Kumar [2]

[1] *Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar 752050, India*
[2] *Biodiversity and Conservation Lab., Ambika Prasad Research Foundation, Cuttack 753015, India*
*(e-mail: sujatapradhan.lect@gmail.com; jatindranath.mohanty@cutm.ac.in)

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ABSTRACT

A lot of health problems are observed worldwide; among them, antimicrobial resistance (AMR) is more serious. Urgent formulations of antimicrobial agents from natural sources and Indigenous Traditional Knowledge (ITK) are needed. The ITK belongs to different tribal communities for their day-to-day traditional practices. Those communities are storehouses of traditional therapeutic values that need to be explored. Santhal, a tribal community in India and more developed has sound knowledge of forest foods, forest products, sustainable agriculture, and medicinal plants. They use the local plants as food, nutraceuticals, medicinal agents, and as a source of livelihood, which should be documented for the formulation of new antimicrobial agents to mitigate the global health problems. Therefore, in the present study, the Santhal community was selected and enumerated 120 medicinal plants along with their uses and local names used by them. The active constituents of 31 medicinal plants and their pharmacological activities are also documented. 34 nutraceuticals and 10 economically important plants were enumerated through a field survey and presented. Since less documentation is available on plants used by the Santhal community, the present study focuses on their medicinal uses, pharmacological activities, and their nutraceutical potential to provide sources of future medicinal foods and antimicrobial agents to cope with the global health problems.

Key words: antimicrobial resistance, medicinal agents, tribal communities

INTRODUCTION

Antimicrobial resistance (AMR) has become an area of concern and a threat to human health worldwide (Prestinaci et al., 2015). AMR occurs when pathogens resist or act against antibiotics, making the administered medications less effective. Resistance to antibiotics decreases the susceptibility of the medicines used in the therapy, operations, and prevention of infectious diseases (Adedeji, 2016; Cornaglia et al., 2004). However, in the current situation, antibiotics are highly misused. The lack of education and knowledge of medications in society is leading to deaths due to the irresponsible use (Bhat et al., 2023). The administered antibiotics act against all the good and bad bacteria in the human body and kill them; however, some bacteria survive and become resistant to these antibiotics (Muteeb et al., 2023). The mutant bacteria then multiply rapidly and cause more dangerous and incurable diseases. Human negligence and a deficit of knowledge are leading to the incompletion of the prescription for the disease, which kills half the pathogens and leaves the other half to mutate and develop resistance against the antibiotics (Lobanovska and Pilla, 2017). Then, a time will come when no antibiotics available in the markets will work on the mutant pathogens (Abdallah, 2023). With developed recombinant DNA technology, better healthcare facilities, and the availability of low-cost medications, more multidrug-resistant pathogens are developing (Micoli et al., 2021). Complications or infections caused by multidrug-resistant bacterial strains have no cure and eventually cause death of the patients, as no antibiotics can be administered to the patients that will work on them. Therefore, most of the mortality cases recorded in India are due to no proper working of antibiotics in the aftercare of any operation or other infections rather than any health disorder (Kumar et al., 2013; Salam et al., 2023).

Presently, the global community is slowly reverting to the traditional practices and using herbal medicines with fewer side effects (Shrivastava et al., 2015; Wanjohi et al., 2020). Observing the rich traditional ayurvedic systems of Indian culture, European scholars then started documenting the ethnobotanical and ethnomedicinal practices followed by the tribal people of India from the villagers, medicine experts, hakims, vaidyas, and ojhas (Thomas et al., 2020). India has 75 Particularly Vulnerable Tribal Groups (PVTGs) and 705 Scheduled Tribes (STs) spread over 17 states and 1 union territory who have unique cultural and life practices, and rich traditional knowledge (Narain, 2022). The states of Madhya Pradesh, Chhattisgarh, Jharkhand, Odisha, Maharashtra, Gujarat, Rajasthan, Andhra Pradesh, West Bengal, and Karnataka are some of the tribal states of India (Pandey et al., 2022). The lack of proper healthcare facilities and easy availability of medicinal plants in the forests near them, traditional methods of treatment, and healing are the first treatment options among the tribal population

(Ganesh et al., 2021). Santhal is one of the most populous tribal communities in India. They used to live as nomads but have now settled down in the Chhotanagpur plateau (Dutta and Sinha, 2022). At the end of the 18th century, they migrated to the Santhal Paraganas of Bihar and they then came to Odisha. Now, they are found in Odisha, Jharkhand, West Bengal, Bihar, and Assam (Soren and Jamir, 2020). They usually stay close to forest areas and mostly depend on forest plants for primary healthcare systems. The traditional therapeutic knowledge of Santhal is very old and they use plants for treating various health problems, including microbial infections. Therefore, an attempt has been made to gather the ethnobotanical plants used by them from the literature and field survey. Several studies have documented the medicinal plants used by different tribes in India, like Ignacimuthu et al. (2006) reported the use of 60 ethnomedicinal plants by tribals of Madurai, Tamil Nadu. Similarly, Duraipandiyan et al. (2006) found that 18 plants used by the Paliyar tribe of Tamil Nadu exhibited antimicrobial activities. Jagtap et al. (2006) documented the use of 66 ethnomedicinal plants by the Korku tribe of Amravati district of Maharashtra. More recent studies have also contributed to the growing body of knowledge on medicinal plants used by indigenous communities. Thomas et al. (2014) reported the use of 34 plants by the Kuruma tribes of Kerala for various purposes. Laldingliani et al. (2022) recorded 93 ethno-medicinal plants used by the Mizo tribe of Mizoram. Mir et al. (2022) documented 109 ethnomedicinal plants used by ethnic groups in Jammu & Kashmir. Ralte et al. (2024) reported the use of 124 ethnomedicinal plants by indigenous communities of Mizoram. The present study on plants used by the Santhal community for the treatment of various health problems will be useful to provide a source of future antimicrobial agents and other life stuffs to fight against AMR and other health problems.

METHODOLOGY

A thorough review was conducted through a comprehensive survey of existing literature on the ethnomedicinal plants used by the Santhal community, focusing on their traditional and pharmacological properties, along with reported bioactive compounds present in them. A range of databases including PubMed, Scopus, Web of Science, NCBI, etc., were searched using keywords such as "ethnomedicinal plants", "Santhal", "traditional practices", "pharmacological potential", "medicinal uses", "bioactive compounds", and "bioactivity". Relevant books and articles were reviewed to gather information on the ethnomedicinal plants used by the Santhal community (Goel et al., 1984; Iyer, 1992; Singh, 2017; Das, 2018; Mandal et al., 2020). Field surveys were also carried out during 2023–2024 in Mayurbhanj district, Odisha, India to document the nutraceutical plants consumed by the Santhal community along with the economic values. Information was collected through interactions with Santhal people. The selected age group of informants was 35–60 years. 10 villages of Mayurbhanj were visited and 28 informants were interviewed. Prior information consent was taken orally after explanation of the objectives of the study. The plant species were identified by authors followed by flora books (Kumar et al., 2022). Photographs are taken and given in the manuscript.

MEDICINAL PLANTS USED BY THE SANTHAL COMMUNITY

Santhals are very close to nature and usually depend on nearby forest areas. They collect the leaves of Saal and Bhalia for making plates. They collect the leaves of *Andrographis paniculata* for making powder and use it against cough, cold, and malaria. They collect the root of *Abroma augustum, Aristolochia indica, Curculigo orchioides, Curcuma longa, Desmodium gangeticum,* etc. for different health problems (Figure 1. Details are listed in Table 1.

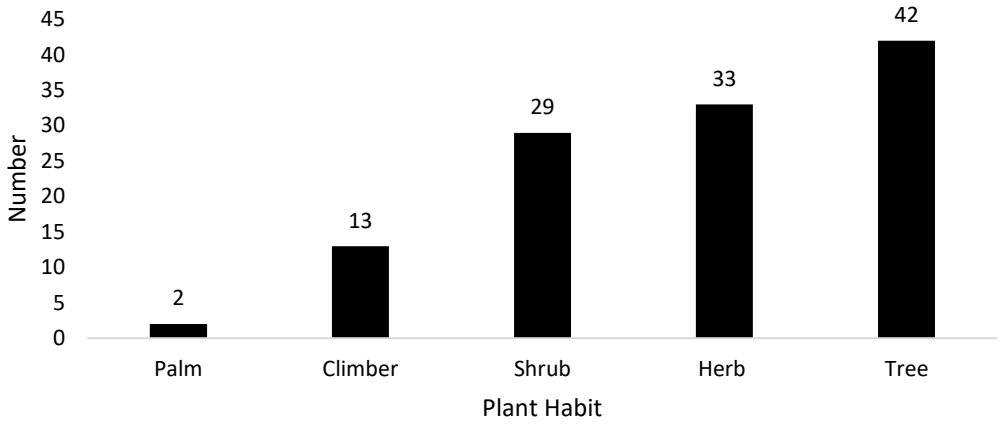

Fig. 1. Habit of the enumerated plants.

Table 1. Ethnomedicinal plants used by the Santhal community.

Plant Name (Family)	Local Name	Uses	References
Abroma augustum (L.) L.f. (Malvaceae)	Ulatkambal	Root extract is used to treat the menstrual disorder.	Mandal et al. (2020)
Achyranthes aspera L. (Amaranthaceae)	Cipcirap, kakra lata, kara lattha	Leaf paste is used to treat skin disease and fresh root decoction is used for abortion. Roots are used to treat cough, cold, asthma, and bronchitis. Plants are used for headaches.	Mandal et al. (2020) & Goel et al. (1984)
Aegle marmelos (L.) Corrêa (Rutaceae) (Figure 2e)	Singedaro	Fruit juice is taken orally to treat stomach problems and leaf paste is used to treat fever.	Hembrom and Kumar, (2017), Mandal et al. (2020) & Singh, (2017)
Alangium salviifolium (L.f.) Wangerin (Cornaceae) (Figure 2a)	Kumbri, dhela	The stem bark is used for abortion and the treatment of menstrual disorders. Fruit pulp is effective in controlling mucus and relieves constipation.	Goel et al. (1984) & Das, (2018)
Allium cepa L. (Amaryllidaceae)	Pyaz	Paste of the bulb is used in the treatment of joint pain.	Mandal et al. (2020)
Allium sativum L. (Amaryllidaceae)	Rasun	Juice made from the bulb is used in the treatment of ear problems.	Mandal et al. (2020)
Aloe vera (L.) Burm.f. (Asphodelaceae)	Ghritakumari	Paste prepared from the leaf used for skin care.	Mandal et al. (2020)
Alstonia scholaris (L.) R.Br. (Apocynaceae)	Chatni, chatta	Latex is massaged on the fractured bone. The stem bark is used to treat malaria and fevers.	Mandal et al. (2020) & Goel et al. (1984)
Amaranthus viridis L. (Amaranthaceae)	Gai gandhaori	The whole plant is crushed and applied to the snake bite area.	Mandal et al. (2020)
Ananas comosus (L.) Merr. (Bromeliaceae)	Anaros	The whitish thick basal portion of the leaf is made into a paste and consumed for the treatment of fever.	Mandal et al. (2020)
Andrographis echioides (L.) Nees (Acanthaceae)	Kusumpuru	Plants are used as an antidote against snake bites and scorpion stings.	Goel et al. (1984)
Andrographis paniculata (Burm.f.) Wall. ex Nees (Acanthaceae) (Figure 2f)	Kalmegh	Leaf extract is taken orally for 3 days to cure stomach problems. Leaves are used as an antiseptic for sores and blood purifiers.	Mandal et al. (2020) & Goel et al. (1984)
Annona reticulata L. (Annonaceae)	Gom	Fruits are used to treat diarrhoea and dysentery.	Das, (2018)
Annona squamosa L. (Annonaceae)	Mandargom	Fruit is consumed for digestion. Seeds are used for abortion and the treatment of menstrual disorders. The thalamus is used for antifertility. Bark powder is used for wound healing.	Hembrom and Kumar, (2017), Mandal et al. (2020) & Goel et al. (1984)
Areca catechu L. (Arecaceae)	Berel gua	Nuts are chewed to treat dysentery.	Mandal et al. (2020)
Aristolochia indica L. (Aristolochiaceae)	Godh	Roots are used as an antidote against snake bites and scorpion stings.	Goel et al. (1984)
Artemisia vulgaris L. (Asteraceae)	Tite pati	It is used to treat nose bleeding, asthma, and nervous problems.	Mandal et al. (2020)
Artocarpus heterophyllus Lam. (Moraceae)	Kanthal	Latex is used to treat skin problems.	Mandal et al. (2020)
Artocarpus lacucha Buch.-Ham. (Moraceae)	Barhal	Fruits are good for the liver.	Das, (2018)
Asparagus racemosus Willd. (Asparagaceae)	Shatamul, surundu	Dried root extract is used to treat dysentery and urine disorders. Plants are used for	Mandal et al. (2020), Goel et al. (1984) & Singh, (2017)

		headaches. Fresh tuber decoction is used for diabetes.	
Atylosia scarabaeoides (L.) Benth. (Fabaceae)	Birghore	Plants are used for treating gastric disorders. Leaves and stems are used for treating venereal diseases.	Goel et al. (1984)
Azadirachta indica A.Juss. (Meliaceae) (Figure 2j)	Neem	A regular bath is taken in warm neem water to treat itching problems. Leaves can be used for tumours.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Baliospermum montanum (Willd.) Müll.Arg. (Euphorbiaceae)	Danti	Seeds are used for treating gastric disorders, gout, and rheumatism.	Goel et al. (1984)
Basella alba L. (Basellaceae)	Purai nari	Leaf decoction is used in the treatment of diarrhoea.	Mandal et al. (2020)
Bauhinia acuminata L. (Fabaceae)	Seeara	Stem bark is used as an antidote against snake bites and scorpion stings.	Goel et al. (1984)
Bombax ceiba L. (Malvaceae)	Shimul	Juice made from the bark is used for excessive menstrual discharge.	Mandal et al. (2020)
Borassus flabellifer L. (Arecaceae)	Taal, tali	Juice of young leaves is mixed with water and given in cases of dysentery. Petioles are used for epilepsy and hysteria.	Mandal et al. (2020) & Goel et al. (1984)
Bridelia squamosa (Lam.) Gehrm. (Phyllanthaceae)	Henhahar	Stem bark is used to treat tuberculosis and as veterinary medicine.	Goel et al. (1984)
Bryophyllum pinnatum (Lam.) Oken (Crassulaceae)	Pathorkuchi	A red-hot iron rod is dipped into the leaf juice and 2 teaspoons of juice is consumed orally thrice daily for a week in diuretic, muscle relaxant, tumor, abdominal pain, etc.	Mandal et al. (2020)
Butea monosperma (Lam.) Kuntze (Fabaceae) (Figure 2d)	Murut, marup	Seeds are ground into powder and one teaspoon of powder is mixed with half a cup of water and taken orally once a day on an empty stomach to treat intestinal worms. Roots are used to treat tuberculosis.	Mandal et al. (2020) & Goel et al. (1984)
Cajanus cajan (L.) Huth (Fabaceae)	Raher	Leaves extract is used in jaundice.	Mandal et al. (2020)
Calotropis gigantea (L.) W.T.Aiton (Apocynaceae) (Figure 2k)	Akana	Heated leaves with a layer of oil are used for heat treatment in fractured bones and rheumatism.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Camellia sinensis (L.) Kuntze (Theaceae)	Cha	Leaf decoction is given orally with sugar as a nerve stimulant.	Mandal et al. (2020)
Cannabis sativa L. (Cannabaceae)	Ganja	Leaf paste is used in bowel complaints.	Mandal et al. (2020)
Carica papaya L. (Caricaceae)	Papaya	Latex is used as a cleansing agent during menstruation and abortion. Leaf paste is used in bone fractures.	Mandal et al. (2020)
Senna hirsuta (L.) H.S.Irwin & Barneby (Fabaceae)	Kadadiri	Seeds are used in impotency and other sexual disorders.	Goel et al. (1984)
Catharanthus roseus (L.) G.Don (Apocynaceae)	Baromasia	Leaf decoction is used in the treatment of diabetes.	Mandal et al. (2020)
Celosia cristata L. (Amaranthaceae)	Kukruchubaha	Flower extract is used in dysentery.	Mandal et al. (2020)
Centella asiatica (L.) Urb. (Apiaceae) (Figure 2l)	Rote ara	A pinch of salt is added to the leaf extract and taken orally to cure dysentery.	Mandal et al. (2020)
Citrus medica L. (Rutaceae)	Jambir	Fruit juice is used to treat intestinal worms.	Mandal et al. (2020)
Clerodendrum divaricatum Jack (Lamiaceae)	Bhetkona	Leaves are used on cuts, wounds, and burns.	Goel et al. (1984)
Clerodendrum viscosum Vent. (Lamiaceae)	Bharni	Plants are used on cuts, wounds, and burns. Leaves are used for headaches.	Goel et al. (1984)
Coccinia grandis (L.) Voigt (Cucurbitaceae) (Figure 2m)	Kenduri	The leaves extract is used to treat hypertension and diabetes.	Mandal et al. (2020)
Cochlospermum Gossypium DC. (Bixaceae)	Hopu	The stem bark is used for jaundice treatment.	Goel et al. (1984)
Cocos nucifera L. (Arecaceae)	Narkol	The copra of the dry fruit is crushed to extract oil and used for ear pain.	Mandal et al. (2020)
Colocasia esculenta (L.) Schott (Araceae)	Kachu	Leaf and tuber curry is consumed with food to treat constipation.	Mandal et al. (2020)
Curculigo orchioides Gaertn. (Hypoxidaceae)	Turum	Roots are used as an antidote against snake bites and scorpion stings.	Goel et al. (1984)
Curcuma longa L. (Zingiberaceae)	Shasang	Rhizome paste is used to treat cuts and wounds.	Mandal et al. (2020)
Cuscuta reflexa Decne. (Convolvulaceae)	Sornolota	Juice prepared from the stem is used to treat stomach problems.	Mandal et al. (2020)
Cynodon dactylon (L.) Pers. (Poaceae)	Dhubi ghas	Leaves are made into a paste by grinding them with teeth and used to stop bleeding.	Mandal et al. (2020)
Cyperus rotundus L. (Cyperaceae)	Mutheghas	Bulbs are used for treating gastric disorders.	Goel et al. (1984)

Datura metel L. (Solanaceae)	Dhutra	Leaves are made into a paste, warmed, and applied to the blister or abscess. Root or leaves are used for chest pain.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Dendrophthoe falcata (L.f.) Ettingsh. (Loranthaceae) (Figure 2b)	Mandargam banda, banda, bandia	Leaves and stems are used for antifertility and skin diseases.	Goel et al. (1984) & Iyer, (1992)
Desmodium gangeticum (L.) DC. (Fabaceae)	Chapot, chopot	Roots are used as an antidote against snake bites and scorpion stings. Plants are used to treat ophthalmic infections.	Goel et al. (1984)
Desmodium microphyllum (Thunb.) DC. (Fabaceae)	Chattoomara	Roots are used for abortion and the treatment of menstrual disorders.	Goel et al. (1984)
Desmodium pulchellum (L.) Benth. (Fabaceae)	Jeetedari	Stem bark is used for headaches.	Goel et al. (1984)
Diospyros melanoxylon Roxb. (Figure 2n) (Ebenaceae)	Terel	Fruits cure dysentery. A paste of unripe fruits is applied over the fractured bones for healing. Leaves are used for a cough.	Hembrom and Kumar, (2017) & Das, (2018)
Diplocyclos palmatus (L.) C.Jeffrey (Cucurbitaceae)	Kahu botke, kahubhutki	Leaf decoction is used in the treatment of stomach pain. Leaves are used to treat ophthalmic infections.	Mandal et al. (2020) & Goel et al. (1984)
Elaeodendron glaucum (Rottb.) Pers (Celastraceae)	Nimri	The stem bark is used for treating gastric disorders.	Goel et al. (1984)
Elephantopus scaber L. (Figure 2o) (Asteraceae)	Marachutta	Roots are used for abortion and the treatment of menstrual disorders.	Goel et al. (1984)
Eleusine indica (L.) Gaertn. (Poaceae)	Kharkosa	The root paste is used to treat vaginal diseases.	Mandal et al. (2020)
Euphorbia hirta L. (Euphorbiaceae)	Pusitoa	Leaves are used as an antidote against snake bites and scorpion stings. Plant extract is used to treat skin diseases.	Goel et al. (1984) & Iyer, (1992)
Evolvulus nummularius (L.) L. (Convolvulaceae)	Sukrisure	Plants are used on cuts, wounds, and burns.	Goel et al. (1984)
Ficus racemosa L. (Moraceae)	Loa	Latex is mixed with water and taken orally to treat diarrhoea. It is also used to treat boils, blisters, and ulcers. The fruits are given for menorrhagia, bronchitis, dry cough, kidney diseases, urinary troubles, and diabetes.	Mandal et al. (2020) & Das, (2018)
Flacourtia indica (Burm.f.) Merr. (Salicaceae)	Serali	Fruits cure liver disorders.	Das, (2018)
Gnaphalium luteoalbum L. (Asteraceae)	Dudhumulu	Plants are used in mother and child health care.	Goel et al. (1984)
Grewia obtusa Wall. ex Dunn (Malvaceae)	Kuletaro	Plants are used for treating boils, blisters, and ulcers.	Goel et al. (1984)
Hemidesmus indicus (L.) R.Br. ex Schult. (Apocynaceae)	Dudhilota	Roots are used to treat skin diseases, impotency, and other sexual disorders.	Goel et al. (1984) & Iyer, (1992)
Holoptelea integrifolia (Roxb.) Planch. (Ulmaceae)	Chiroradari	The stem bark is used in hydrocele.	Goel et al. (1984)
Hygrophila auriculata (Schumach.) Heine (Acanthaceae)	Kulekhara	Freshly prepared leaf extract is used to treat anaemia.	Mandal et al. (2020)
Indigofera cassioides Rottler ex DC. (Fabaceae)	Gada phool	Plants are used for easy delivery and to promote contraception.	Goel et al. (1984)
Indigofera linnaei Ali (Fabaceae)	Tejomola	Roots are used for antifertility. Plants are used in veterinary medicine.	Goel et al. (1984)
Justicia adhatoda L. (Figure 2h) (Acanthaceae)	Harbakama, vasakdog	Leaf extract is taken orally to treat cough after keeping the extract in an iron pot for purification. Leaves are also used to treat colds, asthma, and bronchitis. The plant is used for treating venereal diseases.	Mandal et al. (2020) & Goel et al. (1984)
Lagerstroemia speciosa (L.) Pers. (Lythraceae)	Jarul	Bark extract is used as an astringent.	Mandal et al. (2020)
Leonotis nepetifolia (L.) R.Br. Lamiaceae	Dhompo	Flowers and seeds are used on cuts, wounds, and burns.	Goel et al. (1984)
Leucas aspera (Willd.) Link (Lamiaceae)	Durfa	Leaves are crushed and mixed with a little salt and 2 drops of the juice are applied to the nose to treat headache problems.	Mandal et al. (2020)
Mangifera indica L. (Anacardiaceae)	Aam	The juice obtained from the crushed bark is taken orally for diarrhoea and applied to treat rheumatic pain.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Mimosa rubicaulis Lam. (Fabaceae)	Jhapnidari	Leaves are used for treating epilepsy and hysteria.	Goel et al. (1984)

Momordica charantia L. (Cucurbitaceae)	Karla	5 teaspoons of leaf or fruit extract are taken orally once daily to prevent diabetes, stomach disorders, asthma, and anaemia.	Mandal et al. (2020)
Moringa oleifera Lam. (Moringaceae)	Chainma, munga, mungedog	Mature leaves are boiled and taken orally to treat high blood pressure. Tender leaves powder is used for scurvy and catarrhal diseases. Bark extract is used to treat epilepsy. The stem bark is used for treating baldness. Leaves are used in mother and child health care.	Hembrom and Kumar, (2017), Mandal et al. (2020) & Goel et al. (1984)
Musa paradisiaca L. (Musaceae)	Kayra	Sap obtained from the lower side of the stock is used for liver problems.	Mandal et al. (2020)
Neolamarckia cadamba (Roxb.) Bosser (Rubiaceae)	Kodom	Leaf decoction is used to treat mouth ulcers. Bark is used to treat cholera.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Nicotiana tabacum L. (Solanaceae)	Tamakur	Leaf decoction is given orally to the snake-bite patient.	Mandal et al. (2020)
Ochna obtusata DC. (Ochnaceae)	Champa	Roots are used for treating venereal diseases.	Goel et al. (1984)
Ocimum tenuiflorum L. (Lamiaceae)	Tulsi	The leaves extract is mixed with ginger paste and honey to treat a cough.	Mandal et al. (2020)
Oroxylum indicum (L.) Kurz (Bignoniaceae)	Banahata	Stem bark paste is taken orally in the morning on an empty stomach to treat jaundice. The bark is used for spleen enlargement. Seeds are used against snake bites and tender fruit is used for flatulence.	Mandal et al. (2020) & Singh, (2017)
Oxalis corniculata L. (Oxalidaceae)	Tandi chatam ara	Leaves are made into a paste and taken 2 teaspoons for 2-3 days for stomach ache or 10-12 days for gastric problems. Whole plant juice is used for curing skin diseases.	Mandal et al. (2020) & Iyer, (1992)
Persicaria barbata (L.) H.Hara (Polygonaceae)	Jiyeti	The leaf extract is taken orally to prevent pregnancy.	Mandal et al. (2020)
Phyllanthus emblica L. (Euphorbiaceae)	Merel	Decoction of dried fruit juice treats diarrhoea, dysentery, anaemia, and cystitis in women. Leaf decoction is used to treat fever.	Singh, (2017), Mandal et al. (2020) & Hembrom and Kumar, (2018)
Piper betle L. (Piperaceae)	Pan	Leaf juice is used externally for headaches.	Mandal et al. (2020)
Piper longum L. (Piperaceae)	Ralee	Fruit juice is used to treat dysentery and bark extract is used to reduce lethargy.	Mandal et al. (2020)
Piper nigrum L. (Piperaceae)	Golmirac	Dried fruit decoction is used to treat cough and dysentery.	Mandal et al. (2020)
Premna latifolia Thwaites (Lamiaceae)	Sitapan	Latex is used for treating boils, blisters, and ulcers.	Goel et al. (1984)
Pterocarpus marsupium Roxb. (Fabaceae)	Murga	Leaves are used to treat skin diseases. Heartwood infusion is used for diabetes, diarrhoea, and dysentery.	Goel et al. (1984), Iyer, (1992) & Singh, (2017)
Pygmaeopremna herbacea (Roxb.) Moldenke (Lamiaceae)	Borogiriha	Roots are used to treat rheumatism and gout.	Goel et al. (1984)
Rauvolfia serpentina (L.) Benth. ex Kurz (Apocynaceae)	Sarpagandha	Root paste is used to treat cuts and wounds and applied to snake bites. Decoction of the root is also used to treat fever, dysentery, and hypertension.	Mandal et al. (2020) & Singh, (2017)
Ricinus communis L. (Euphorbiaceae)	Eradom	Seed oil is applied on the belly to treat stomach aches.	Mandal et al. (2020)
Rivea hypocrateriformis (Desr.) Choisy (Convolvulaceae)	Kidura	Plants are used for treating toothaches and gum problems.	Goel et al. (1984)
Scoparia dulcis L. (Plantaginaceae)	Chini dare	The plant leaves are crushed and taken orally to treat blood dysentery.	Mandal et al. (2020)
Semecarpus anacardium L.f. (Anacardiaceae)	Soso	The red-orange part of the fruits is considered good for the female reproductive system.	Das, (2018)
Senna sophera Roxb. (Fabaceae)	Chakoda	Leaves' decoction is used as a laxative.	Mandal et al. (2020)
Shorea robusta C.F.Gaertn. (Figure 2i) (Dipterocarpaceae)	Sarjam	Young leaf paste is used to treat wounds. Resin is used to treat cystitis in women.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Solanum khasianum C.B.Clarke (Solanaceae)	Hanje	Fruits and roots are used to treat cough, cold, asthma, and bronchitis.	Goel et al. (1984)
Solanum tuberosum L. (Solanaceae)	Alu	Boiled tubers are taken with a little salt for stomach pain.	Mandal et al. (2020)
Streblus asper Lour. (Figure 2g) (Solanaceae)	Sahora	Used in toothache.	Mandal et al. (2020)

Syzygium cumini (L.) Skeels (Figure 2c) (Myrtaceae)	Kode dare, sokod	Juice is made from bark and taken orally for stomach aches and gastric problems. Decoction of the fruits and seeds is given to control diabetes and urinary troubles.	Hembrom and Kumar, (2017), Mandal et al. (2020) & Das, (2018)
Tagetes erecta L. (Asteraceae)	Kusumbibaha	The leaves extract is used to stop bleeding.	Mandal et al. (2020)
Tamarindus indica L. (Fabaceae)	Jojo dare	Fruit is used as a laxative.	Mandal et al. (2020)
Taxillus tomentosus (B.Heyne ex Roth) Tiegh. (Loranthaceae)	Guthibanda	Leaves are used to treat malaria and fevers.	Goel et al. (1984)
Terminalia arjuna (Roxb. ex DC.) Wight & Arn. (Combretaceae)	Kouha	Bathing with bark decoction reduces body pain and is used to treat leprosy.	Hembrom and Kumar, (2018) & Mandal et al. (2020)
Terminalia bellirica (Gaertn.) Roxb. (Combretaceae)	Boyra	Seeds are used to treat dysentery. Ripe dry fruits are used for diarrhoea, dropsy, headache, indigestion, and piles. The bark is used for anaemia and leukoderma.	Mandal et al. (2020) & Singh, (2017)
Terminalia catappa L. (Combretaceae)	Badam	The kernel of the fruits is eaten fresh to relieve constipation but high doses can cause diarrhoea.	Das, (2018)
Thysanolaena maxima (Roxb.) Kuntze (Poaceae)	Veerkunga	Roots are used in veterinary medicine.	Goel et al. (1984)
Toona ciliata M.Roem. (Meliaceae)	Tun	The stem bark is used for treating gastric disorders.	Goel et al. (1984)
Vachellia nilotica (L.) P.J.H.Hurter & Mabb. (Fabaceae)	Babla	Pods are used for the treatment of dysentery.	Mandal et al. (2020)
Viscum articulatum Burm.f. (Santalaceae)	Banda	Plants are used for the treatment of bone fractures.	Goel et al. (1984)
Vitex negundo L. (Lamiaceae)	Sinwari	Leaves are used to treat pains, swellings, and body aches.	Goel et al. (1984)
Woodfordia fruticosa (L.) Kurz (Lythraceae)	Iccha	Flowers are used for cooling effects.	Goel et al. (1984)
Zingiber officinale Roscoe (Zingiberaceae)	Ada	Rhizome paste is used to treat a cough.	Mandal et al. (2020)
Ziziphus mauritiana Lam. (Rhamnaceae)	Kul	Paste of seeds is good for leucorrhea.	Mandal et al. (2020)

Fig. 2. Some common medicinal plants used by the Santhal community (**a**) *Alangium salviifolium*, (**b**) *Dendrophthoe falcata*, (**c**) *Syzygium cumini*, (**d**) *Butea monosperma*, (**e**) *Aegle marmelos*, (**f**) *Andrographis paniculata*, (**g**) *Streblus asper*, (**h**) *Justicia adhatoda*, (**i**) *Shorea robusta*, (**j**) *Azadirachta indica*, (**k**) *Calotropis gigantea*, (**l**) *Centella asiatica*, (**m**) *Coccinia grandis*, (**n**) *Diospyros melanoxylon*, (**o**) *Elephantopus scaber*.

BIOACTIVE COMPOUNDS AVAILABLE ON MEDICINAL PLANTS USED BY THE SANTHAL COMMUNITY

The reported bioactive compounds of selected medicinal plants used by the Santhal community of India have diverse therapeutic uses and some are discussed below. The most important bioactive compounds isolated like Achyranthine from *Achyranthes aspera,* Allitridin from *Allium sativum,* Andrographolide from *Andrographis paniculata,* Asiaticosides from *Centella asiatica,* Azadirachtin from *Azadirachta indica,* Betulin from *Diospyros melanoxylon* and Deoxyelephantopin from *Elephantopus scaber* (Figure 3). Details are listed in Table 2.

Table 2. Important bioactive compounds in commonly used medicinal plants by the Santhal community.

Secondary Metabolites	Plants	Bioactivity	Source
Achyranthine and Achyranthoside C	*Achyranthes aspera*	Cardiovascular activity	Ghimire et al. (2015)
Allitridin	*Allium sativum*	Anti-ulcer activity	Gupta et al. (2021)
Andrographolide	*Andrographis paniculata*	Antidiabetic activity	Bhatnagar (2023)
Aristolochic acid I	*Aristolochia indica*	Antitumour activity	Lerma-Herrera et al. (2022)
Asiaticosides	*Centella asiatica*	Wound-healing activity	Gupta et al. (2021)
Asperoside, indroside, and strebloside	*Streblus asper*	Anti-diabetic activity	Chamariya et al. (2022)
Azadirachtin	*Azadirachta indica*	Antioxidant activity	Alzohairy, (2016)
Baicalein	*Oroxylum indicum*	Anti-tumour and anti-cancer activity	Salleh et al. (2020)
Betulin	*Diospyros melanoxylon*	Anti-diabetic activity	Al Rashid et al. (2018)
Bhilawanol and anacardic acid	*Semecarpus anacardium*	Anti-cancer, anti-bacterial and anti-inflammatory activity	Al Mughairbi et al. (2021)
Curcumin	*Curcuma longa*	Anti-inflammatory activity	Gupta et al. (2021)
Deoxyelephantopin	*Elephantopus scaber*	Anti-oxidant activity and anticancer activity	Wang et al. (2014); Hirdeve and Rangari, (2014)
Eugenol	*Ocimum tenuiflorum*	Anti-ulcerogenic property	Gupta et al. (2021)
Gangetin	*Desmodium gangeticum*	Anti-cancer activity	Joshi et al. (2023)
Hemidesmol	*Hemidesmus indicus*	Anti-cancer activity	Darshini et al. (2024) & Nandy et al. (2020)
Leucasperosides	*Leucas aspera*	Hepato-protective activity	Das et al. (2012)
Lycopene	*Carica papaya*	Anti-oxidant activity	Gupta et al. (2021)
Marsupsin & pterostilbene	*Pterocarpus marsupium*	Anti-diabetic activity	Ahmad et al. (2022)
Phyllantine	*Phyllanthus emblica*	Anti-oxidant activity	Gupta et al. (2021)
Piperine	*Piper nigrum*	Antihypertensive, anti-asthmatic, and anti-inflammatory activity	Ashokkumar et al. (2021)
Piperine	*Piper longum*	Anticancer and antioxidant activity	Carsono et al. (2022)
Quercetin	*Bauhinia acuminata*	Antimicrobial activity	Malek et al. (2024)
Racemosic acid	*Ficus racemosa*	Anti-fungal activity	Chaware et al. (2020)
Racemosides	*Asparagus racemosus*	Antioxidant activity	Negi et al. (2010)
Reserpine	*Rauvolfia serpentina*	Antihypertensive activity	Kumari et al. (2013)
Salviifosides	*Alangium salviifolium*	Anti-inflammatory activity	Panara et al., (2016)
Serpentine	*Rauvolfia serpentina*	Antipsychotic activity	Kumari et al. (2013)
Shogaol	*Zingiber officinale*	Anti-ulcer activity	Gupta et al. (2021)
Vasicine	*Justicia adhatoda*	Anti-inflammatory activity and antioxidant activity	Ahmad et al. (2009) & Narasimhaji et al. (2023)
Viridiflorol	*Vitex negundo*	Anti-inflammatory, antioxidant, and anti-mycobacterium tuberculosis activity	Garg et al. (2024)
Vitexin	*Butea monosperma*	Anti-inflammatory activity	Gupta et al. (2021)

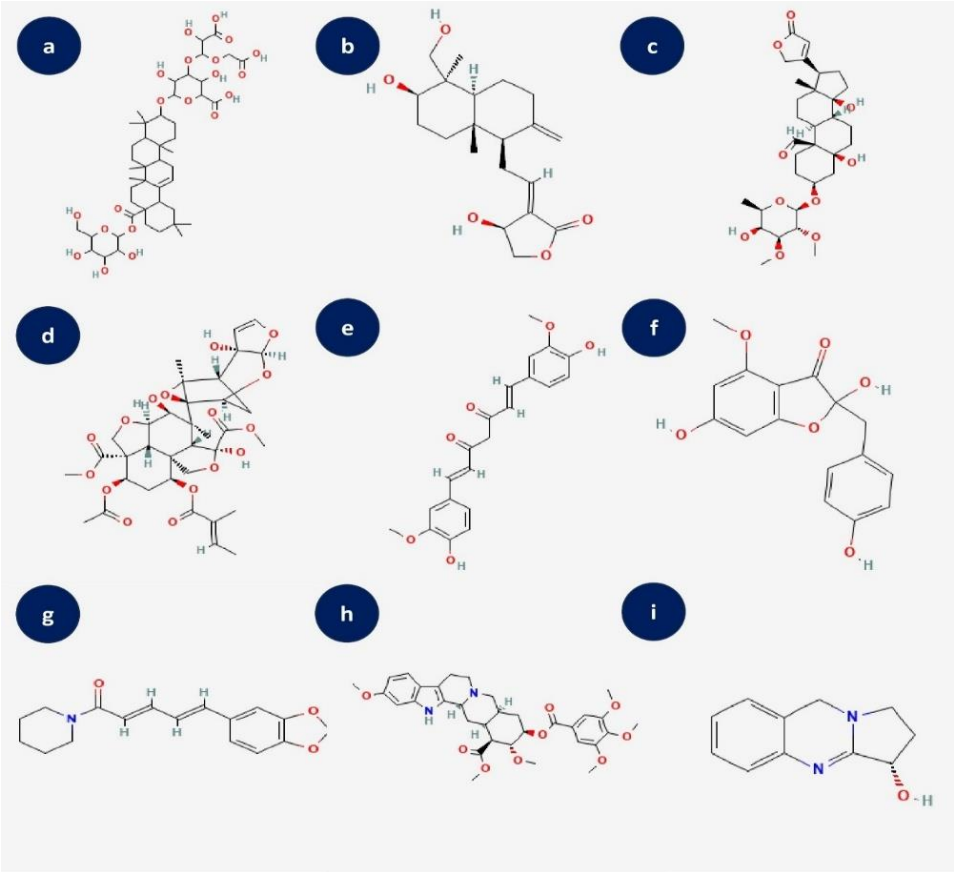

Fig. 3. Bioactive compounds present in the medicinal plants used by Santhal community (**a**) Achyranthoside C, (**b**) Andrographolide, (**c**) Strebloside, (**d**) Azadirachtin, (**e**) Curcumin, (**f**) Marsupsin, (**g**) Piperine, (**h**) Reserpine and (**i**) Vasicine (https://pubmed.ncbi.nlm.nih.gov/ (accessed on 28 December 2024)).

NUTRACEUTICALS USED BY THE SANTHAL COMMUNITY

Nutraceuticals are an important seasonal food of the Santhal community throughout their inhabitant areas. They usually consume the fruits of *Aegle marmelos*, *Alangium salviifolium*, *Annona reticulata*, *Annona squamosa*, *Antidesma acidum*, *Antidesma bunius*, *Artocarpus heterophyllus*, *Artocarpus lacucha*, *Baccaurea ramiflora*, *Bridelia retusa*, *Buchanania lanzan*, *Myena spinosa*, *Cordia dichotoma*, *Dillenia pentagyna*, *Diospyros malabarica*, *Diospyros melanoxylon*, *Ficus benghalensis*, *Flacourtia indica*, *Flacourtia jangomas*, etc. They also consume the leafy nutraceuticals like *Achyranthes aspera*, *Aerva lanata*, *Amaranthus spinosus*, *Amaranthus viridis*, *Alternanthera sessillis*, *Azadirachta indica*, *Bacopa monieri*, *Centella asiatica*, *Bauhinia purpurea*, *Begonia picta*, etc. The most common tuberous nutraceuticals consumed by the Santhal community are *Amorphophallus paeoniifolius*, *Dioscorea bulbifera*, *Dioscorea pubera*, *Dioscorea wallichi, Dioscorea hispida* and *Solena amplexicaulis*. These plant parts have a lot of nutraceutical and pharmacological potential, which should be explored scientifically.

UNEXPLORED MEDICINAL FOOD CONSUMED BY THE SANTHAL COMMUNITY

A Santhal community has very good knowledge about the therapeutic agents, they also use such plants which are not been explored. During the fieldwork for this review, the authors found some plants with very less or no reports. These plants are most important in the contemporary situation where the world faces AMR and drug failure. The enumerated unexplored plants are *Zanthoxylum rhetsa*, *Vitex leucoxylon*, *Symplocos cochinchinensis*, *Styrax serrulatum*, *Solanea sterculiacea*, *Prunus pygeoides*, *Phoebe wightii*, *Ocotea lancifolia*, *Meliosma simplicifolia* and *Maytenus bailadillana*.

ECONOMIC VALUES OF MEDICINAL PLANTS USED BY SANTHALS

Local medicinal plants collected by the Santhal community also have economic value. They collect medicinal plants like *Andrographis paniculata*, *Asparagus racemosus*, *Cissampelos pareira*, *Centella asiatica*, *Myena spinosa*, *Antidesma bunius*, *Syzygium cumini*, *Schleichera oleosa* and *Diospyros melanoxylon* and used to sell them in local markets. Sometimes, they also collect seeds of *Bauhinia vahlii*, and their stem bark to sell in tribal weekly markets.

CONCLUSIONS

The Santhal community has sound traditional therapeutic knowledge on plants and their food, medicinal and economic uses. In present study, 120 medicinal, 34 nutraceutical and 10 economically important plants are presented, commonly used by Santhal community, highlighting the importance of providing food, medicines and livelihood. These plants can be used for value addition for sustainable development and conservation of plants for the bioresources of the study areas.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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