An ethnobotanical study of medicinal plants used by ethnic communities of Nuapada District, Odisha to treat periodontal disorders

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Research

Abstract

Background: The herbal remedies commonly employed in the management of dental disorders have antimicrobial, anti-inflammatory, analgesic, and astringent characteristics. Antibacterial plant species can prevent tooth decay and bacterial growth. Despite the fact that ethnobotanical knowledge offers insightful perspectives on conventional thought, scientific inquiry and secure dental disease treatments, some cultures have established specific customs related to the use of botanical specimens for oral hygiene. The study's main goal was to document Nuapada's indigenous people's ethnomedicinal uses of plant species to treat periodontal disorders.

Methods: Questionnaires in local languages were used to collect information from 30-80-year-olds in multiple locations. The survey covered each recommended plant's component, therapeutic uses and preparation. Study findings were analyzed using frequency of citation (FC), relative frequency of citation (RFC), cultural importance index (CI), informant participants (IP), informant response (IR) and use report (UR).

Results: The outcomes of the investigation proved that *Azadirachta indica* showed the highest RFC and highest CI value of 0.96 among the plants that were investigated. The plant species *Ocimum basilicum* , *Curcuma longa* and *Withania somnifera* also showed a significant RFC value of 0.90, 0.89, and 0.87, respectively. The CI of each plant lies in its therapeutic value, as it offers a pharmacological approach for treating dental disorders.

Conclusions: The above ethnobotanical surveys conclude that *Azadirachta indica* is widely recognized as a traditional medicinal plant with significant potential for treating dental disorders, as compared to other plant species.

Keywords: Ethnobotanical Study, Nuapada District, Medicinal Plants, RFC, CI, Oral Diseases

Background

Ethnobotanical applications of plants are the ways that native groups have used plants in the past for belongings like food, medicine, housing, clothing, and cultural practices (Abdin *et al.*2022).This area of study tries to figure out how people and plants interact with each other and how plants have been used in different societies' daily lives and traditional traditions. Indigenous people have learned a lot about the plants in their area and how they can be used for good over time. They have seen how certain plants can be used to treat illnesses, improve general health, and meet other useful needs, and have passed this information on to future generations (Guo *et al.*2022). Ethnobotanical understanding includes figuring out how to identify, collect, prepare, and use plants as medicine. This includes using drinks, poultices, ointments, or inhalations made from plant parts like leaves, bark, roots, fruits, and seeds. Traditional healing methods like Ayurveda, Traditional Chinese Medicine, and Native American healing practices often use plant-based medicines that come from ethnobotanical knowledge. In addition to health, ethnobotany has uses in other areas as well. Plants have been used in cooking and have given people food and energy. They have also been used to build shelters, make tools, make clothes, and take part in events and traditions (Sulaiman *et al.*2022). Ethnobotany not only looks at how plants can be used in everyday life, but it also looks at the cultural and spiritual links that native people have with the plants around them. It helps protect wildlife, keep traditional knowledge alive, and understand the complex connection between people and the rest of the natural world. Overall, the ethnobotanical use of plants is a bridge between traditional knowledge and current scientific knowledge. It gives us useful information about how different cultures have used plants for different things (Mlilo and Sibanda 2022).

The ethnobotanical data pertaining to plants utilized in the treatment of dental ailments pertains to the customary knowledge and practices of employing plants for the promotion of oral health across various cultures and native populations. The aforementioned customs have been transmitted across successive cohorts and frequently grounded on the perceptions and encounters of the indigenous populace (Ahmed *et al.*2022).Plants have been utilized in various traditional medical systems, such as Ayurveda, traditional Chinese medicine, and indigenous healing practices, for the purpose of managing dental ailments and enhancing oral well-being. The medicinal properties of different plant parts, including leaves, bark, twigs, and roots, are utilized for therapeutic purposes (Al Eid 2021).The botanicals utilized in the treatment of dental ailments frequently exhibit characteristics such as antimicrobial, anti-inflammatory, analgesic, and astringent properties. Several plant species, such as *Azadirachta indica*, *Acacia nilotica* and *Syzygium aromaticum*, are recognized for their antimicrobial characteristics, which have the potential to inhibit bacterial growth and avert dental infections (Albuquerque *et al.*2006). *Aloe barbadensis* and *Curcuma longa* possess anti-inflammatory properties that may facilitate the reduction of gum inflammation. Various forms of these plants are commonly utilized, such as mastication, brushing, gargling, or integration into self-made treatments, dentifrices, oral rinses, or powders (Arumugam *et al.*2020). Certain cultures have established particular customs or arrangements that are linked to the utilization of these botanical specimens for the purpose of maintaining oral hygiene. It is noteworthy that although ethnobotanical knowledge offers valuable perspectives on customary practices, scientific investigation is imperative to substantiate the effectiveness and safety of these botanical treatments for dental ailments. Hence, it is recommended to seek the guidance of a healthcare expert or dental practitioner for accurate identification and management of dental concerns (Baby *et al.*2022).

There exist numerous plant species that have been utilized in traditional practices for a significant duration of time. *Azadirachta indica* (Damtew 2022)is recognized for its antimicrobial characteristics and has been traditionally employed for maintaining oral hygiene through practices such as masticating *Azadirachta indica* twigs or leaves, or utilizing toothpaste and mouthwash derived from *Azadirachta indica*. *Syzygium aromaticum* (de Alba *et al.*2023) exhibits analgesic and antiseptic properties. Frequently employed for dental pain management this substance can be administered topically to the affected region or incorporated as a constituent in oral hygiene products such as toothpaste or mouth rinses. The utilization of *Commiphora myrrha* (Domb 2014) for oral health purposes has been a customary practice owing to its antimicrobial and anti-inflammatory characteristics. It has the potential to be utilized in oral rinses or administered externally to enhance oral sanitation. *Salvia officinalis* contains antimicrobial and anti-inflammatory characteristics, which make it a valuable resource in certain societies for treating oral ulcers, gingivitis, and halitosis. *Salvadora persica* (Faiza Fedoul *et al.*2022) commonly referred to as the toothbrush tree, has been utilized in customary oral hygiene routines. It is widely believed that the act of chewing on twigs can provide benefits such as promoting dental hygiene by cleaning teeth, stimulating gum tissue and mitigating the occurrence of plaque and gum-related ailments. *Curcuma longa* exhibits anti-inflammatory and antimicrobial properties. The application of this substance is occasionally employed in oral health care routines as a means of mitigating gingival inflammation and fostering comprehensive oral cleanliness. The plant species *Aloe barbadensis* (Hashem *et al.*2023) has been historically employed in certain societies due to its purportedly therapeutic and palliative characteristics. It has the potential to be administered either topically or orally for the treatment of ailments such as oral ulcers and periodontal inflammation. The research focused on identifying medicinal plants used to treat dental disorders among ethnic

communities in Nuapada District of Odisha, India. Further ethnobotanical knowledge was utilized to gather practical information about various plants.

Materials and Methods

Study area

The geographical location of Nuapada district is situated in the western part of the state Odisha. Nuapada district is about 20°0' to 21°5' north and 82°32' to 83°20' east in terms of latitude and longitude (Hamrouni *et al.*2023). About 3,852 square kilometers (1,487 square miles) make up the area of the district. The forest of Nuapada districts is characterized by a diverse range of tree species, including *Shorearo busta, Tectona grandis*, *Bambusa vulgaris*, and *Madhuca longifolia*. These trees provide a dense canopy that offers shade and shelter to a diverse range of flora and fauna. Additionally, the forest is also home to various perennial woody plants, Lianas and Poaceae that contribute to the overall biodiversity of the area along with several ethnobotanical importances (Jadid *et al.*2020). The ethnobotanical importance of the forest in Nuapada district is evident through the traditional uses of these plants in medicine, crafts, and rituals by the indigenous people residing in the area (Ez zoubi *et al.*2022). The district is known for its ethnic groups, rich cultural history, and political importance. It is an important rural area, and most of the people who live there work in agriculture. The ethnic communities such as bhulia, kutia, kondha, bhulia, harijan, teli are the resident of Nuapada district. These ethnic communities are preserving their unique cultural traditions and way of life. They contribute to the rich diversity of the region and play a significant role in its social fabric (Ndhlovu *et al.*2023).

Methodology

The ethnobotanical survey involved 15 visits to 10 villages in the Komna block of Nuapada district, including Litibahal, Bisibahal, Barkot, Batibahal, Michhapali, Thongo, Haluapali, Belaradana, Bhalukona, and Jipabahal. During each visit, the researchers spent four days in each village and four hours per day, resulting in total study duration of 40 days or 160 hours. The researchers carefully selected these villages to ensure a diverse representation of the local flora and traditional knowledge as depicted in (Table S1). The ethnobotanical survey aimed to document the traditional uses of plants by the local communities for medicinal, culinary, and other purposes. The researchers conducted interviews with members of the community and documented data pertaining to the customary utilization of plants for medicinal, nutritional, and various other applications. The collection of ethnobotanical data, including local names, methods of preparation, and medicinal applications, was conducted through interviews and discussions with ethnic practitioners in and around the study area (Kuttappan *et al.*2022). By including participants from the age group of 30 to 80, a wide range of experiences and insights were expected to be gathered. Additionally, this age range was chosen as it is commonly associated with accumulated wisdom and a deeper understanding of traditional practices related to plants. In the end, a total of 105 participants were included in our study. The detailed questionnaire has been mentioned in Appendix 1. In addition to common names, the survey inquired about each prescribed plant's plant part, therapeutic applications, preparation methods (e.g., decoction, paste, powder, and juice), the mode of usage (fresh or dried), and the combination with other plants. The botanical specimens possessing medicinal properties were identified by their local names, visually documented through photography, and subsequently collected for the purpose of creating a herbarium as mentioned in Tabke S1. Several photographs were captured during the process of collecting ethnobotanical data on medicinal plants, as depicted in Figure 1.

Measurement of Quantitative Parameters

Frequency of Citation (FC) and Relative Frequency of Citation (RFC)

The FC was calculated as follows:

FC=Number of times a particular species was mentioned/total number of times that all species were mentioned×100

The RFC index (Acharya *et al.*2022) was evaluated by dividing the number of informants who mentioned the use of the species (FC) by the total number of informants participating in the survey (N).

The RFC index ranges from “0” when nobody referred to a plant as useful to “1” when all informants referred to a plant as useful.

$$\text{RFC} = \frac{FC}{N}$$

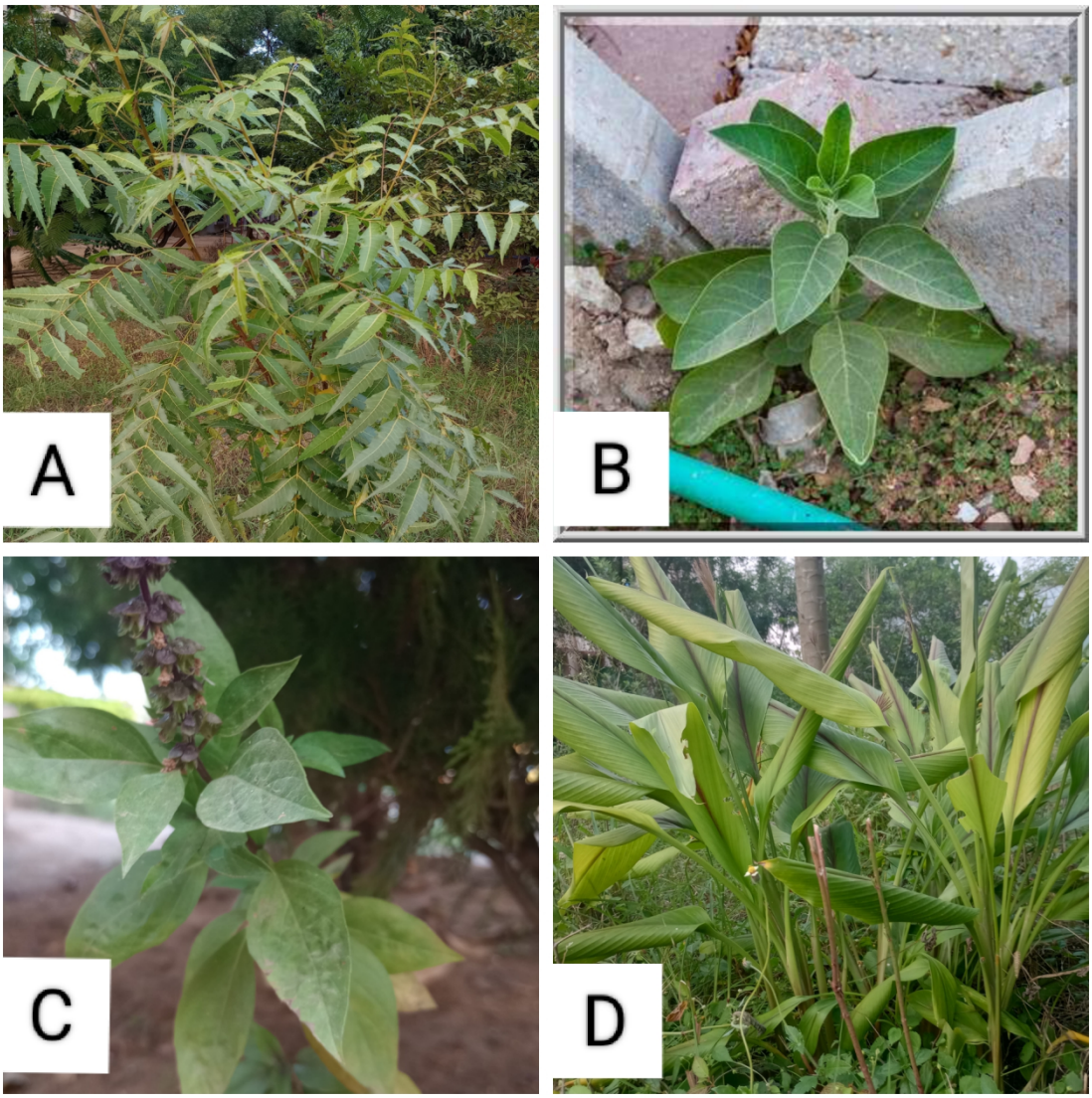

Figure 1. A pictorial representation of plant specimen with highest RFC values (A) *Azadirachta indica (*B) *Withania somnifera* (C) *Ocimum basilicum* (D) *Curcuma longa*.

Cultural Importance Index

In order to find out cultural significance (Mahmoud *et al.*2020) of each species in every locality cultural importance index (CI) was calculated as the summation of the use report (UR) in every use category mentioned for a species in the locality divided by number of participants (N) in that locality. Similarly mean cultural importance index (mCI) of each, specie was also deliberate. The cultural significance of each family (CIf) was calculated by adding cultural importance index (CI) of the species from each family.

$$CI = \sum_{i=1}^{i=NU} \frac{URi}{N}$$

The therapeutic value of each plant held cultural significance in providing a pharmacological application for treating dental disorders (Mesfin *et al.*2014).

Results

Demographic Information

This study involved conducting interviews with a total of 105 participants, comprising 55 males and 50 females. The informants were selected from various age groups and backgrounds to ensure diversity in our sample (Merouane *et al.*2022). Additionally, we include participants from various educational levels. The analysis of the demographic characteristics indicated that there were a greater proportion of informants with no formal education compared to other educational levels.

The level of participation among informants who have completed their education is very low. It has been discovered that individuals with limited educational backgrounds tend to provide greater quantity of information in comparison to those who have graduated. The study surveyed participants aged 30-80, with the majority falling within the 70-80 age range. The age group with the most informants was the older age group, possibly reflecting increased interest in participating. The study found that younger informants had a decrease in ethnomedicinal knowledge, possibly due to modern medicine, urban lifestyles, and the lack of traditional knowledge transmission. A group (Nakayama *et al.*2022) explained the majority of participants were older, and older individuals tend to provide more information than younger ones. The detailed demographic information of the respondent was mentioned in Table 1. The study demonstrated demographic data and socioeconomic backgrounds of tribal communities like kutia, bhulia, kondha, harijan, and teli. Bhulia community had a higher level of participation, possibly due to stronger social networks or cultural practices. The Nuapada district had a higher proportion of bhulia community, demonstrating more extensive dissemination of information.

Table-1.Demographic profile of participants

Demographic parameter	**Sub parameter**	**Obtained result (number of individual)**
Educational Qualification	No formal Education (No Elimentary Education)	39
	Primary (Elimentary Education)	36
	Matriculation (10 standard pass)	21
	Higher secondary (12th Standard pass)	07
	Graduation (University Level)	02
Age group	30-40 years	08
	40-50 years	20
	50-60 years	22
	60-70 years	25
	70-80 years	30
Name of ethinic community	Kutia	24
	Kondha	18
	Bhulia	31
	Harijan	20
	Teli	12

The demographic profile in this study was determined by considering three different parameters such as academic qualification, age group and ethnicity (ethnic community names). A total of 105 participants were considered for the demographic study.

Relative Frequency Citation Data

In the present investigation, the relative frequency of citation (RFC) has been computed for every individual medicinal plant, as presented in Table 2. The RFC is a measure that indicates the importance and popularity of a medicinal plant in traditional medicine practices. It considers the number of times a plant is mentioned in ethnobotanical surveys or studies (Navia *et al.*2021). The plants *Azadirachta indica, Curcuma longa, Ocimum basilicum* and *Withania somnifera* were found to 0.96, 0.89, 0.90, and 0.87, respectively exhibit the highest reported RFC (Relative Frequency of Citation) values. These high RFC values suggest that these plants are widely recognized and utilized in traditional medicine practices. The significant presence of these plants in ethnobotanical surveys and studies indicates their potential therapeutic properties and the trust placed in them by traditional healers and communities.

This observation can be attributed to the substantial number of informants who reported the use of theses medicinal plant species. The relative frequency of citation (RFC) metrics is dependent on the count of respondent who reference the utilization of a particular plant species. Notably, exhibited the highest RFC value of 0.96.This suggests that *Azadirachta indica*

was widely recognized and frequently used for its medicinal properties. The high RFC value indicates that this plant species holds significant importance in traditional healing practices and may have a wide range of therapeutic benefits.

Table 2. Quantitative values of different plant specimen obtained from the study

Plant	Number of Informant (IP)	Informant response (IR)	Use report (UR)	Relative frequency citation (IR/N), where N=105	Cultural index (UR/IP)
Syzygium aromaticum (L.) Merr. & L.M.Perry	85	76	72	0.72	0.84
Matricaria chamomilla L.	90	87	83	0.82	0.92
Withania somnifera (L.) Dunal	95	92	90	0.87	0.94
Ocimum basilicum L.	98	95	92	0.90	0.93
Coriandrum sativum L.	87	85	83	0.80	0.95
Eucalyptus obliqua L'Hér.	94	87	83	0.82	0.95
Vachellia nilotica (L.) P.J.H.Hurter & Mabb.	78	72	67	0.68	0.88
Annona squamosa L.	83	76	73	0.72	0.87
Buchananiaco chinchinensis (Lour.) M.R. Almeida	87	83	80	0.79	0.91
Curcuma longa L.	97	94	92	0.89	0.94
Madhuca longifolia (J.Konig) J.F.Macbr.	93	89	86	0.84	0.92
Plumeria alba L.	79	77	73	0.73	0.92
Pterocarpus marsupium Roxburgh	87	84	81	0.8	0.93
Sapindu strifoliatus L.	89	86	84	0.81	0.94
Senna alexandrina Mill.	89	87	83	0.82	0.93
Azadirachta indica A.Juss.	103	101	99	0.96	0.96
Shorea robusta Roth	76	74	72	0.7	0.94
Sida acuta Burm. f.	67	63	58	0.6	0.86
Solanum virginianum L.	56	52	49	0.49	0.87
Solanum viarum Dunal	76	74	71	0.70	0.93
Acmella repens (Walter) Rich.	88	82	75	0.78	0.85
Symplocos racemosa Jacq	87	82	79	0.78	0.90
Terminalia elliptica Willd.	78	74	70	0.70	0.89
Tragia involucrata L.	76	72	69	0.68	0.90
Mallotu snudiflorus (L.) Kulju & Welzen	79	75	71	0.71	0.89
Vitex negundo L.	82	74	63	0.70	0.76
Wrightia tinctoria (Roxb.) R.Br.	70	64	60	0.60	0.85
Ziziphus rugosa Lam.	59	54	51	0.51	0.86

This table depicts details about use of native plants by informants of Nuapada district and from that information, relative frequency citation and cultural index were calculated.

Cultural Index Data

The CI analysis indicated that the species *Azadirachta indica* exhibited the greatest value of 0.96. This indicates that *Azadirachta indica* is highly regarded and extensively utilized for its medicinal properties compared to other plants. The high CI value further supports the notion that this plant species is deeply embedded in traditional healing practices and is likely to possess numerous therapeutic advantages (Megersa and Woldetsadik 2022). Two prominent plant species, specifically

Coriandrum sativum and *Eucalyptus obliqua*, were discovered to exhibit a CI value of 0.95. Furthermore, it was observed that three specific plant species, specifically *Withania somnifera, Shorearo busta,* and *Sapindustri foliatus*, exhibited a noteworthy CI value of 0.94. Table 3 displays the following variables: plant name, informant participants, informant response, use report, relative frequency citation, and cultural index.

Ethnobotanical Data

The current investigation discovered 28 medicinal plants from 21 families. Table 3 lists the botanical name, vernacular name, family name, habit, nature, availability season, portion used, mode of application, and route of administration of each medicinal plant. Euphorbiaceae has the most medicinal plant species in this survey, followed by Apocynaceae, Fabaceae, Asteraceae, Myrtaceae, and Solanaceae. Figure 2 summarizes the study's family number findings. The surveyed plants included 43% trees and 14% shrubs. According to the survey by Reddy *et al.*2019 75% of species are wild type, compared to 25% are cultivated types of species. The survey found that 39% of plant species thrived in the Rainy season, the best of the five seasons amongst all. However, just 3% of plant species are found in autumn. Figure 3 shows seasonal species availability. The indigenous culture in the study region uses many plant components to make therapeutic compositions. Bark has a 36% higher therapeutic value than the other options. The root, with 4% cumulative proportion, was the least used component in herbal treatments. Figure 4 shows how plant components are used to make herbal dentistry remedies (Banerjee *et al.*2022).The bioavailability and efficacy of therapeutic plants depend on their administration. Topical application is the most prevalent, accounting for 43% of utilization. This entails applying plant extract or preparation directly to the afflicted area. Oral administration, including capsules, teas, and tinctures, is the second most common method, used by 39% of species (Salehi *et al.*2019) Finally, 18% of medicinal herbs are chewed or sucked for their therapeutic effects. Topical treatment is extensively utilized to treat dental issues since it targets the problematic area. This treatment involves applying medicinal plant leaves or substances directly to the mouth (Saikrishna macharyulu *et al.*2022).These natural medicines can treat gum inflammation and toothache due to their antibacterial and anti-inflammatory qualities. The different methods of preparation for all dosage form have been mentioned in Figure 5.

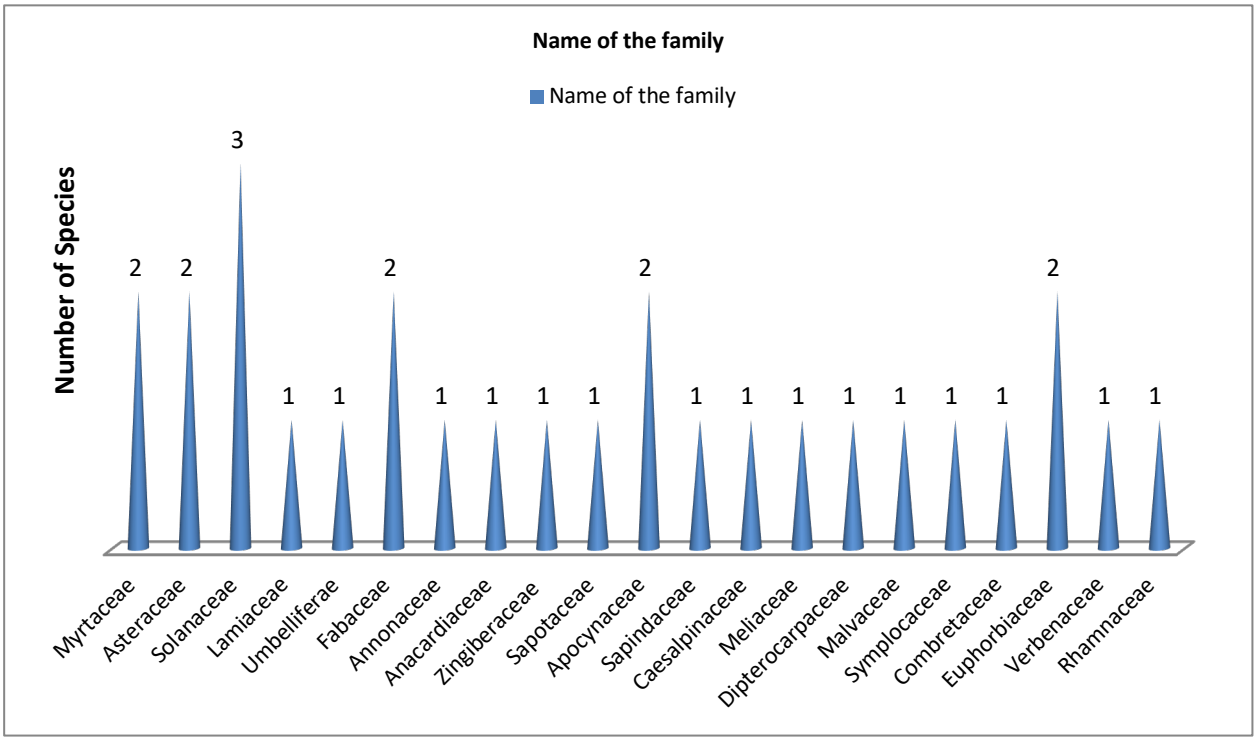

Figure 2.Brief information about number of family obtained from the study

Table 3. Plants used by the local population of Nuapada district, Odisha for the treatment of oral health in Nuapada districts

Plant name	Family	Vernacular Name	Voucher specimen number	Habit	Nature	Most available season	Plant Part used	Therapeutic application	Method of application	Route of administration
Buchananiacochinchinensis (Lour.) M.R. Almeida	Anacardiaceae	Char,Chinyar	CUTM/BOT/2023/009	Tree	W	Spring	Bark Antiseptic	Antiseptic	Bark is cut in to small pieces to be used for tooth cleaning.	Topical
Annona squamosa L.	Annonaceae	Atto	CUTM/BOT/2023/008	Tree	W	Winter	Leaves	Dental pain	Fresh decoction of leaves used as gargle to reduce dental pain.	Oral
Coriandrum sativum L.	Apiaceae	Dhania	CUTM/BOT/2023/005	Plant	C	Rainy	leaves	Reduce gum infection and mouth ulcer	Gargles of Fresh leaves used.	Topical
Plumeria alba L.	Apocynaceae	Gulanchi	CUTM/BOT/2023/012	Plant	C	Summer	Bark	Antiseptic and analgesic	Paste of crushed bark and apply on affected cavity of teeth to reduce pain.	Oral
Wrightia tinctoria R.Br.	Apocynaceae	Kurwan	CUTM/BOT/2023/027	Plant	W	Spring	Bark	Tooth carries	Bark used as toothbrush	Mouth
Acmella repens Rich. ex Pers.	Asteraceae	Akararabochh	CUTM/BOT/2023/021	Shrub	W	Rainy	Flower and total plant	Dental pain and gum disease	Gargle and power of Flower used to reduce gum infection	Topical
Matricariachamomilla L.	Asteraceae	Ban sabti	CUTM/BOT/2023/002	Shrub	W	Rainy	Dries flower	Gingivitis, periodontal disease, and cure oral ulcers	Chamomilla oil applied on tooth as mouthwash	Topical
Terminalia elliptica Willd.	Combretaceae	Asana	CUTM/BOT/2023/023	Tree	W	Summer	Bark, fruits	Toothache and pyorrhea.	Bark use as toothbrush powder bark and fruits used	Mouth

Shorea robusta C.F.Gaertn.	Dipterocarpaceae	Sala	CUTM/BOT/2023/017	Tree	W	Summer	Bark	Dental pain	Bark used as toothbrush .	Oral
Mallotus nudiflorus (L.) Kulju & Welzen	Euphorbiaceae	Gular	CUTM/BOT/2023/025	Tree	W	Summer	Bark	Dental carries	Paste of Crushed bark used.	Oral
Tragia involucrata L.	Euphorbiaceae	Bichha	CUTM/BOT/2023/024	Plant	W	Summer	Root	Reduce pain, Dental decay	Pills of root used.	Oral
Pterocarpus marsupium Roxb.	Fabaceae	PiyaSal	CUTM/BOT/2023/013	Tree	W	Spring	Stem	Gum disease	Resins used to reduce microbial infection.	Topical
Senna alexandrina Mill.	Fabaceae	Chakunda	CUTM/BOT/2023/015	Plant	W	Rainy	Stem	Antiseptic and mouth cleanser	Stems are cut in to small pieces and use as tooth brush to clean the teeth from infections.	Oral
Vachellia nilotica (L.) P.J.H.Hurter &Mabb	Fabaceae	BamurGach	CUTM/BOT/2023/007	Tree	W	Summer	Stem	Antiseptic	Bark or stem used as toothbrush for tooth cleaning.	Topical
Ocimum basilicum L.	Lamiaceae	Dahana	CUTM/BOT/2023/004	Plant	W	Rainy	leaves	*Reduce pain*	Toothpaste of Dried leave mixed with mustard oil used.	Topical
Sida acuta Burm.f	Malvaceae	Bajra-muli	CUTM/BOT/2023/018	Plant	W	Autumn	Stem	Dental pain	Stems used as toothbrush to remove infections.	Oral
Azadirachta indica A.Juss.	Meliaceae	Nimba	CUTM/BOT/2023/016	Tree	W	Spring	Complete plant	Anti-inflammatory,Antiseptic	Powder of neem leaves, Bark used as toothbrush Mouth wash to use to reduce	Oral

									bacterial infection	
Eucalyptus obliqua L.'Hér. 1789	Myrtaceae	Nilagiri	CUTM/BOT/2023/006	Tree	C	Summer	leaves	Antiseptic, Pyorrhea	Mouth wash of dries leaves used.	Topical
Syzygium aromaticum (L.) Merr. & L.M.Perry	Myrtaceae	Labang	CUTM/BOT/2023/001	Tree	C	Rainy	Bud & Flower	Pain reliever Pyorrhea, periodontal disease	Clove oil used in the form of gargle	Topical
Ziziphus rugosa Lam.	Rhamnaceae	KanteiKoli	CUTM/BOT/2023/028	Plant	W	Winter	Bark	Toothache and gum infection	Bark use as brush and Decoction of bark use as gargle.	Oral
Sapindu strifoliatus L.	Sapindaceae	Ritha	CUTM/BOT/2023/014	Tree	W	Rainy	Seed	Pyorrhea	Powder the seeds used as toothpowder to reduce infections.	Topical
Madhuca longifolia (L.) J.F.Macbr.	Sapotaceae	Mahulo, Mahul, Tolgachh	CUTM/BOT/2023/011	Tree	W	Spring	Bark	Gum Disease, Dental Pain	Bark used as toothbrush to remove gum infection and powder of stem used directly to the affected area.	Oral
Solanum viarum Dunal	Solanaceae	Bheji	CUTM/BOT/2023/020	Shrub	C	Rainy	Seed	Antiseptic, Tooth caries.	Dried Seeds used to make cigarette	Mouth
Solanum virginianum L.	Solanaceae	Kantabaigana	CUTM/BOT/2023/019	Shrub	W	Rainy	Fruits,flower	Dental pain, Dental Carries	Tooth powder of fruit and Cigarette of burnt flower and fruits used	Topical
Withania somnifera (L.) Dunal	Solanaceae	Ashwagandha	CUTM/BOT/2023/003	Plant	W	Rainy	leaves	Pyorrhea, Gingivitis, periodontal	A paste of Ashwagandha leaves used.	Topical

Symplocos racemosa Roxb.	Symplocaceae	Lodh	CUTM/BOT/2023/022	Plant	W	Rainy	Bark	Gum Infection	Bark use as gargle Toothbrush to remove gum infection.	Mouth
Vitex negundo L.	Verbenaceae	Baigna	CUTM/BOT/2023/026	Plant	C	Summer	Bark and leaves	Tooth and gum diseases, Pyorrhea.	Paste of leaves and brush of Bark used	Mouth
Curcuma longa L.	Zingiberaceae	Haldi	CUTM/BOT/2023/010	Plant	C	Winter	Rhizome	Gum Disease, Dental Pain and inflammation, Antiseptic	Turmeric, clove and dried leaves of guava boiled together to make a mouth wash and Fresh turmeric paste was also used to reduce inflammation.	Oral

C=Cultivated species, W=Wild species. The plant parts used, therapeutic application, method of application and route of administration mentioned in the table was acquired from the informants of Nuapada district.

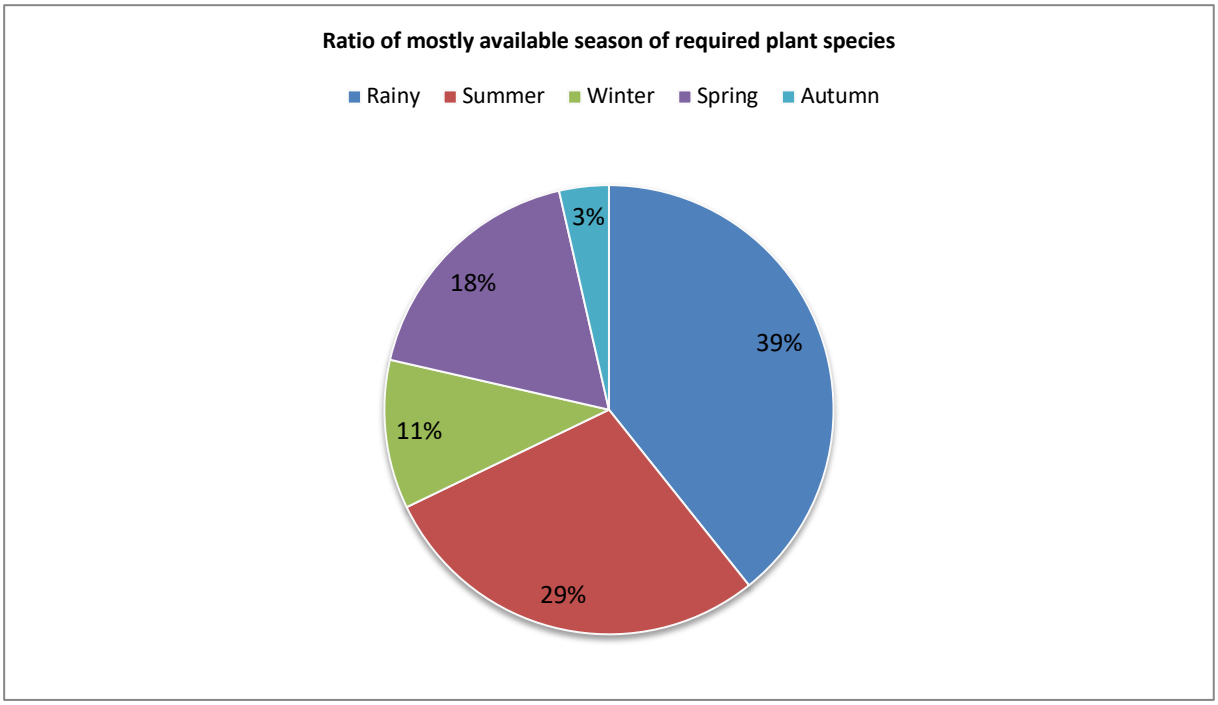

Figure 3.Pictorial representation of ratio of different season in which species are mostly available

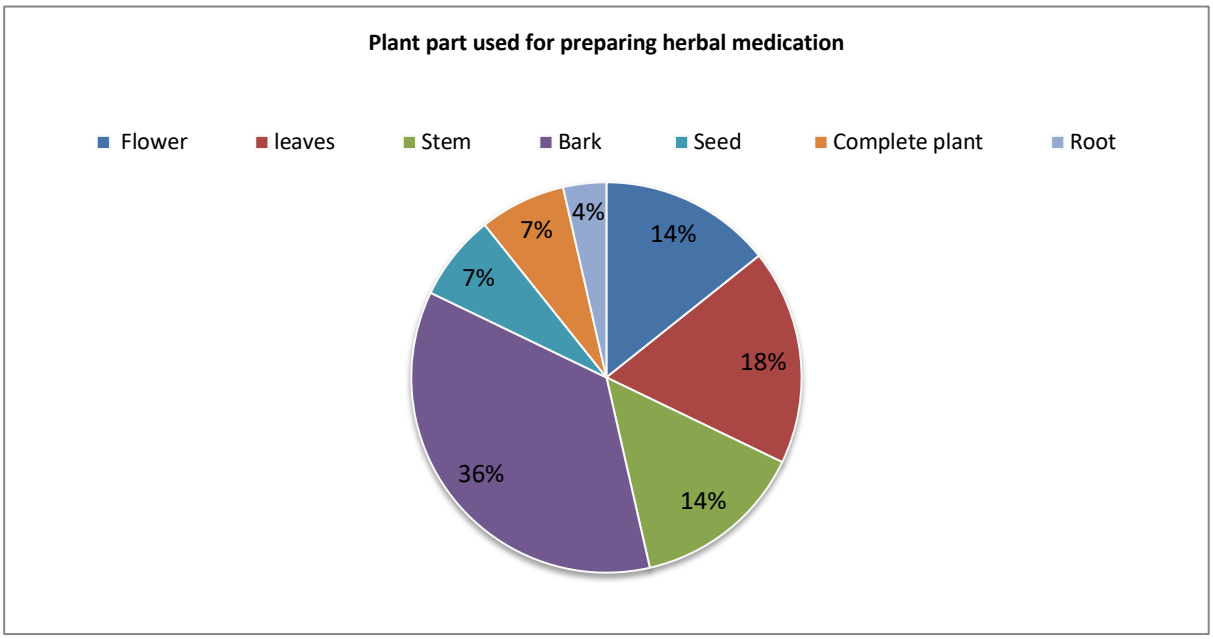

Figure 4. Representation of different plant part used to make several herbal dosage forms for treating dental disorder

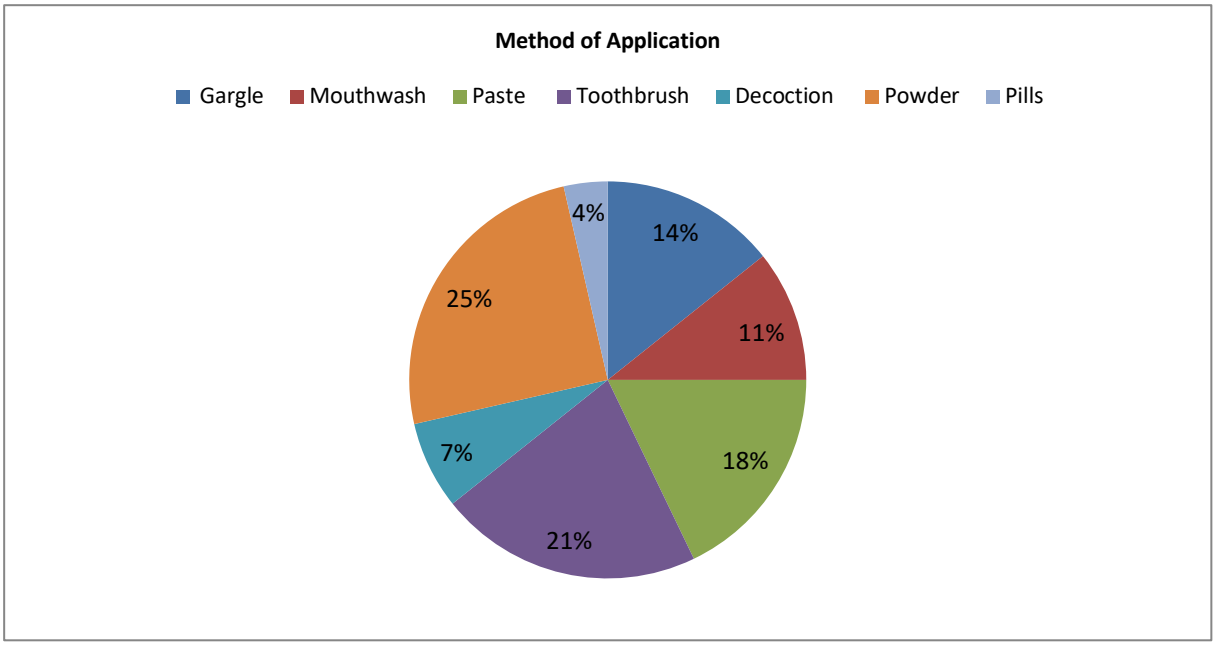

Figure 5. Different Method of Application

Discussion

Indigenous and local populations have significant oral traditions and possess extensive knowledge regarding the therapeutic attributes of various plant species for the purpose of addressing dental ailments. This traditional knowledge has been passed down through generations, allowing these communities to develop effective remedies for dental problems. Their understanding of the medicinal properties of plants offers valuable insights that can complement modern dental practices (Lawal *et al.*2022). The indigenous communities have a deep respect for nature and understand the importance of sustainable practices in harvesting these medicinal plants. They have developed techniques to ensure the preservation of these species, ensuring their availability for future generations. Additionally, their holistic approach to dental care takes into account not just the physical aspects but also the emotional and spiritual well-being of individuals, providing a more comprehensive and personalized approach to oral health. For traditional survey (Sharma *et al.*2023) reported that about the oral health practices of indigenous communities in India, highlighting the importance of incorporating traditional knowledge into modern dental care. This research underscores the need for further collaboration between traditional healers and modern dental professionals to create a more inclusive and culturally sensitive approach to oral healthcare.

The *Azadirachta indica* is a species of tree in the mahogany family, Meliaceae. It is commonly known as the *Azadirachta indica* tree and is native to the Indian subcontinent. *Azadirachta indica* trees have been used for centuries in traditional medicine and are highly valued for their medicinal properties. The RFC and CI standards for *Azadirachta indica* tree products are important for ensuring their quality and safety. These standards help regulate the production and distribution of *Azadirachta indica* based products, ensuring that they meet certain criteria for efficacy and purity. Additionally, adherence to these standards can help build consumer trust and confidence in the effectiveness of *Azadirachta indica* tree products. The oral and dental health benefits of *Azadirachta indica* tree products have been widely recognized, as they have been shown to possess antibacterial and anti-inflammatory properties. *Azadirachta indica* based products such as toothpaste and mouthwash have been found to effectively combat oral infections, reduce plaque formation, and promote healthy gums. Regular use of these products can contribute to improved oral hygiene and overall dental health. The chemical constituents responsible for the dental practice of *Azadirachta indica* by Singh *et al.*(Singh *et al.*2018) include triterpenoids, flavonoids, and alkaloids, which have been found to inhibit the growth of bacteria that cause dental caries and gum diseases. Additionally, *Azadirachta indica* products have been shown to help alleviate symptoms of gingivitis and periodontitis, such as bleeding gums and bad breath. These findings highlight the potential of *Azadirachta indica* based dental products as a natural and effective alternative for maintaining optimal oral health. Nimbin, Nimbidin and margolone are some of the triterpenoids found in *Azadirachta indica* that have been shown to possess antimicrobial properties. Flavonoids, such as quercetin and kaempferol, have also been identified in *Azadirachta indica* and are known for their anti-inflammatory and antioxidant effects, which can further contribute to improved oral health.

The other species such as *Ocimum basilicum, withania somnifera* and *curcuma longa* are also found highest usable species for treating Periodontal disorder with impressive RFC and CI value. These species have been traditionally used in Ayurvedic medicine for their medicinal properties. They contain bioactive compounds that have shown promising results in reducing inflammation and promoting oral health. The indigenous community used these plant species for centuries to treat various dental and gum problems, including periodontal disease. Scientific research has demonstrated the efficacy of these plants in treating oral health issues, making them a useful addition to contemporary dental care practices. Furthermore, incorporating these plant-based remedies into dental treatments can also contribute to reducing the reliance on synthetic chemicals and antibiotics, promoting a more sustainable and holistic approach to oral health. Similarly, Umapathy *et al.* (Umapathy *et al.*2022) studied about the chemical constituents such as polyphenols, flavonoids, and essential oils present in these plant extracts that contribute to their antibacterial properties. They found that these compounds not only inhibit the growth of oral pathogens but also possess anti-inflammatory and antioxidant effects, further enhancing their potential as natural oral care agents. Additionally, incorporating plant-based remedies into dental treatments can help address the growing concern of antibiotic resistance, as these natural alternatives may offer a safer and more effective option for maintaining oral health.

The plant part also play significant role in determining the major target for treating periodontal infections. For instances, the leaves of certain plants contain antimicrobial compounds that can effectively combat periodontal bacteria. Additionally, the roots of certain plants have been found to possess anti-inflammatory properties, making them a potential target for reducing gum inflammation associated with periodontal infections. The dosage forms are also necessary to consider when developing treatments for periodontal infections. Different dosage forms, such as decoction, mouthwashes, or powder, can affect the effectiveness and ease of administration of the treatment. Furthermore, the choice of dosage form can also impact patient compliance and satisfaction with the treatment, as some individuals may prefer certain forms over others (Wendorff-Tobolla *et al.*2023).The habitat and season of growing plant species used in the treatment of periodontal infections can also impact the effectiveness of the treatment. Certain plants may thrive better in specific habitats or seasons, which can affect their potency and concentration of active compounds. Therefore, it is important to carefully select and source plant species that are known to be effective against periodontal infections and ensure they are grown in optimal conditions to maximize their therapeutic benefits. With this concept, Acharya *et al.* studied about how different family members of plants, such as Lamiaceae and Asteraceae, have shown promising antimicrobial properties against periodontal infections. Additionally, they investigated the impact of various environmental factors, such as temperature and humidity, on the production of bioactive compounds in these plants. Their findings suggest that understanding the relationship between plant families and environmental conditions can help optimize the cultivation and utilization of medicinal plants for periodontal treatment.

Conclusion

In conclusion, the ethnobotanical study of plants used to treat different oral diseases provides valuable insights into traditional medicinal practices and the potential development of new therapeutic approaches. These plants have been traditionally used for their antimicrobial, anti-inflammatory, and analgesic properties, which are essential for managing dental ailments. By documenting the knowledge and practices of local communities, this study contributes to the preservation of cultural heritage and promotes the sustainable utilization of plant resources for oral health care. The identified species can serve as a basis for further research and the development of new oral health products. Additionally, understanding the traditional uses of these plants can help bridge the gap between modern medicine and traditional healing practices, leading to a more holistic approach to oral health care. Furthermore, this research highlights the importance of preserving indigenous knowledge and cultural practices for future generations. The incorporation and in-depth examination of traditional knowledge can potentially enhance the advancement of efficacious and sustainable methodologies within modern dental healthcare practices. Hence, the above ethnobotanical surveys conclude that *Azadirachta indica* is widely recognized as a traditional medicinal plant with significant potential for treating dental disorders compared to other plant species. Its effectiveness in treating dental ailments makes it a valuable resource that should be further explored and integrated into modern dental healthcare practices.

Future Prospects

Ethnobotanical surveys can identify new therapeutic plants and chemicals for medication development. Ethnobotanical surveys also help conserve and sustain plant resources by providing traditional plant species knowledge and practices. With research and scientific understanding, dental hygiene plants can help in many ways. Conventional herbal therapies may support empirical dental treatments. Conventional dental care may require standardized plant extracts, herbal medications, or natural products. Combining traditional herbal medicines with contemporary dentistry may provide patients more

treatment alternatives. Natural products in dental care improve patient well-being and encourage a greener approach to oral health. Herbal mouthwashes and toothpaste promote oral health and preventative dental care. Plant-based medications are natural. These strategies can enhance awareness of therapeutic flora species, ecosystems, and sustainable procurement and production. Promoting plant-based medications can also help people realize how oral health and natural resource preservation are linked, advocating a more sustainable dental care approach.

Declarations

List of abbreviations: IP-Informant participants, IR-Informant response, UR-Use report, RFC-Relative frequency citation ,CI-Cultural index, N-number of participants, CIF -cultural significance of family, MCI -mean cultural importance index, FC -Frequency of Citation,

Ethics approval and consent to participate: The current investigation did not involve the transportation of any plant **specimens.** The data were obtained from participants who willingly provided their information. Verbal consent was obtained from all informants prior to their participation.

Consent for publication: All authors have read the manuscript and agree for its publication.

Availability of data and materials: The manuscript encompasses complete information.

Competing interests: All authors mutually declare no conflict of interest among each other.

Funding: There is no funding information for the present work

Author contributions: The study was designed by BB and GDP, fieldwork was carried out by BB and BSS, and the primary statistical analysis was done by BA and BB. The manuscript was written by BB, while LA was responsible for revising the data analysis and the manuscript. All authors participated in reading, correcting, and approving the manuscript.

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Appendix-1: Questionnaire

Demographic Data
1.1. Name:
1.2. Age:
1.3. Gender:
1.4. Educational Information:
1.5. Employment Status:
1.6. Marital status:
2. Understanding of oral diseases
2.1. Do you know anything about oral diseases?
2.2. What do you think about the origins of oral diseases?
2.3. In your opinion, what are the potential treatment approaches for oral diseases?
2.4. The utilization of herbal extracts as a therapeutic approach.
3.1. Have you ever employed herbal extracts for the management of oral ailments?
3.2. Which particular herbs have been utilized?
3.3. What is the procedure for preparing and administering herbal remedies?
3.4. What is the recommended dosage and frequency of administration?
3.5. What is the procedure for the application of herbal medicine on affected areas?
3.6. To what extent do you perceive these remedies to be efficacious?

Table S1 Census data of community, their literacy and occupation of different ethnic groups of Nuapada District

Sl.No	Name of Villages	Number of HH	Total POP	POP in SC	POP in ST	POP LIT	POP ILL	TOTAL WORK POP	Occupations	NON_WORK-Population
1	Barakothi	114	472	8	372	190	282	301	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	171
2	Bhalukona	169	748	208	320	368	380	418	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	330
3	Jhipabahal	55	184	0	0	57	127	119	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	65
4	Belardana	369	1467	247	772	711	756	937	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	530
5	Haluapali	97	342	4	333	60	282	239	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	103
6	Bisibahal	318	1236	99	618	601	635	723	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	513
7	Batibahal	93	333	140	92	175	158	198	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	135
8	Michhapali	265	1180	97	865	639	541	651	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	529

9	Thongo	361	1597	39	1257	697	900	912	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	685
10	Litibahal	31	127	6	121	49	78	68	Leading Employees, Farmer, Agricultural Worker, Daily Wages, Additional employees, Partially Employed	59
Total		**1872**	**7686**	**848**	**4750**	**3547**	**4139**	**4566**		**3120**
Total in %				**11.03**	**61.8**	**46.14**	**53.85**	**59.4**		**40.6**

HH; House hold, POP; Population, SC; Scheduled Caste, ST; Scheduled Tribe, LIT; Literate, ILL; Illiterate, A brief information about ethnic community in the study area along with their education and occupation . This information was obtained from the official website of Government of India (https://www.censusindia.co.in/district/nuapada-district-odisha-394).

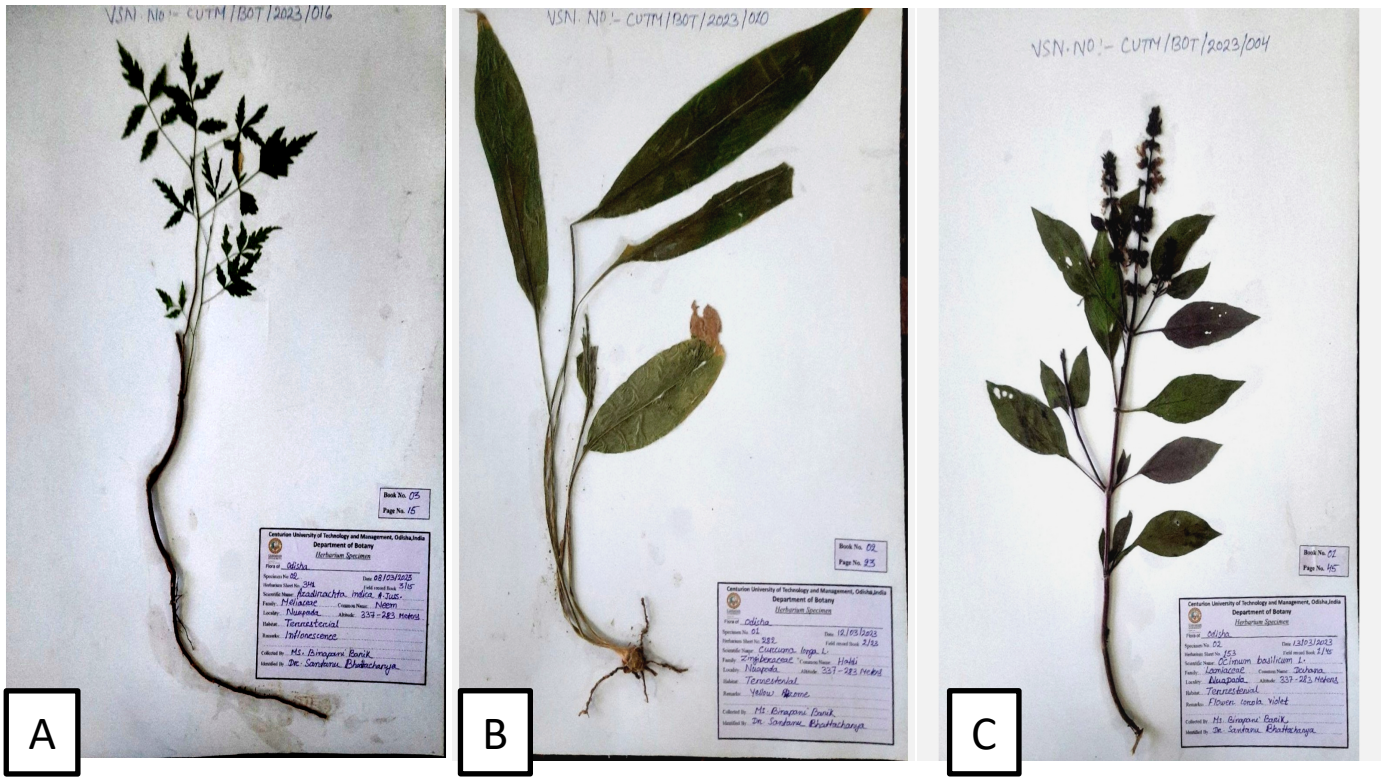

Figure S1. A Scan images of plant specimen with highest RFC values (A) *Azadirachta indica* (B) *Curcuma longa* (C) *Ocimum basilicum*