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Healing from the wild: an ethnozoological exploration of animal-based medicine in Jhargram, West Bengal, India

Rakesh Acharya[1†], Sanjib Kumar Das[1†], Ankur Bhowal[2] and Koushik Sen[1*]

Abstract

Background India possesses immense faunal, floral, and cultural diversity that supports numerous ethnic communities relying on traditional medicine for primary healthcare. The Jhargram district, an underprivileged area in West Bengal, India, and part of the Chota Nagpur Plateau, is rich in biodiversity. This area is home to various ethnic communities that practice their own ethnobiological medicine. Despite this, there is a lack of documented use of animal-based traditional medicine in this region. This study aims to explore and document the use of animal parts/products for medicinal purposes among indigenous communities in Jhargram. A summary of the study is presented in the Graphical Abstract.

Method The study was conducted in Jhargram district, West Bengal, India, from March 2023 to January 2024. A semi-structured questionnaire was used to conduct face-to-face interviews with 55 selected individuals (29 males and 26 females) to document the medicinal uses of animals in the traditional healthcare system. The questionnaire included queries about the local names of animals, modes of preparation, applications, and other ethnozoological details. The photographs were also recorded using a camera. The collected data were analyzed using a Microsoft Excel 2019; quantitative ethnobiological indices such as the informant consensus factor (ICF) and the degree of fidelity (FL) were calculated to assess the reliability and significance of the information provided by the respondents. Additionally, use value (UV), Jaccard index (JI), and frequency of citation (FC) were also calculated.

Result This study recorded 57 species from 57 distinct genera across 47 families, used by ethnic communities in Jhargram addressing a wide range of ailments categorized into 14 groups. Birds accounted for the highest proportion (33%) of utilized species. *Apis cerana* exhibited the highest use value (UV = 5.69). *Apis cerana* and *Homo sapiens sapiens* recorded the highest fidelity levels (FL = 94.54%), indicating their critical roles in treating respiratory ailments and wound healing, respectively. Conversely, *Dinopium benghalense* had the lowest FL (FL = 3.63%), reported for kidney stone treatment. Four species, including *Hydrophilus* sp., demonstrated the lowest use value (UV = 1.00), suggesting their specialized or rare application in the community's ethnomedicinal practices. In terms of informant consensus, infectious diseases recorded the highest informant consensus factor (ICF = 1.00), followed closely by eye ailments (ICF = 0.99). Common preparation methods included cooking, boiling, roasting, and frying, with oral administration being the most frequently used method, followed by topical, inhalation and anal applications.

Conclusion This study documents 57 species, including several novel species and their therapeutic uses, within the indigenous communities of Jhargram. It emphasizes the continued relevance of animal-based traditional

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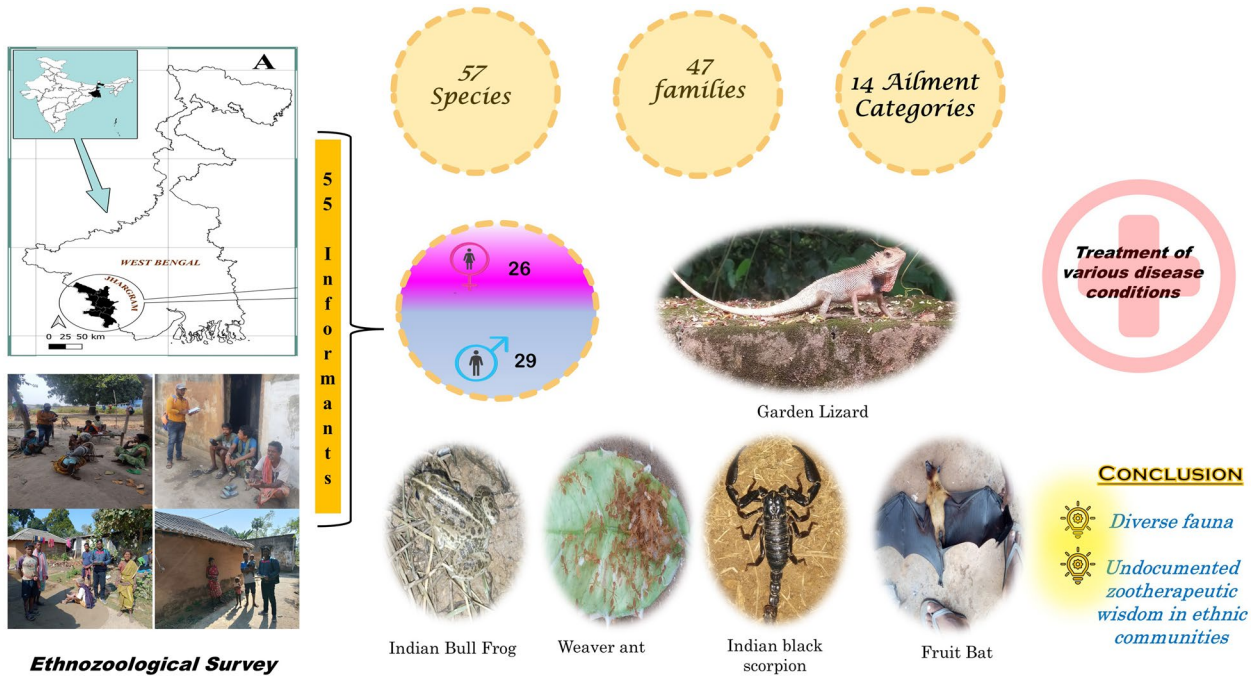
medicine in addressing a broad spectrum of health issues. The observed variability in fidelity level and use value across species highlights the dynamic role of these resources in local healthcare systems. The discovery of novel species and previously undocumented uses significantly contributes to the expansion of ethnobiological knowledge. As traditional medicine remains a primary healthcare resource in areas with limited access to modern medical facilities, it is crucial to prioritize the documentation, conservation, and sustainable use of these species. This study provides a valuable framework for integrating traditional knowledge into contemporary healthcare and biodiversity conservation strategies. Preserving and safeguarding this knowledge is essential not only for maintaining cultural heritage but also for exploring potential biomedical applications that could benefit modern healthcare systems.

Keywords Indigenous knowledge, Ethnozoology, Zootherapy, Biodiversity conservation, Jhargram

Graphical abstract



Background

Since prehistoric times, human beings, particularly ethnic communities, have been acquainted with the use of wild faunal and floral resources for diverse purposes [1]. This interrelationship persists even today as socioethnic customs manifested through the realms of traditional medicine and folk culture [2]. Indigenous people possess a vast array of natural remedies employing traditional medicine derived from wild plants and animals, forming a diverse pharmacopeia that blends scientific and artistic knowledge [3]. Traditional medicine encompasses a comprehensive knowledge base, skills, and practices rooted in the theoretical frameworks, cultural beliefs, and experiences indigenous to various cultures, and it is explicable or not, used to prevent, diagnose, improve, or treat physical and mental ailments [4, 5]. The knowledge of indigenous people about traditional medicine has significant implications for human and livestock well-being. This knowledge is mainly based on local resources and expertise, offering a vital alternative in low-income countries where access to pharmaceuticals is limited and expensive. Traditional medicine serves as a driving force in the discovery of modern therapies.

Despite its potential significance, the field of zootherapeutic practices, a key component of traditional medicine, has frequently been eclipsed by the prevailing focus on ethnobotanical studies and surveys. The prevailing focus has largely centered on the documentation of medicinal plants, leaving the exploration of zootherapeutic practices relatively underexplored [6,

7]. However, many societies are rapidly losing their ethnopharmacological knowledge. Therefore, the documentation of this knowledge before it is lost becomes increasingly important to preserve and harness its invaluable potential [8].

Animals and their derived products play crucial roles in numerous traditional therapies [8, 9], and their utilization can be traced back to prehistoric eras. Both wild and domesticated animals, along with their byproducts such as hooves, skins, bones, feathers, and tusks, constitute essential components in the formulation of remedial, protective, and prophylactic pharmaceuticals [10, 11]. According to the World Health Organization, traditional medicines meet the primary medical needs of 80% of the rural population in the developing world.

Traditional Chinese medicine encompasses nearly or more than 1500 animal species. Similarly, within Ayurvedic medicine, approximately 20% incorporates animals and their byproducts, encompassing a minimum 500 invertebrate species employed for the treatment of diverse health issues [1, 12]. Presently, it is estimated that 8.7% of the crucial compounds utilized in contemporary medicine are sourced from animals or derived from them [13]. Traditional medicine is increasingly used for primary healthcare in developing countries like India, Pakistan, and Bangladesh, and its utilization is also growing in developed nations [12].

Indigenous communities across India possess a wealth of knowledge regarding the medicinal properties of animals, serving as a critical resource for primary healthcare in rural areas [14]. However, this knowledge is increasingly at risk due to socioeconomic and cultural shifts, including urbanization, migration, and declining reliance on traditional medicine, as reported in studies across India [15–18]. Field surveys in Jhargram, West Bengal, revealed a similar trend, with younger generations showing diminished interest in traditional practices. Despite the limited scope of research on the therapeutic uses of animals in India, ancient texts such as Ayurveda and Charaka Samhita provide valuable insights into the importance of ethnozoology, mentioning nearly 380 types of animal substances [2, 19]. The Ayurvedic system describes a diverse array of animals, including 24 insects, 16 reptiles, 21 fishes, 41 birds, and 41 mammals. Various ethnic and tribal groups in India continue to use animals and their products for healing human ailments. Notably, the Hindu religion has historically utilized five products from cows—milk, urine, dung, curd, and ghee—for purification purposes [20, 21].

Several studies have elucidated the traditional zootherapeutic practices in distinct regions of India, including Odisha, Chhattisgarh, Tamil Nadu, Assam, Arunachal Pradesh, and Rajasthan [20, 22–27]. These ethnozoological studies underscore the crucial importance of research in this domain within the Indian context.

West Bengal, a strategically important state of Eastern India, is enriched with a vast heritage of biodiversity and the traditional use of plants and animal medicines practiced by several tribal groups. According to the 2011 Census of India [28], West Bengal harbors approximately 5.08% tribal population of the country. As many as 40 tribal groups are found in the state in which a large number of tribal populations, such as Santals, Bhumijs, Lodhas, Sabars, Kurmis, Mahalis, and Koras, are concentrated in the western part of West Bengal, particularly in the Jhargram district [29, 30].

Jhargram, an eastern Indian plateau extension within West Bengal, harbors significant biodiversity alongside a rich tribal heritage. This region, with 30% tribal inhabitants, boasts a unique combination of ethnic diversity, forest resources, and wildlife. Tribal communities in Jhargram have a long-standing tradition of utilizing forest resources for various purposes, including ethnomedicine. They collect specific plants and animals for food, traditional practices, and treatment of ailments using animal-based medicine. Despite the well-documented plant-based traditional medicine practices in Jhargram, systematic studies on zootherapeutic medicine in this region remain scarce [31, 32].

Knowledge about the use of animals in traditional medicine is typically transmitted orally among different ethnic communities and passed down from generation to generation. However, this knowledge often faces the risk of extinction with the death of the elderly knowledgeable person. Presently, the traditional knowledge system in this region is rapidly eroding accelerated by the urbanization of this area, particularly following the establishment of Jhargram as a district in 2017. Furthermore, the younger generation also hesitates to fully embrace and preserve the invaluable wealth of ethnic and traditional knowledge, primarily being influenced by the profound effects of urbanization. Therefore, it is important to study and record the ethnozoological information regarding the therapeutic use of various animals or their parts in traditional medicine among different ethnic communities to prevent the complete loss of these traditional cultures.

The primary objective of this study is to systematically document and explore the ethnozoological knowledge and practices of indigenous communities in the Jhargram region of West Bengal, India, with a focus on animal-based traditional medicines. This research aims to examine the specific species of animals used, the particular parts and derivatives employed, the ailments treated, and the preparation and administration methods, with an emphasis on preserving this invaluable knowledge, which

is at risk of being lost due to rapid urbanization and cultural shifts. Furthermore, this study seeks to underscore the significance of zootherapeutic practices within traditional medicine systems, which have historically been overshadowed by the emphasis on ethnobotany. By documenting these practices, the research aims to contribute to both the conservation of biodiversity and the recognition of species that play critical roles in local healthcare systems. In addition to documenting local practices, this study compares the zootherapeutic knowledge of Jhargram with that from other parts of India, identifying unique aspects and commonalities in animal-based medicinal traditions. To ensure the reliability of the data, quantitative ethnobiological indices such as the ICF, FL, UV, FC, and Jaccard index were employed, offering a rigorous framework for assessing the significance and consistency of the information gathered. This work aims to preserve a crucial aspect of indigenous knowledge, inform conservation strategies, and potentially inspire novel biomedical applications.

We believe that the present systematic study not only documents and signifies the ethnozoological uses of animal medicine across different ethnic groups of this region but also serves to protect this valuable knowledge before it is completely eroded from this region due to rapid urbanization and infusion of urban culture into the young generation of this ethnic communities. It is also anticipated that the present documentation will be fundamental to protect traditional knowledge and the conservation and sustainable use of the rich biodiversity of "Junglemahal" for future generations.

Methodology

Study area location, climate and ethnobiological background of people

The study area exhibits the geographical characteristics along with its physical, geo-environmental, socioeconomic, and cultural context. The term 'Jhar' originates from the Austric word 'Jhanti', meaning 'small bushes'. Alternatively, the term 'Jhargram' may be derived from the Sanskrit word 'Jhat', meaning 'bunch of branches'. The name reflects the existence of the dense forests in this area [30]. For this reason, the district with the surrounding area is known as 'Junglemahal'—the land of forests.

The Jhargram district (Fig. 1) of West Bengal, India, spans between 21°56′00.2"N and 22°42′05.3"N latitude and 86°44′03.6"E to 87°06′02.4"E longitude. The district and its adjoining region are full of wildlife and wilderness

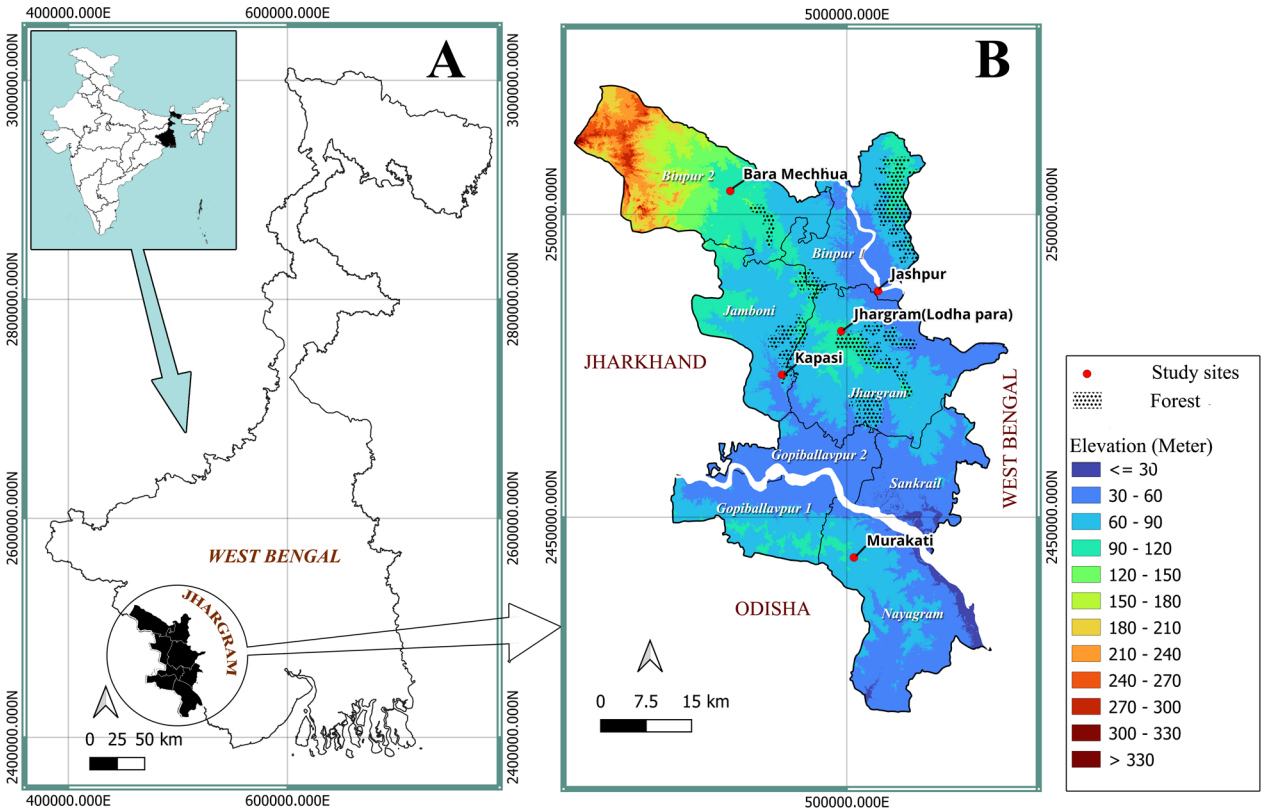


Fig. 1 **A** Map showing the location of West Bengal in India and highlighting the Jhargram district within the state. **B** Detailed map of Jhargram district indicating study sites (marked with red circles)

[33, 34]. The region lies between the Kangsabati river in the north and the Subarnarekha in the south; this area is a part of the Chota Nagpur Plateau, which gradually slopes down toward the east into the lower Gangetic plain and experiences a southwest monsoon climatic zone [35]. The Jhargram district comprises a total size of 3037.64 sq km, among which, nearly 594.98 sq km are covered with forest [30]. The climate is hot and humid tropical monsoon with an average annual rainfall of 1550 mm. The coolest month has a mean minimum temperature of 10 °C, and the warmest month has a mean maximum temperature of 42 °C [34]. This area is characterized by a west-to-east gradient in soil types. In the western portion, the soil is infertile red lateritic soil, while the eastern part is dominated by thin alluvium. Tropical dry deciduous mixed forest is the dominant natural vegetation, with sal (Shorea robusta) as the key species [36]. Tropical dry deciduous mixed forest is the dominant natural vegetation, with sal (Shorea robusta) as the key species [36]. This vegetation creates a suitable habitat for diverse animal biodiversity because of its complex structure and resource availability, supporting various ecological niches and promotes species richness.

Jhargram district with a population of approximately 1.14 million includes a significant proportion of tribal or ethnic communities, accounting for about 29.37% of the total population (Census 2011) [28]. This district accommodates a higher percentage of primitive tribes, such as the Santals, Bhumijs, Lodhas, Sabars, and Kurmis, compared to any other district in West Bengal [29, 30]. All the blocks of this district are under the Integrated Tribal Development Program (ITDP) of the central government of India. People, especially aboriginals, of this region, utilize natural resources [34]. Because of its tropical location, infertile soil, limited rainfall, and uneven terrain, agricultural productivity in this part of West Bengal is notably lower compared to the rest of the state. Regarding primary healthcare, tribal communities predominantly rely on traditional folk medicine practiced by Traditional Healers (THs). Due to the remote villages' distance from conventional medical facilities and the cost-effectiveness, safety, and availability of traditional medicine, it continues to endure and remains one of the most popular treatment option among the ethnic groups in the rural areas of the district.

Informant selection and data collection

The dataset was collected through field surveys conducted in the Jhargram district from March 2023 to January 2024. Informants were purposively selected from five villages, with one village chosen from each of the district's eight blocks (Fig. 1, Table 1), based on their recognized knowledge of traditional animal-based medicinal practices.

To document the medicinal uses of animals in the traditional healthcare system, a multifaceted approach was employed. This included face-to-face interviews, informal meetings, and open and group discussions, facilitated using semi-structured questionnaire (Supplementary File: QUESTIONNAIRE FINAL. docx) [2, 20, 37]. A total of 55 individuals (29 males and 26 females) were purposefully selected for this study to ensure the inclusion of knowledgeable informants capable of providing reliable and detailed ethnomedicinal data. The interviews were conducted in the local languages of the informants, primarily Bengali or Santali, which are widely spoken in the study area. The sampling approach was guided by the need to ensure the inclusion of knowledgeable individuals who could provide reliable and detailed ethnomedicinal data. The selection process was further constrained by logistical and resource limitations inherent to remote fieldwork in ethnobiological studies. This is a standard approach widely employed in previous ethnobiological studies, ensuring the collection of comprehensive and relevant information [20, 38] (Fig. 2). They were queried regarding the local names of animals and the specific parts utilized for therapeutic purposes, as well as the ailments treated, methods of preparation, modes of administration, and other relevant details [20, 39, 40]. The animals were identified based on their presence within the study area, available digital records,

Table 1 Summary of study sites in Jhargram district

Block	Avg. elevation (m) ± SD	Max. elevation (m)	Min. elevation (m)	Agro-ecology	Study site (Village)	Latitude	Longitude	Elevation (m)
Nayagram	55.664 ± 17.833	99	11	Lowland	Murakati	22.095054	87.01143	87
Jamboni	82.221 ± 13.874	121	45	Lowland	Kapasi	22.367506	86.896307	70
Jhargram	70.695 ± 16.576	117	32	Lowland	Lodha Para	22.432771	86.991249	96
Binpur-I	69.971 ± 16.645	115	37	Lowland	Jashpur	22.49265	87.050321	53
Binpur-II	154.617 ± 58.795	329	55	Low-midland	Bara Mechhua	22.64178	86.812946	110

Fig. 2 **a**–**d** Representative photographs from the field survey illustrating group discussions with informants, Jhargram District. **e**–**f** Photographs showing the local landscape and residential structures in the area

and descriptive characteristics provided by respondents, following established literature. While most species were identified at the species level, some taxa were identified only at the genus level due to limitations in distinguishing certain species based on local knowledge and available references [41, 42].

Ethical considerations

Authorization to carry out this study was secured from the administrative authority of the college. The participants were thoroughly briefed on the aims and scope of the research prior to providing their verbal consent. Their involvement was entirely voluntary, with the freedom to withdraw from the interviews at any point without any consequences. The purpose of the research—exploring and documenting the medicinal significance of animal species in the study area—was clearly explained to the contributors. It was emphasized that the study was conducted solely for academic purposes and not intended for any commercial use. After fully understanding and accepting these terms, participants voluntarily shared their knowledge about the medicinal uses of the animal species in their region. A sample handwritten consent note, voluntarily provided by a participant, is included as supplementary file (supplementary file: ADDITIONAL FILE 2.jpg).

Data analysis

Fidelity level

Fidelity level (FL) is calculated to determine the most commonly used species for treating certain ailments; a higher FL value indicates that most of the respondents used the same animal species for treating a certain ailment [2, 43]. The following formula is used to calculate FL [44].

$$\mathrm{FL}(\%) = N_P/N \times 100$$

Here, N_P represents the number of informants who mentioned using a specific animal species to treat a particular ailment, and N is the total number of informants who utilized animals for medicinal purposes to treat any ailment.

Frequency of citation

The frequency of citation (FC) represents the percentage of local informants who acknowledged the use of specific animal species for ethnomedicinal purposes. It was calculated using the formula [45, 46]:

$$\mathrm{FC} = (n/N) \times 100$$

where n is the number of mentions of a particular species, and N is the total number of mentions for all species. Animal species with higher FC values reflect their

broader recognition and extensive utilization within the local community. A higher FC value indicates greater cultural and medicinal significance attributed to those species by the informants.

Use value

The use value (UV) represents the significance of a specific animal species in traditional medicinal practices. It is determined using the formula [46, 47]:

$$UV = \Sigma Uvi/Ni$$

where Uvi denotes the total number of uses reported by respondents for a particular species, and Ni refers to the total number of respondents who mentioned that species. A higher UV indicates that the species holds considerable importance within the community, as it was referenced by a larger proportion of participants during the study.

Informant consensus factor

To evaluate the ethnopharmacological significance of documented practices and assess the level of agreement among informants, we employed the informant consensus factor (ICF) [48, 49]. The ICF is a quantitative measure ranging from 0.00 to 1.00. Higher ICF values indicate a greater consensus among informants regarding the use of a specific plant or animal species for treating a particular ailment. Conversely, low or near-zero ICF values suggest disagreement among informants or a conservative approach toward the utilization of certain species. The ICF was calculated as follows [46]

$$ICF = n_{ur} - n_t/n_{ur} - 1$$

where n_{ur} is the number of citations and n_t is the number of species used.

Jaccard index (JI)

The Jaccard index (JI) was employed to compare the animal species used in traditional medicine in the Jhargram region with those documented in other ethnozoological studies conducted across various regions and indigenous communities. This index measures the similarity between two sets of data, specifically the shared species utilized in zootherapeutic practices.

The JI was calculated using the formula provided by González-Tejero et al. [50], a method that was recently applied in similar studies [51, 52] where

$$JI = \frac{C \times 100}{A + B - C}$$

A represents the number of species documented in the study area (Area *a*), B represents the number of species documented in the comparison area (Area *b*), and C denotes the number of species common to both areas (*a* and *b*).

The Jaccard index value ranges from 0 to 100, with a higher value indicating a greater degree of similarity between the two areas or communities in terms of species used in traditional medicine.

Results and discussions

Sociodemographic characteristics of informants

The study encompassed 55 participants including 29 males (52.7%) and 26 females (47.3%). The majority of respondents were aged 40–60 years ($N=30$, 54.5%) or over 60 ($N=10$, 18.2%), indicating a predominantly older demographic profile that plays a key role in preserving traditional knowledge systems (Table 2). The majority of participants had basic literacy and can read and write ($N=36$, 65.5%), followed by 20%($N=11$) with no formal education and only 14.5% ($N=8$) achieving secondary education or higher (Table 2). Our study revealed that a significant portion of participants within the community possessed basic literacy, emphasizing the indispensable role of foundational education in the preservation and effective application of ethnobiological knowledge. Our result converges with previous studies that have reported a higher proportion of male respondents possessing ethnobiological knowledge, along with a tendency for older individuals to serve as key knowledge holders [37, 46, 53–58]. This observation is also consistent with prior research, which has recognized basic education as a cornerstone for sustaining traditional knowledge systems [2, 59–61].

Ethnic composition revealed significant diversity, with Santals forming the majority (50.9%), followed by Lodha (20%), Munda (14.5%), Kurmi (9.1%), and Pashtun (5.5%). Religious affiliations reflected this diversity, with Sarnaism as the predominant faith among tribal groups, followed by Hinduism and Islam. As the largest primitive tribe in West Bengal and Jhargram, the Santals have preserved a profound connection to their cultural heritage which is deeply intertwined with Sarnaism and their reverence for mother nature [62, 63]. They demonstrate extensive knowledge of nature and biodiversity, emphasizing sustainable living and conservation practices [64, 65]. This is consistent with previous studies on other indigenous groups in India, who are recognized for their close relationship with the natural world, deep respect for ecological systems, and extensive traditional knowledge of biodiversity [23, 54, 66, 67].

The respondents in this study primarily engage in livelihoods such as agriculture, forest gathering, and animal-related activities, with zootherapy being practiced on a part-time basis. Previous research also highlights that the

Table 2 Demographic profile of informants included in the survey (N = 55)

Block	THH	No. of Int	Gender		Education			Ethnicity					Age			Religion			Occupation					
			M	F	NFE	RW	SE +	SN	KU	LO	PA	MU	20–40	40–60	> 60	SA	HI	IS	AGW	ARW	GL	FG	HT	TH
Nayagram	1137	12	7	5	–	10	2	12	–	–	–	–	3	7	2	12	–	–	✓	✓	✓	✓	×	✓
Jamboni	527	10	5	5	–	8	2	5	5	–	–	–	2	8	–	5	5	–	✓	✓	✓	✓	✓	✓
Jhargram	1333	14	6	8	9	3	2	–	–	11	3	–	3	6	5	11	–	3	✓	✓	×	✓	✓	✓
Binpur–I	347	9	6	3	2	7	–	5	–	–	–	4	5	4	–	5	4	–	✓	✓	✓	✓	✓	×
Binpur–II	480	10	6	4	–	8	2	6	–	–	–	4	2	5	3	10	–	–	✓	✓	✓	✓	×	✓
Total	3824	55	29	26	11	36	8	28	5	11	3	8	15	30	10	43	9	3						

THH—Total Number of Households, No. of Int.—Number of interviewees, M—Male, F—Female, NFE—No Formal Education, RW—Read and write, SE + —Completed School education and above.; SN—Santal, Ku—Kurmi, LO—Lodha, PA—Pashtun, MU—Munda, SA—Sarnaism, HI—Hindu, IS—Islam, AGW—Agricultural Worker, ARW—Animal-Related Work, GL—General Labourer, FG—Forest Gatherer, HT—Hunter, TH—Traditional Healer

use of animal resources in ethnomedicine is commonly observed among economically disadvantaged communities with limited access to resources [2, 68]. In certain cases, zootherapeutic practices have also provided supplementary income, where such practices contribute to sustaining their way of life [20].

Ethnozoological analysis

A total of 57 animal species, belonging to 57 distinct genera, encompassing 11 classes, across 47 families, were documented for their traditional medicinal uses by indigenous communities in Jhargram district. These species are employed to treat various human ailments through different methods (details provided in Table 3). The documented species diversity included both vertebrates (44 species, 77%) and invertebrates (13 species, 23%). Birds comprised the most abundant taxonomic group (33%, $N=19$), followed by mammals (25%, $N=14$), reptiles (12%, $N=7$), insects (10%, $N=6$), bony fish (Actinopterygii, 7%, $N=4$), and crustaceans (3%, $N=2$). Amphibians, bivalves, gastropods, arachnids, and clitellates were each represented by a single species ($N=1$), contributing 2% each (Fig. 3) to the total documented species (representative photographs of species are provided in Fig. 4).

In our study, birds were the most frequently used animals for therapeutic purposes; this finding is concordant with the other research conducted in the Indian subcontinent [8]. This may be attributed to the diversity and easy availability of birds within the study area, as we have already shown in our recent study [69, 70]. Mammals occupy the second highest demand for ethnozoological practices followed by reptiles and insects. However, some reports from India suggest that mammals are the most commonly used animals in ethnomedicine [2, 53, 54]

It is important to highlight that, consistent with our findings, mammals, birds, reptiles, and insects have been repeatedly documented as primary animal groups used in zootherapeutic practices across various regions of India [20, 24, 37, 39, 54] and world [46, 58, 71, 72]. This finding emphasizes the importance of local faunal diversity in providing resources for traditional medicine, as suggested by Alves and Rosa (2007), who observed that the composition, accessibility, and availability of fauna directly shape the selection of zootherapeutic resources within a specific region [73].

Ailment categories

Based on the information gathered from the study area, all the reported ailments were systematically categorized into 14 distinct categories (Table 4), which are: Dermatological Infection/Diseases (DID), Skeleto-Muscular System Disorders (SMSD), Respiratory System Diseases (RSD), Fever (FVR), Gastro-Intestinal Ailments (GIA), Circulatory System/Cardiovascular Diseases (CSCD), General Health (GH), Orthopedic Issues (ORT), Genito-Urinary Ailments (GUA), Hair Care (HC), Eye Ailments (EA), Ear, Nose, Throat Problems (ENT), Neurological Ailments (NA), and Infectious Diseases (ID).

Animal parts and products used as traditional medicine in Jhargram and other regions of India

Our study documented the use of 13 different animal body parts or products employed in traditional zootherapeutic practices within the studied communities. Meat emerged as the most commonly utilized component (58.93%), followed by the whole body (11.59%). Honey accounted for 4.83%, milk for 4.35%, and excreta (including urine and fecal matter) contributed 2.89% of reported uses. Bone (1.45%), tail (1.93%), subcutaneous fat (0.97%), skin (0.97%), egg (0.97%), blood (0.97%), and head (0.48%) were also documented. Additionally, some informants mentioned the use of less common materials (9.66%), like wax, shell, shell water, testis, ghee, feathers, and syrinx for medicinal purposes (Fig. 5), were together included under the category of "Others". This finding is consistent with earlier studies conducted among various ethnic communities in India and across the globe [2, 49, 53, 58, 74]. The medicinal properties of preparations derived from animal parts or products have been validated through both in vivo and in vitro experiments. Examples include studies on whole animals [75, 76], animal oils [77–80], urine [81–83], and milk [84, 85].

Comparative analysis of animal parts and products used as traditional medicine in jhargram and other regions of India

A comparative analysis reveals both shared practices and novel applications, showcasing the rich diversity of traditional knowledge in Jhargram. A detailed summary of these comparisons is provided in Table 3.

Several animal parts and derivatives, such as honey, milk, fat, bones, shells, and meat, are commonly utilized across India for treating various ailments. For instance, honey bees' (*Apis cerana*) honey is widely recognized for its antimicrobial, wound healing, and immunity-boosting properties, with similar uses documented in other states of India, Uttarakhand, Assam, and Kerala [37, 53, 66, 86] (Table 3). However, in Jhargram, application of honey extends further to cardiac health, representing an innovative therapeutic use that underscores the community's adaptive knowledge. Similarly, bones and shells are commonly employed for fracture healing and calcium supplementation in Rajasthan and Tamil Nadu [54, 87]. In Jhargram, powdered *Lissemys punctata* shell is applied topically to strengthen fontanelle of newborns,

Table 3 Knowledge of animal resource use among ethnic communities in the study area of Jhargram district

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
1	Clitellata	*Hirudinaria* sp (IV) (Whitman, 1886)	Cylicobdellidae	NE	Leech	Jok/Jok or hapad	Whole body	Psoriasis (DID)	Suck (Live leeches are applied to the affected area to suck and extract infected blood)	Topical	54.54	54.54	Living leeches are used in Assam to treat wounds, piles, and muscle swelling by sucking blood and pus from the affected area [149, 150]. In Chhattisgarh, the Madia tribe employs leeches to treat wounds by removing pus. Tribal communities in Central India use ash mixed with oil for baldness [151, 152]. In Maharashtra, leech therapy is practiced for piles and muscle swelling [153]. In Jammu and Kashmir, leeches are used for bloodletting to alleviate swelling, bruises, and pain [89]
							Whole body	Scabies (DID)	Suck (Same recipe as above)	Topical	45.45		
2	Arachnida	*Heterometrus* sp (IV) (Ehrenberg, 1828)	Scorpionidae	NE	Indian black scorpion	Kankra bichhe/Kai Kiring	Tail	Rheumatism (SMSD)	Oil (The tail is heated in a pan with coconut oil or Bengal monitor's body fat, cooled, and applied to the affected area.)	Topical	41.81	58.18	In Uttarakhand, fat is used to treat rheumatism and piles [66]. In Manipur, boiled or roasted body is used for cancer treatment [154]. In Kerala, fat is applied to treat arthritis and headache [53]. In Tamil Nadu, red scorpion is tied around malnourished children's necks for treatment [54]
							Tail	Psoriasis (DID)	Oil (Same recipe as above)	Topical	20.00		
							Tail	Arthritis (ORT)	Oil (Same recipe as above)	Topical	36.36		
3	Insecta	*Bombyx mori* (IV) (Linnæus, 1758)	Bombycidae	NE	Silk worm	Tasar moth/ Lumang	Meat	Cough (RSD)	Roasted (The fire-roasted moth is fed until symptoms subside, mainly for children)	Oral	61.81	67.27	The whole animal or ash of its body is used for digestive problems and in eye diseases in Kerala [53, 155], while dried silkworms are powdered and taken orally to treat flatulence in Jammu & Kashmir [89]
							Meat	Fever (FVR)	Roasted (Same recipe as above)	Oral	27.27		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Meat	Malnutrition (GH)	Roasted (Same recipe as above)	Oral	18.18		
4	Insecta	*Apis cerana* (IV) (Fabricius, 1798)	Apidae	NE	Honey bee	Moumachi/ Nele	Honey	Cough (RSD)	Raw (Honey is extracted from the beehive and consumed. It is often mixed with warm or lemon juice to soothe the throat, to reduce irritation)	Oral	94.54	94.54	In Uttarakhand, honey is consumed to address weakness and applied locally for eye ailments and wound healing [66]. In Arunachal Pradesh, fresh honey is consumed for coughs and colds, used as an ointment for eye problems, and consumed for throat pain and irregular menstruation [27, 91]. In Assam, honey treats coughs and colds, and the whole body of bees are consumed for cancer treatment [37, 150]. In Rajasthan, honey is rubbed on gums of children to aid teething [156]. In Kerala, honey is used for asthma, diarrhea, and vomiting [53]. In Manipur, it treats joint pain and purifies blood [154]. In Odisha, the whole body is consumed for gastric ulcers [23], while in Purulia, West Bengal, bee wax is applied for rheumatism [67]. In Sikkim, honey is consumed for coughs and colds [67]. In Tamil Nadu, honey treats vomiting, obesity, and cataracts [54]. In Madhya Pradesh, beehive fumes are used for conjunctivitis. In Mizoram and Arunachal Pradesh, honey treats throat pain, burns, and cuts [88]
							Honey	Fever (FVR)	Raw (Honey is combined with hot water, ginger, or turmeric to promote sweating)	Oral	61.81		
							Honey	Diarrhea (GIA)	Raw (Consumed to treat diarrhea, as it helps to soothe the digestive system, reduce irritation)	Oral	43.63		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Honey	Indigestion (GIA)	Raw (A mixture of honey and ginger is consumed to improve digestion, reduce bloating, and alleviate stomach discomfort)	Oral	49.09		
							Honey	Cardiac Health (CSCD)	Raw (Honey is consumed with warm water or lemon to promote heart health)	Oral	47.27		
							Honey	Scratch on Face or Skin Cut (DID)	Raw (Honey is applied directly to the wound to speed up healing, reduce infection)	Topical	36.36		
							Honey	Wound Healing (DID)	Raw (Honey is applied directly to the wound to speed up healing, reduce infection)	Topical	40.00		
							Honey	Immunity Booster (GH)	Raw (Small amount of honey is consumed regularly to strengthen the immune system)	Oral	60.00		
							Honey	Muscle Pain or Muscle Injury (SMSD)	Raw (Raw honey is applied topically to the affected area to reduce pain and inflammation)	Topical	10.90		
							Honey	Joint Pain (ORT)	Raw (Honey is applied locally to the affected joints to provide relief from pain)	Topical	14.54		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Wax	Burning (DID)	Raw (After honey extraction, the bee hives are cut into small pieces and placed in a clean cloth. The mixture is then heated in a pan with water, allowing the melted wax to separate and float on the surface. Once cooled, the wax is removed and applied to the affected area)	Topical	41.81		
							Wax	Wound Healing (DID)	Raw (Wax is applied to the affected area to promote healing, reduce inflammation, and protect the wound from infection)	Topical	38.18		
5	Insecta	*Hydrophilus* sp (IV) (Geoffroy, 1762)	Hydrophilidae	NE	Water scavenger beetle	Jal Ghurni/ Uru	Whole body	Tetany (SMSD)	Raw (The entire animal is consumed raw, often along with a banana, as for tetany)	Oral	14.54	14.54	No previous records found in India (to the best of our knowledge)
6	Insecta	*Oecophylla smaragdina* (IV) (Fabricius, 1775)	Formicidae	NE	Weaver ant	Lal Pipre/Kurkut or Hao	Whole body	Cough (RSD)	Cooked (Dead ants are cooked with oil and mustard paste, reducing throat inflammation, and aiding in cough relief)	Oral	81.81	81.81	In Assam it is used for digestive issues and nose bleeding [157], in Kerala for treating myopia [53], and in Odisha for respiratory diseases, inflammation, and lactation support [23]. In Tamil Nadu, their larvae treat pediatric ailments [54], in Chhattisgarh they improve eyesight and treat malaria [152], and in Madhya Pradesh, they are eaten with rice for gastritis prevention and nutrition [158]
							Whole body	Fever (FVR)	Cooked (Same recipe as above)	Oral	65.45		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
7	Insecta	*Periplaneta americana* (IV) (Linnæus, 1758)	Blattidae	NE	Cockroach	Arsola/Katya or Asla	Fecal matter	Indigestion/ Constipation (GIA)	Paste (The fecal matter is mixed with a small amount of water to create a semi-solid paste which is consumed to help alleviate symptoms of indigestion and constipation)	Oral	23.63	40	In Mizoram, Arunachal Pradesh [91], Maharashtra [153], and Assam [37], the whole body is used for asthma. In Manipur, the whole body is consumed for diabetes [154]. Among the Bhotiya tribe, Uttarakhand, the whole body is used for tuberculosis [66]. In Kerala, the whole body treats earaches, tetanus, dyspnea, and urinary obstruction [53]. In Odisha, the whole body is used for asthma and as an anti-inflammatory agent [23]
							Whole body	Asthma (RSD)	Boil (soup) (The animal's meat is boiled in water to prepare a soup. The resulting broth is then consumed by the patient, to help alleviate asthma symptoms)	Oral	25.45		
							Whole body	Cough and Cold (RSD)	Boil (soup) (Same recipe as above)	Oral	32.72		
8	Insecta	*Reticulitermes* sp (IV) (Holmgren, 1913)	Rhinotermitidae	NE	Termite	Kaloiburi/ Badlapoka or Nidir	Whole body	Malnutrition (GH)	Fried (The entire body is fried in oil and consumed with rice to help address malnutrition, providing essential nutrients and energy)	Oral	43.63	67.27	In Kerala, the whole animal is consumed raw for diabetes and for eye diseases [53]
							Whole body	Cough and Cold (RSD)	Fried (The whole body is fried in oil and consumed with warm water)	Oral	32.72		
							Whole body	Fever (FVR)	Fried (The entire body of the animal is fried and consumed to help alleviate fever)	Oral	32.72		
							Whole body	Indigestion (GIA)	Fried (Same recipe as above)	Oral	12.72		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
9	Crustacea	*Palaemon* sp (IV) (Weber, 1795)	Palaemonidae	NE	Prawn	Chingri/Ichok or Icha haku	Whole body	General Weakness (GH)	Fried (The entire body is fried in oil and consumed with rice)	Oral	92.72	92.72	In Silent Valley, Kerala [53], and Rajasthan [156], a species from the same family as Palaemon sp. (Palaemonidae) is powdered and taken orally as a remedy for tuberculosis. In Tripura, the whole animal is cooked and eaten to treat general weakness [159]. In Bihar, soup and curry made from species of the Palaemonidae family (*Macrobrachium* sp.) are used to cure anemia, vitamin deficiencies, paralysis, and arthritis, as well as to promote strength [113]
10	Crustacea	*Scylla serrata* (IV) (Forsskål, 1775)	Portunidae	LC	Crab	Kakra/Kadkom	Shell	Fontanelle Strengthening (DID)	Powdered (The shell is removed, powdered, and applied to the head of newborn babies to strengthen the soft spot (fontanelle) on the head)	Topical	18.18	70.90	In Maharashtra, whole body soup treats asthma and typhoid [153]. In Arunachal Pradesh and Mizoram, it aids diabetes, the elderly, and skin diseases [91]. In Assam, it treats skin allergies [157]. In Manipur, cooked crabs address smallpox, weakness, and immunity [154]
							Meat	Muscle Pain or Muscle Injury (SMSD)	Cooked (The shell is removed; the meat is cut into small pieces, boiled until soft, and then prepared with mustard oil for consumption)	Oral	54.54		
							Meat	Respiratory Disease (RSD)	Cooked (Same recipe as above)	Oral	20		
							Meat	Cardiac Health (CSCD)	Cooked (Same recipe as above)	Oral	23.63		
							Meat	General Weakness (GH)	Cooked (Same recipe as above)	Oral	47.27		
							Meat	Joint Pain (ORT)	Cooked (Same recipe as above)	Oral	7.27		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
11	Gastropods	*Bellamya bengalensis* (lV) (Lamarck, 1822)	Viviparidae	LC	Snail	Gehri/Rokoi or Rokoj	Shell Water	Conjunctivitis or eye infection (EA)	Raw (The shell is carefully broken to extract the inside water, which is then applied drop by drop into the eyes to treat conjunctivitis, redness, or infections)	Topical	81.81	81.81	In Bihar, foot is consumed for night blindness, and water from soaked *Bellamya bengalensis* is used as eye drops for conjunctivitis [113]
							Shell Water	Lens Cleansing (EA)	Raw (The water extracted from the shell is used as a natural cleanser for cleaning the eyes and improving lens clarity. It is applied drop by drop, typically 1–2 drops per eye, once daily)	Topical	72.72		
							Meat	Muscle Injury (SMSD)	Cooked (The meat is extracted by cracking the shell, mixed with ginger–garlic paste, and cooked in mustard oil. It is consumed to promote recovery from muscle injuries)	Oral	10.90		
							Meat	Malnutrition (GH)	Cooked (Same recipe as above)	Oral	30.90		
							Meat	Hair Care or Hair Loss (HC)	Cooked (Same recipe as above)	Oral	18.18		
							Meat	Clear Vision (EA)	Cooked (Same recipe as above)	Oral	58.18		
12	Bivalvia	*Mytilus edulis* (lV) (Linnæus, 1758)	Mytilidae	LC	Edible blue mussel	Shamuk/Ketla or Ghonga	Meat	Malnutrition (GH)	Cooked (The meat is harvested by cracking the shell, mixed with ginger–garlic paste, and then prepared with mustard oil for consumption)	Oral	40.00	72.72	No previous records found in India (to the best of our knowledge)

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Meat	Pregnancy and Post-pregnancy Nutritional Support (GUA)	Cooked (The meat is cooked and consumed to provide essential nutrients to support maternal health during pregnancy and post-pregnancy recovery)	Oral	36.36		
							Meat	Abdominal Pain (GIA)	Cooked (Consumption of cooked meat can help alleviate abdominal pain)	Oral	38.18		
							Meat	Lens Cleaning (EA)	Cooked (The meat is cooked and consumed to promote improve vision and cleanse the eyes)	Oral	41.81		
13	Actinopterygii	*Anguilla bengalensis* (V) (J. E. Gray, 1831)	Anguillidae	NT	Indian mottled eel	Kunche/ Kunche or Kunchai	Whole body	Anemia (CSCD)	Cooked (The whole body is mixed with ginger–garlic paste and cooked with mustard oil for consumption that supports recovery from anemia)	Oral	47.27	76.36	In Kerala [53] and Tamil Nadu [54] the meat is cooked and consumed to treat cough. In Arunachal Pradesh body mucus is applied on burn areas of the body [55], and fresh blood is consumed to treat asthma and general weakness by Ao tribe of Nagaland [114]
							Whole body	Blood Loss (CSCD)	Cooked (The entire body is prepared in a similar manner, promoting blood replenishment, and improving overall vitality post blood loss)	Oral	60		
							Whole body	Muscle Pain or Muscle Injury (SMSD)	Cooked (The whole body is cooked and consumed to help alleviate muscular pain and injuries)	Oral	27.27		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Whole body	Hair Loss (HC)	Cooked (The meat is cooked and consumed orally to support hair health, promote hair growth, and help prevent hair loss)	Oral	18.18		
							Blood	Hair Loss (HC)	Raw (Fresh fish is cut to collect its blood, which is then applied on the sculp)	Topical	36.36		
							Blood	Ankle Scratch (DID)	Raw (Fresh fish blood is applied topically to the ankle scratch to promote healing)	Topical	7.27		
14	Actinopterygii	*Channa punctatus* (V) (Bloch, 1793)	Channidae	LC	Lata fish	Letha machh/ Goroi Haku	Whole body	Aphrodisiac (GUA)	Cooked (The whole body is cooked with mustard oil and spices, which is then consumed to enhance libido, sexual health, and vitality in males)	Oral	41.81	65.45	In Assam, the fish is boiled and used to treat diabetes, pain, and high blood pressure [37]. The eyes, when mixed with common salt, are applied to treat corns [37]. The whole fish is used to alleviate abdominal pain. In Tamil Nadu, the fish is used for colon-related issues [54], while in Uttar Pradesh, it is used for general weakness and malaria [160]
							Whole body	Joint Pain (ORT)	Cooked (The whole body is cooked and consumed orally to help alleviate joint pain and improve mobility)	Oral	14.54		
							Whole body	General Weakness (GH)	Cooked (Cooked and consumed orally to help alleviate general weakness (GH). It boosts energy levels and provides essential nourishment to combat fatigue and weakness)	Oral	25.45		
							Whole body	Muscle Pain (SMSD)	Cooked (Cooked and consumed orally to help alleviate muscle pain)	Oral	10.90		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
15	Actinopterygii	*Oreochromis mossambicus* (V) (W. K. H. Peters, 1852)	Chiclidae	VU	Tilapia	Telapia mach/ Tilapia	Skin	Burning (DID)	Raw (The skin is removed and applied raw to the affected area to treat burns, reduce pain, and promote skin healing)	Topical	18.18	18.18	No previous records found in India (to the best of our knowledge)
16	Actinopterygii	*Puntius sophore* (V) (Hamilton, 1822)	Cyprinidae	LC	Punti fish	Puti mach/ Ponta haku or Punti	Bone	Muscle Pain (SMSD)	Powdered (Bones are ground into a fine powder using a mortar and pestle. Small amount of the powder is mixed with warm water or milk and consumed once or twice daily to alleviate muscle pain)	Oral	20.00	43.63	In Assam, the whole fish is used as a blood purifier [161] and cooked for eye problems [157]. In Purulia, West Bengal, it is used to address scanty milk production in breastfeeding mothers [162]
							Bone	Joint Pain (ORT)	Powdered (Same recipe as above)	Oral	32.72		
							Bone	Calcium Deficiency (GH)	Powdered (Same recipe as above)	Oral	20.00		
17	Amphibia	*Hoplobatrachus tigerinus* (V) (Daudin, 1803)	Dicroglossidae	LC	Indian bull frog	Sona bang/ Baru dang or Reto	Meat	General Weakness (GH)	Roasted (The meat is prepared by removing the skin, roasting it over a fire, and seasoning it with salt and consumed to combat general weakness and restore vitality)	Oral	10.9	47.27	In Jammu & Kashmir, fat is applied topically to alleviate headache, muscular pain, and joint pain [89]. In Uttarakhand [66] and Madhya Pradesh [88], crushed flesh is used on wounds for healing. In Rajasthan [20], cooked meat is consumed for tuberculosis and cough, while in Uttar Pradesh, fresh skin is removed to treat ringworm and skin diseases [160]. In Tripura, crushed flesh is applied to wounds [159]
							Meat	Anemia (CSCD)	Roasted (The meat is roasted, sprinkled with lemon juice, and consumed orally, often to help manage anemia)	Oral	9.09		
							Meat	Blood Loss (CSCD)	Roasted (Same recipe as above)	Oral	25.45		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Meat	Eczema/Atopic Dermatitis (DID)	Roasted (Consumed orally to support the management of skin conditions, promote skin healing, and aid in regeneration)	Oral	12.72		
							Meat	Scabies (DID)	Roasted (Same recipe as above)	Oral	12.72		
							Meat	Muscle Pain or Muscle Cramp (SMSD)	Roasted (Roasted meat mixed with a small amount of curcumin, ginger, and garlic and is consumed to alleviate muscle pain)	Oral	9.09		
							Meat	Asthma (RSD)	Roasted (Same recipe as above)	Oral	12.72		
							Meat	Tuberculosis (RSD)	Roasted (Same recipe as above)	Oral	9.09		
18	Reptilia	*Fowlea piscator* (V) (Schneider, 1799)	Colubridae	LC	Checkered keelback	Gharchiti/ Aurachiti or Dhoda Sanp	Meat	Rheumatism (SMSD)	Roasted (After removing the skin, head, and tail, the meat is roasted over a fire and cut into small pieces, and salt is added before consumption)	Oral	14.54	14.54	No previous records found in India (to the best of our knowledge)
							Meat	Wound Healing or Skin Disease (DID)	Roasted (Same recipe as above)	Oral	9.09		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
19	Reptilia	*Ptyas mucosa* (V) (Linnaeus, 1758)	Colubridae	LC	Rat snake	Daransh Sap/ Jamruh	Meat	Rheumatism (SMSD)	Roasted (After removing the skin, head, and tail, the meat is roasted over a fire and cut into small pieces, and salt is added before consumption)	Oral	12.72	12.72	In Kerala, fat is massaged to relieve body pain and rheumatism [155]. In Tamil Nadu, meat or soup is given orally for joint pain and swelling [163], and meat is boiled in oil and applied externally for snake bites [54]. Among the Birhor tribe of West Bengal, oil extracted from the skin is applied externally on burns and infections. In Uttarakhand, the gall bladder is cooked and eaten for diabetes [67]. In Odisha, cooked meat is prescribed to eat for body pain [23]
							Meat	Wound Healing (DID)	Roasted (Same recipe as above)	Oral	7.27		
20	Reptilia	*Calotes versicolor* (V) (Daudin, 1802)	Agamidae	LC	Oriental garden lizard	Girgiti or Roktochosha or/ Kakra	Whole body	Rheumatism or Muscle Pain (SMSD)	Oil (The entire body is heated in a pan to render the Bengal Monitor's body fat into oil. The extracted oil then applied topically to the affected area)	Topical	29.09	29.09	In Tamil Nadu, blood is given with milk to prevent skin ailments in children. The meat is cleaned and boiled in *Ricinus communis* (castor) oil. The prepared oil is consumed orally to manage hemiplegia and convulsions [54]. In Uttarakhand, the flesh is consumed orally to manage jaundice and the flesh is boiled in oil and applied topically to aid in wound healing [66]. In Kerala, raw blood is used for skin diseases and oil extracted from meat is topically applied treat rheumatism [53]. In Arunachal Pradesh and Mizoram, the dried or roasted meat is traditionally consumed to manage asthma, cough, and cold [91]
							Whole body	Joint Pain (ORT)	Oil (Same recipe as above)	Topical	16.36		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
21	Reptilia	*Varanus bengalensis* (V) (Daudin, 1802)	Varanidae	NT	Bengal monitor	Guisap/ Tarhath or Satna	Meat	Immunity Booster (GH)	Cooked (The meat is prepared by removing the skin and subcutaneous fat, cutting it into medium pieces, and boiling until tender. It is then cooked with garlic-ginger paste in mustard oil and consumed orally to boost immunity and support overall health)	Oral	30.90	70.90	In Assam, burned skin ash mixed with coconut oil is used for skin diseases, and meat is consumed for body pain [150]. In Dooars, West Bengal, oil from flesh is used for rheumatic pain [164]. In Purulia, the head is used for convulsion medicine [67]. In Rajasthan, cooked flesh promotes body stamina [20]. In Jharkhand, fat is used as massage oil for aches and impotency [165]. In Madhya Pradesh, skin oil is massaged for arthritis, and the penis and testis are eaten raw as a sexual stimulant of male sex organs [88]
							Meat	Joint Pain (ORT)	Cooked (Same recipe as above)	Oral	23.63		
							Meat	Stomach Pain (GIA)	Cooked (Same recipe as above)	Oral	10.90		
							Meat	Muscle Pain (SMSD)	Cooked (Same recipe as above)	Oral	41.81		
							Fat under skin	Rheumatism or Muscle Pain (SMSD)	Oil The subcutaneous fat is carefully harvested and heated in a pan until it melts into oil. The rendered oil is then collected, cooled, and applied to affected area	Topical	67.27		
							Fat under skin	Joint Pain (ORT)	Oil (Same recipe as above)	Topical	23.63		
22	Reptilia	*Psammophilus dorsalis* (V) (Gray, 1831)	Agamidae	LC	Rock agama	Agama Girgiti or Roktochosha or/Kakra	Whole body	Rheumatism (SMSD)	Oil (The entire body is heated in a pan with Bengal Monitor's body fat; the resulting oil is harvested through sieving and then applied to the affected area)	Topical	23.63	23.63	No previous records found in India (to the best of our knowledge)
							Whole body	Joint Pain (ORT)	Oil (Same recipe as above)	Topical	9.09		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
23	Reptilia	*Chamaeleo zeylanicus* (V) (Laurenti, 1768)	Chamaeleonidae	LC	Indian chameleon	Bohurupi or Girgiti/Rai Kakra	Tail	Neonatal Skin Discoloration (Redness/ Blackness) (DID)	Powdered (The tail is carefully dissected, sun-dried, and ground into a fine powder using a stone bowl. This powder is then mixed with breast milk and administered orally to newborns once or twice daily until the symptoms subside)	Oral	87.27	87.27	In Tiruppur, Tamil Nadu, the whole body is used for treating chronic wounds, paronychia, and paralysis; the meat is consumed for piles [163]. In Theni District, Tamil Nadu, the meat is used for treating paralysis, rheumatism, and cough [54]
24	Reptilia	*Lissemys punctata* (V) (Lacépède, 1788)	Trionychidae	VU	Indian flap shell turtle	Kachhim/ Horo	Meat	Malnutrition (GH)	Cooked (The head, carapace, plastron, and nails are removed to harvest the meat, which is then cut into small pieces. It is marinated with ginger–garlic paste and a few drops of lemon juice, prepared with mustard oil, and then consumed)	Oral	50.90	74.54	In Rajasthan, ash from turtle carapaces is used for treating lung diseases (cough, asthma, TB) and internal injuries [156]. In Gujrat, used for pruritus and cough [136]. In Theni, Tamil Nadu, burnt shell powder is used for hemorrhoids, while shell rubbed with water is given to infants for digestion; meat consumed for asthma, cough, and metrorrhagia [54]. In Tiruppur, Tamil Nadu, meat is used for piles and fistula [163]. In Goa, plastron ash used to treat burns and swollen throats [94]. In Purulia, West Bengal, shell dust is applied to burns for skin recovery [162]
							Meat	Cardiac Health (CSCD)	Cooked (Same recipe as above)	Oral	23.63		
							Meat	Indigestion (GIA)	Cooked (Same recipe as above)	Oral	20		
							Meat	Muscle Injury (SMSD)	Cooked (Same recipe as above)	Oral	43.63		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Shell	Wound Healing (DID)	Powdered (The carapace is either burnt in fire and crushed into a fine powder or dried under sunlight and ground on a stone to create powder. The resulting powder is applied directly to the wound to promote healing and prevent infection)	Topical	47.27		
							Shell	Pox or Measles (DID)	Powdered (Same recipe as above)	Topical	47.27		
							Shell	Fontanelle Strengthening (DID)	Powdered (The powder is applied to the head of newborn babies to strengthen the soft spot, fontanelle, on the head)	Topical	70.90		
25	AVES	*Gallus gallus domesticus* (V) (Linnaeus, 1758)	Phasianidae	LC	Red jungle fowl	Bon murgi/ Sim or Kurkura	Meat	Maternal Nutrition (GUA)	Boil (Soup) (The feathers are plucked, and the meat along with the skin is cut into small pieces. Cumin powder and mustard oil are added, and the mixture is boiled in water until it forms a broth-like consistency)	Oral	58.18	90.90	The Bhotiya tribe of Uttarakhand consumes chicken fat and eggs for weakness, cough, and cold [66]. Tharu tribes in Uttar Pradesh apply fresh blood to skin diseases like measles [160]. In Mizoram and Arunachal Pradesh, fatty oil is used for nasal congestion and burns [91]. The Tangsa and Wancho tribes use feather ash for allergies [27]. In Assam, chicken meat helps with post-labor recovery, bone fractures, and low blood pressure [150, 157]. In Kerala, chicken soup treats snake bites and raw fat is used for typhoid [53]. In Darjeeling [93] and Purulia [67] (West Bengal), chicken soup and eggs aid postpartum recovery, and raw eggs and liver oil are used for burns and skin eruptions
							Meat	Malnutrition (GH)	Boil (Soup) (Same recipe as above)	Oral	87.27		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Egg	Maternal Nutrition (GUA)	Boil (The boiled egg is deshelled and consumed)	Oral	47.27		
							Egg	Malnutrition (GH)	Boil (Same recipe as above)	Oral	87.27		
26	AVES	*Athene brama* (V) (Temminck, 1821)	Strigidae	LC	Spotted owlet	Khurule pencha/Kokor	Meat	Malnutrition (GH)	Cooked (Feathers are plucked; the meat is cut into small pieces, added with cumin powder, garlic-ginger paste, and mustard oil, and then cooked in water until the meat becomes soft)	Oral	14.54	36.36	In Kerala, liver juice is used for treating rickets, and ash from feathers is used for cough [155]
							Meat	Night Vision (EA)	Cooked (Same recipe as above)	Oral	27.27		
							Head	Night Vision (EA)	Powdered (The head is separated from the body, sun-dried, and ground into a fine powder and mixed with water and consumed to enhance night vision)	Oral	27.27		
27	AVES	*Halcyon smyrnensis* (V) (Linnaeus, 1758)	Alcedinidae	LC	White throated kingfisher	Machranga/ Kikir	Meat	Malnutrition (GH)	Roasted (After removing the feathers, the bird is roasted with mustard oil and salt and then given to the patient)	Oral	45.45	61.81	No previous records found in India (to the best of our knowledge)
							Meat	Stomach Pain (GIA)	Roasted (Same recipe as above)	Oral	16.36		
							Meat	Typhoid (GIA)	Roasted (Same recipe as above)	Oral	10.90		
							Meat	Tetany (SMSD)	Roasted (Same recipe as above)	Oral	7.27		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
28	AVES	*Dinopium benghalense* (V) (Linnaeus, 1758)	Picidae	LC	Black rumped flameback	Katthokra/Tuh	Meat	Malnutrition (GH)	Roasted (The feathers are removed, and the meat is roasted over a fire with a light coating of mustard oil. Salt is sprinkled on the roasted meat, which is then served to the patient)	Oral	52.72	61.81	No previous records found in India (to the best of our knowledge)
							Meat	Kidney Stone (GUA)	Roasted (Same recipe as above)	Oral	3.63		
							Meat	Stomach Pain (GIA)	Roasted (Same recipe as above)	Oral	12.72		
29	AVES	*Corvus splendens* (V) (Vieillot, 1817)	Corvidae	LC	Crow	Patikak/Kahu	Meat	Tuberculosis (RSD)	Roasted (Feathers are removed, the body is lightly scratched, roasted over a fire with mustard oil, sprinkled with salt, and consumed orally)	Oral	52.72	56.36	The Garsiya tribe of Rajasthan applies fecal, excreta for blisters and ulcers [20]. In Tamil Nadu, bile is consumed as an aphrodisiac, mixed with honey for defective vision, and meat is cooked to treat anemia and piles [54, 98]. The Nyishi and Galo tribes of Arunachal Pradesh use dried meat for stomach upsets and to improve children's intelligence [55]. The Ao tribe of Nagaland uses flesh for rheumatism, paralysis, and earaches [114]. In Gujarat, the Kachch community treats whooping cough with meat cooked in mustard oil [136]. The Madia tribe of Chhattisgarh uses remedies for conjunctivitis [152]. In Kerala, the Irular, Mudugar, and Kurumber tribes use meat for leucoderma [166], and bone powder is used for earaches [53]
							Meat	Lung Problem (RSD)	Roasted (Same recipe as above)	Oral	43.63		
							Meat	Typhoid (GIA)	Roasted (Same recipe as above)	Oral	9.09		
							Meat	Cardiac Health (CSCD)	Roasted (Same recipe as above)	Oral	3.63		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
30	AVES	*Cuculus micropterus* (V) (Gould, 1838)	Cuculidae	LC	Indian cuckoo	Bou katha kou/Kurih	Meat	Bone Fracture (ORT)	Boil (Soup) (Feathers are plucked; the meat is sliced into small pieces, salted, and boiled in water until soft. The prepared soup is consumed by the patient until symptoms are relieved)	Oral	36.36	63.63	In Kerala, the flesh is cooked and consumed for treating cough and breathing trouble [155]
							Meat	General Weakness (GH)	Boil (Soup) (Same recipe as above)	Oral	54.54		
							Meat	Muscle Pain (SMSD)	Boil (Soup) (Same recipe as above)	Oral	25.45		
31	AVES	*Centropus sinensis* (V) (Stephens, 1815)	Cuculidae	LC	Greater coucal	Kukkal/Kuili	Meat	Malnutrition (GH)	Boil (Soup) (Feathers are plucked; the meat is sliced into small pieces, added with salt, boiled in water until soft, and given to the patient until the symptoms are relieved)	Oral	63.63	67.27	No previous records found in India (to the best of our knowledge)
							Meat	Larynx and Vocal Cord problems (ENT)	Boil (Soup) (Same recipe as above)	Oral	12.72		
							Meat	Respiratory Diseases (RSD)	Boil (Soup) (Same recipe as above)	Oral	34.54		
32	AVES	*Amaurornis phoenicurus* (V) (Pennant, 1769)	Rallidae	LC	White breasted waterhen	Dahuk/Dahuk	Meat	Weakness (GH)	Cooked (Feathers are plucked; the meat is cut into small pieces, added with cumin powder, garlic-ginger paste, and mustard oil, and then cooked in water until the meat becomes soft and then given to the patient)	Oral	54.54	58.18	No previous records found in India (to the best of our knowledge)
							Meat	Indigestion (GIA)	Cooked (Same recipe as above)	Oral	32.72		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Meat	Muscle Pain (SMSD)	Cooked (Same recipe as above)	Oral	14.54		
33	AVES	*Ardeola grayii* (V) (Sykes, 1832)	Ardeidae	LC	Indian pond heron	Kanibok/Pushi kong	Meat	General Health and Nutritional Supplement (GH)	Boil (Soup) (Feathers are plucked; the meat is sliced into small pieces, added with cumin powder, salt, and mustard oil, boiled in water until soft, and then given to the patient)	Oral	56.36	72.72	No previous records found in India (to the best of our knowledge)
							Meat	Gall Bladder Stone (GIA)	Boil (Soup) (Same recipe as above)	Oral	25.45		
							Meat	Kidney Stone (GUA)	Boil (Soup) (Same recipe as above)	Oral	21.81		
34	AVES	*Egretta garzetta* (V) (Linnaeus, 1766)	Ardeidae	LC	Small white heron	Choto boga/ Pushi kong	Meat	General Health and Nutritional Supplement (GH)	Boil (Soup) (Feathers are plucked; the meat is sliced into small pieces, added with cumin powder, salt, and mustard oil, boiled in water until soft, and then given to the patient)	Oral	56.36	72.72	In Silent Valley, Kerala, and Theni, Tamil Nadu, the meat is cooked and consumed as an immune enhancer [53, 54]. In, Tamil Nadu, the cooked meat is consumed for body strength [24]
							Meat	Gall Bladder Stone (GIA)	Boil (Soup) (Same recipe as above)	Oral	25.45		
							Meat	Kidney Stone (GUA)	Boil (Soup) (Same recipe as above)	Oral	21.81		
35	AVES	*Ardea alba* (V) (Linnaeus, 1758)	Ardeidae	LC	large white heron	Boro boga/ Kong	Meat	General Health and Nutritional Supplement (GH)	Boil (Soup) (Feathers are plucked; the meat is sliced into small pieces, added with cumin powder, salt, and mustard oil, boiled in water until soft, and then given to the patient)	Oral	"	76.36	No previous records found in India (to the best of our knowledge)
							Meat	Gall Bladder Stone (GIA)	Boil (Soup) (Same recipe as above)	Oral	25.45		
							Meat	Kidney Stone (GUA)	Boil (Soup) (Same recipe as above)	Oral	21.81		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
36	AVES	*Anas poecilorhyncha* (V) (Forster, 1781)	Anatidae	LC	Indian spot-billed duck	Mete hans/ Bali Gende	Meat	Muscle Pain or Muscle Injury (SMSD)	Cooked (Feathers are plucked; the meat is cut into small pieces, added with cumin powder, garlic-ginger paste, onion, and mustard oil, and then cooked in water until the meat becomes soft and then given to the patient)	Oral	34.54	74.54	In Assam, for slurred speech, the tongue is burned, and the smoky tongue is consumed with salt [150]. In Kerala and Tamil Nadu, cooked meat is used to treat fever, while boiled eggs with salt are prescribed for erectile dysfunction [53, 54]. In Western Himalayas, Roasted flesh is used to increase virility and libido [95]
							Meat	Skin Care (DID)	Cooked (Same recipe as above)	Oral	27.27		
							Meat	General Health and Nutritional Supplement (GH)	Cooked (Same recipe as above)	Oral	45.45		
							Meat	Gall Bladder Stone (GIA)	Cooked (Same recipe as above)	Oral	52.72		
							Meat	Kidney Stone (GUA)	Cooked (Same recipe as above)	Oral	38.18		
							Feather	Water Removal from Ear (ENT)	Raw (Feather is used as roving gear to remove water from ear canal)	Topical	49.09		
37	AVES	*Spilopelia chinensis* (V) (Scopoli, 1786)	Columbidae	LC	Spotted dove	Tila ghughu/ Potam	Meat	Aphrodisiac (GUA)	Boil (Soup) (Feathers are plucked, the meat is cut into small pieces, mixed with cumin powder, salt, and mustard oil, then boiled until tender; it is given to females to support menstrual health and enhance fertility.)	Oral	78.18	76.36	In Kerala and Tamil Nadu, the meat is traditionally used to treat asthma [53, 54]
							Meat	Muscle Weakness (SMSD)	Boil (Soup) (Same recipe as above)	Oral	12.72		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
38	AVES	*Streptopelia decaocto* (V) (Frivaldszky, 1838)	Columbidae	LC	Eurasian collard dove	Kola ghughu/ Mala Potam	Meat	Aphrodisiac (GUA)	Boil (Soup) (Feathers are plucked, the meat is cut into small pieces, mixed with cumin powder, salt, and mustard oil, then boiled until tender; it is given to females to support menstrual health and enhance fertility)	Oral	78.18	76.36	No previous records found in India (to the best of our knowledge)
							Meat	Muscle Weakness (SMSD)	Boil (Soup) (Same recipe as above)	Oral	12.72		
39	AVES	*Columba livia* (V) (Gmelin, JF, 1789)	Columbidae	LC	Common pigeon	Jalali kobutor or Payra/ Paroya	Meat	Cardiac Health (CSCD)	Boil (Soup) (Feathers are plucked, the meat is sliced into small pieces, and then cumin powder, salt, and mustard oil are added. It is boiled in water until soft and then consumed for cardiac health)	Oral	63.63	90.90	In Central India [151], as well as in Gujarat [167] and Rajasthan [20], fresh blood is used to treat paralysis. In Maharashtra, raw blood is consumed for leprosy, and the flesh of young birds is cooked to aid recovery from general weakness [153]. Among the Ao tribe of Nagaland, soup is warmed and used for asthma [114]. In Tamil Nadu, cooked meat is consumed for bronchitis [98], and blood is applied externally for rheumatoid arthritis [163]. In Assam, meat is cooked or boiled with spices to treat anemia and low blood pressure [150, 157]. In Darjeeling, West Bengal, soup or cooked meat is given to asthma patients [93]. In Odisha, the meat of black pigeon is used to treat paralysis [23]

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Meat	Blood Pressure (CSCD)	Cooked (Feathers are plucked; the meat is cut into small pieces, added with cumin powder, garlic-ginger paste, onion, and mustard oil, and then cooked in water until the meat becomes soft)	Oral	54.54		
							Meat	Iron Deficiency (GH)	Cooked (Same recipe as above)	Oral	47.27		
							Meat	Intestinal Disease (GIA)	Cooked (Same recipe as above)	Oral	27.27		
							Meat	Muscle Injury or Muscle Pain (SMSD)	Cooked (Same recipe as above)	Oral	18.18		
							Fecal matter	Skin Rash or Blotch (DID)	Paste (Feces are dissolved in a small amount of water and applied to the affected area)	Topical	81.81		
							Fecal matter	Wound Healing (DID)	Paste (Same recipe as above)	Topical	54.54		
40	AVES	*Passer domesticus* (V) (Linnaeus, 1758)	Passeridae	LC	House sparrow	Chorui/ Gheroa	Meat	Skin Care (DID)	Roasted (Feathers and the digestive tract are removed, then burnt over fire greasing mustard oil, sprinkled with salt, and given to the patient)	Oral	38.18	56.36	In Assam cooked brain is consumed to treat impotence [25]. In Gujarat, the ash of sparrow excreta is used to treat childhood asthma [167]. Among ethnic groups in the Western Himalayas, soup from female flesh is believed to prevent heart issues, and blood mixed with curd and salt is applied to wounds [95]. In Maharashtra and in Assam, cooked flesh is consumed to treat stammering [26]. In Rajasthan [39] and among the Uttarakhand [66], fecal matter is applied to a baby's anus to relieve constipation. In, Tamil Nadu, blood is used as eardrops to treat otorrhea and ENT issues [163]

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Fecal matter	Constipation (GIA)	Paste (Feces is dissolved in a small amount of water and applied to the anal region)	Anal	47.27		
41	AVES	*Phalacrocorax fuscicollis* (V) (Stephens, 1826)	Phalacrocoracidae	LC	Indian cormorant	Pankouri/Seral	Meat	Energy Booster (GH)	Cooked (Feathers are plucked; the meat is cut into small pieces, then added with cumin powder, garlic-ginger paste, onion, and mustard oil, and then cooked in water until the meat becomes soft)	Oral	40	63.63	No previous records found in India (to the best of our knowledge)
							Meat	Lung-Related Problem (RSD)	Cooked (Same recipe as above)	Oral	49.09		
							Syrinx	Asthma (RSD)	Paste (The syrinx is rubbed on a stone, then mixed with water to form a paste, which is given to the patient)	Oral	38.18		
							Syrinx	Respiratory Disease (RSD)	Paste (Same recipe as above)	Oral	29.09		
42	AVES	*Upupa epops* (V) (Linnaeus, 1758)	Upupidae	LC	Common hoopoe	Mohonchura/	Meat	Gall Bladder Stone (GIA)	Boil (Soup) (Feathers are plucked, the meat is sliced into small pieces, added with salt, boiled in water until soft, and then given to the patient)	Oral	38.18	45.45	In Manipur, boiled meat is traditionally used to treat kidney stones, urination problems, and white discharge in women [154]. In Assam, dried meat is used for gallstones [25]. In Mizoram and Arunachal Pradesh, meat is utilized for managing kidney-related issues [91]
							Meat	Kidney Stone (GUA)	Boil (Soup) (Same recipe as above)	Oral	36.36		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
43	AVES	*Anthus rufulus* (V) (Vieillot, 1818)	Motacillidae	LC	Paddy field pipit	Dhani tulika/ Chanchir	Meat	Indigestion (GIA)	Boil (Soup) (Feathers are plucked and the meat is sliced into small pieces. The pieces are then boiled in water with added salt until the meat becomes soft. This soup is consumed by the patient)	Oral	32.72	47.27	No previous records found in India (to the best of our knowledge)
							Meat	Blood Loss (CSCD)	Boil (Soup) (Same recipe as above)	Oral	29.09		
							Meat	Skin Care (DID)	Boil (Soup) (The soup is consumed to support skin healing and enhance skin health)	Oral	9.09		
44	Mammals	*Pteropus giganteus* (V) (Temminck, 1825)	Pteropodidae	LC	Indian flying fox	Fol badur/ Badra or Barduj	Meat	Asthma (RSD)	Boil (Soup) (After being deskinned, the meat is sliced into small pieces, added with salt, boiled in water until soft, and then given to the patient)	Oral	49.09	65.45	In Central India, feather ash is used to treat asthma [151]. In Tiruppur, Tamil Nadu, cooked meat is consumed to cure piles [163], while in Theni, Tamil Nadu, cooked meat is used for asthma and bronchitis [54]. The Ao tribe of Nagaland uses rice-soaked and dried urine to treat kidney stones [114]. In the Western Ghats, cooked flesh is eaten for asthma and chest pain [166]. In, Kerala, raw meat is consumed orally for asthma while fat is rubbed topically for bronchitis [53]. In Purulia, West Bengal, cooked flesh is eaten to treat asthma and burns, and feces are used topically as an ointment for skin burns [67]. In Sikkim, meat is boiled without salt and consumed to treat piles, cold, and cough [2]
							Meat	Tuberculosis (RSD)	Boil (Soup) (Same recipe as above)	Oral	43.63		
							Meat	Blood Loss (CSCD)	Boil (Soup) (Same recipe as above)	Oral	9.09		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Skin	Fever (FVR)	Raw (The skin is removed, dried under sunlight, and then applied on forehead)	Topical	47.27		
45	Mammals	*Viverricula indica* (V) (Geoffroy Saint-Hilaire, 1803)	Viverridae	LC	Small Indian civet	Choto khatash/ Ruroh	Meat	Mental Illness (NA)	Boil (Soup) (After removing the skin, the meat is sliced into small pieces and seasoned with salt, lemon juice, and ginger paste. It is boiled in water until soft and then mainly given to patients with psychosis)	Oral	40	43.63	In Tamil Nadu, it is used to treat acne [54]. In Kerala, its flesh is cooked to address breathing troubles, and soup prepared from it is used for general weakness [155]
							Meat	Body Strength (GH)	Boil (Soup) (Same recipe as above)	Oral	14.54		
46	Mammals	*Rattus rattus* (V) (Linnaeus, 1758)	Muridae	LC	Black rat	Indur/Godo	Meat	Indigestion (GIA)	Roasted (After removing the digestive tract and skin, it is burnt in fire and then consumed with salt)	Oral	45.45	52.72	In Chhattisgarh, meat is consumed as food, believed to be protein-rich and beneficial for overall health [152]. Among Shoka tribe of Pithoragarh, Uttaranchal, and in Andhra Pradesh, meat is considered a promoter of semen [92, 168]. Among the Niyashi and Galo tribes in Arunachal Pradesh, the whole body of certain animals is burned, powdered, and consumed with rice as a painkiller to alleviate pain after conception, particularly in early pregnancy [55]. In the Tangsa and Wancho tribes of Arunachal Pradesh, rat meat is eaten to treat allergies and body itching, particularly from scabies [27]
							Meat	Immunity Booster (GH)	Roasted (After removing the digestive tract and skin, it is burnt in fire and then consumed with salt)	Oral	38.18		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
47	Mammals	*Vulpes bengalensis* (V) (Shaw, 1800)	Canidae	LC	Bengal fox	Khekshiyal/ Khekri	Meat	Rheumatism (SMSD)	Cooked (After removing the skin, the meat is cut into small pieces, added with cumin powder, garlic-ginger paste, onion, and mustard oil, and then cooked in water until the meat becomes soft and given to the patient)	Oral	40.00	41.81	In Arunachal Pradesh, flesh is consumed to treat tuberculosis [55]. In the Tangsa and Wancho tribes of Arunachal Pradesh, flesh is used for body and joint pains and as an energy booster for weak individuals and pregnant women; dried or cooked gall bladder and bile is used to treat Tuberculosis, liver problem, rheumatism, malaria [27]. In Assam, meat is consumed to treat paralysis [37]. In Darjeeling, West Bengal, flesh is used for gout, arthritis, and chickenpox. Flesh is fermented to make alcohol, and used for body massage to relieve aches, gout, and arthritis [93]
							Meat	Tetany (SMSD)	Cooked (Same recipe as above)	Oral	36.36		
							Meat	Indigestion Problem (GIA)	Cooked (Same recipe as above)	Oral	10.90		
							Meat	Mental Illness (NA)	Cooked (Same recipe as above)	Oral	16.36		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
48	Mammals	*Lepus nigricollis* (V) (F. Cuvier, 1823)	Leporidae	LC	Indian hare	Khorgose/ Kuloi	Meat	Muscle Strength (SMSD)	Boil (Soup) (After removing the skin, the meat is sliced into small pieces and seasoned with salt, lemon juice, and ginger paste. It is boiled in water until soft and given to the patient)	Oral	41.81	60	In Kerala, the tribals use flesh soup to treat general weakness [155]. In Rajasthan, the Garsiya people apply a tuft of fur topically to stop bleeding [156]. The Shoka tribe uses liver to treat chickenpox and excreta for ringworm [168]. In Andhra Pradesh, blood is used to treat asthma [92], while in Tamil Nadu, the whole body of certain animals is cooked and consumed to alleviate wheezing and sinusitis. Meat cooked in soup is also used for stomach ache and joint pain [54]. In Gujarat, blood, specifically tail blood, is applied externally to heal swelling, while the ash of the tail mixed with oil is used as a paste to treat burning sensations [167]. In Maharashtra, cooked meat is consumed to prevent miscarriage, and in Uttarakhand, rabbit blood is used to treat asthma [153]
							Meat	Aphrodisiac (GUA)	Cooked (Same recipe as above)	Oral	27.27		
							Meat	Skin Disease (DID)	Cooked (Same recipe as above)	Oral	14.54		
							Meat	Cholesterol level balance (CSCD)	Cooked (Same recipe as above)	Oral	54.54		
							Meat	Blood Loss (CSCD)	Cooked (Same recipe as above)	Oral	52.72		

Table 3 (continued)

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
49	Mammals	*Sus scrofa cristatus* (V) (Wagner, 1839)	Suidae	LC	Indian boar	Suor	Meat	aphrodisiac (GUA)	Cooked (After removing the skin, the meat is cut into small pieces and mixed with cumin powder, garlic-ginger paste, onion, and mustard oil. The mixture is cooked in water until the meat becomes soft and is consumed to enhance sexual health and vitality in males and support menstrual health and fertility in females.)	Oral	16.36	50.90	In Uttarakhand, the Bhotiya tribe uses skin ash to treat pneumonia and fat for rheumatism [66]. In Assam, fat oil is used for rheumatism and skin problems [157], while in Goa, it is applied for burns and fractures [94], in West Bengal for joint pain [67], in Tamil Nadu for earaches [54], in Tripura for wounds [159], and by the Karbi tribe in Assam for tumors [149]. The Biate tribe of Assam uses fat oil for hair care [86]. In Uttar Pradesh, bile is used for hypertension, and urine is consumed for neurotic fits [160]. In Sikkim, powdered teeth are used to treat rheumatism and epilepsy [2]. In Rajasthan, flesh is rubbed in affected area for muscular pain [20], while the Shoka tribe of Uttarakhand uses it for strength [168]. In Kerala, raw fat is applied for muscular pain, and cooked kidney is used for earaches [53]
							Meat	Rheumatism (SMSD)	Cooked (Same recipe as above)	Oral	47.27		
							Meat	Immunity Booster (GH)	Cooked (Same recipe as above)	Oral	36.36		
							Meat	Arthritis (ORT)	Cooked (Same recipe as above)	Oral	12.72		

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
50	Mammals	*Capra aegagrus hircus* (V) (Linnaeus, 1758)	Bovidae	LC	Domestic goat	Chhagol/ Merom	Meat	Body Strength (GH)	Cooked (After removing the skin, the meat is cut into small pieces. Cumin powder, garlic-ginger paste, onion, and mustard oil are added. The mixture is cooked in water until the meat becomes soft and given to the patient)	Oral	87.27	78.18	Urine used to treat tuberculosis in Darjeeling [93], Tripura [159], and Rajasthan [20], and anemia in Kerala [53]. Milk consumed in snake bites in Mizoram and Arunachal Pradesh [91], and eye infections and measles in Darjeeling, West Bengal [93]. Meat used for digestion problem and rhinitis in Andhra Pradesh [92]. Boiled bones for muscle cramps in Assam [157], and leg bone soup for weakness. Liver used to treat night blindness in Mizoram and Arunachal Pradesh [92]. Bladder for dysentery and bone marrow for joint dislocations in Manipur [154]. Excreta used to treat cuts, burns, and umbilical cord detachment in Arunachal Pradesh [27]. Dung mixed with urine and used for chronic wounds in Manipur [154]
							Milk	Clear Vision (EA)	Heated (Raw milk collected from the udder of females is heated in a bowl and then consumed)	Oral	50.90		
							Milk	Nausea (GIA)	Heated (Same recipe as above)	Oral	49.09		
							Milk	Headache (NA)	Heated (Same recipe as above)	Oral	36.36		
51	Mammals	*Ovis aries* (V) (Linnaeus, 1758)	Bovidae	LC	Sheep	Vera/Vera or Medi	Meat	General Weakness (GH)	Cooked (After removing the skin, the meat is cut into small pieces. Cumin powder, garlic-ginger paste, onion, and mustard oil are added. The mixture is cooked in water until the meat becomes soft and then consumed)	Oral	81.81	92.72	In Arunachal, meat treats skin diseases and fat is used for rheumatism [91]. In Darjeeling and Sikkim, sheep ghee heals scars [2, 93]. In Ladakh, meat treats cough [169]. In Tamil Nadu, fat is used for muscular pain. Sheep milk treats sterility, tallow heals cracked feet, meat is applied for swellings, and fat is consumed for body strength [54]

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Testis	Malnutrition (GH)	Boil (The intact testis is thoroughly cleaned and boiled in water with a small amount of salt and cumin powder. It is consumed as a nutritional supplement to address malnutrition)	Oral	54.54		
							Testis	Aphrodisiac (GUA)	Boil (The intact testis is thoroughly cleaned, then boiled in water with a small amount of salt and cumin powder. Once prepared, it is consumed to enhance sexual libido and support reproductive health in males)	Oral	20.0		
							Testis	Indigestion (GH)	Boil (The intact testis is cleaned thoroughly, then boiled in water with a small amount of salt and cumin powder. It is consumed to aid digestion and improve gastrointestinal health)	Oral	12.72		
							Milk	Glossitis or Stomatitis (GH)	Heated (Fresh raw milk collected from the udder of female animals is thoroughly heated in a bowl, allowed to cool slightly, and then consumed to alleviate symptoms of glossitis and stomatitis)	Oral	94.54		

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Cream	Muscle Pain (SMSD)	Extraction (Raw milk is heated and allowed to cool, forming a thick layer on the surface. This layer is separated, rubbed on a stone, and heated in a pan to extract the cream, which is then applied to the affected muscles)	Topical	67.27		
							Cream	Burning (DID)	Extraction (The cream is extracted by heating raw milk, allowing it to cool. It is then applied topically to soothe burning sensations on the skin)	Topical	36.36		
							Cream	Joint Pain (ORT)	Extraction (After separating the cream, it is heated and applied to joints to alleviate pain)	Topical	23.63		
52	Mammals	*Bos indicus* (V) (Linnaeus, 1758)	Bovidae	LC	Cow	Goru or Gai/ Dangri	Meat	Body strength or Malnutrition (GH)	Cooked (After removing the skin, the meat is cut into small pieces. Cumin powder, garlic-ginger paste, onion, and mustard oil are added. The mixture is cooked in water until the meat becomes soft)	Oral	9.09	87.27	In Uttarakhand, the Bhotiya tribe uses urine for eye diseases, milk with droppings for muscle pain, and curd for fever, weakness, and constipation [66]. In Assam, milk treats jaundice [150] and gastritis, urine is applied for skin problems, and curd is used for skin cancer [157]. In Darjeeling, flesh and tail soup aid TB recovery, and milk supplements protein [93]. In Goa, milk treats mouth infections, and dung soothes burns [94]. In Odisha, milk treats chronic dysentery [23]. In Sikkim, urine addresses gall bladder issues, diabetes, colds, and coughs [2]. In Tamil Nadu, milk and buttermilk are consumed for body cooling and ulcers, butter is used for eye infections, liver increases breast milk, and fat treats infected skin and foot corns [163]

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
							Meat	Tuberculosis (RSD)	Cooked (Same recipe as above)	Oral	9.09		
							Milk	Malnutrition (GH)	Heated raw milk collected from the udder of female animals is heated in a bowl and then consumed	Oral	80.0		
							Milk	Cardiac Health (CSCD)	Heated (Same recipe as above)	Oral	69.09		
							Milk	Muscle Weakness/or Muscle Pain (SMSD)	Heated (Same recipe as above)	Oral	14.54		
							Ghee	Body strength or Immunity booster (GH)	Extraction (Raw milk is heated, and upon cooling, a thick layer of cream forms on the surface. This cream is separated, rubbed on a stone to extract butter, and then heated in a pan to produce ghee and consumed to enhance physical strength and boost immunity)	Oral	36.36		
							Ghee	Muscle Weakness or Muscle Pain (SMSD)	Extraction (Same recipe as above)	Oral	23.63		
							Ghee	Joint Pain (ORT)	Extraction (Same recipe as above)	Oral	23.63		
							Urine	Viral Fever (FVR)	Raw (During urination, urine is collected in a container and inhaled to treat viral fever)	Inhalation	47.27		

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
53	Mammals	*Bubalus bubalis* (V) (Linnaeus, 1758)	Bovidae	LC	Buffalo	Mosh/Kada	Meat	Aphrodisiac (GUA)	Cooked (The meat is skinned, cut into small pieces, and then cooked with cumin powder, garlic-ginger paste, onion, and mustard oil in water until tender and consumed to enhance libido, sexual health, and vitality in males.)	Oral	21.81	21.81	In Uttarakhand, the Bhotiya tribe uses fat for weakness [66]. In Assam, the Karbi tribe uses buffalo horn ash for menstrual pain and body pain [149]. In Kerala, ghee treats snake bites, milk is for jaundice and ascites, and dung juice for skin eruptions [53]. In Odisha, buffalo horn ash relieves premenstrual pain [23]. In Tripura, meat is a sex stimulant [159]. In Maharashtra, curd with dung cures eczema [153]. In Nagaland, the Ao tribe applies fat for body pain, sprains, and rheumatism [114]
							Meat	Body Strength (GH)	Cooked (Same recipe as above)	Oral	18.18		
54	Mammals	*Funambulus palmarum* (V) (Linnaeus, 1766)	Sciuridae	LC	Indian palm squirrel	Kathbirali/ Turh	Meat	Cough (RSD)	Boil (Soup) (After removing the skin, the meat is sliced into small pieces. Salt, cumin powder, and mustard oil are added, and then it is boiled in water until soft before being given to the patient)	Oral	23.63	29.09	No previous records found in India (to the best of our knowledge)
							Meat	FVR (Fever)	Boil (Soup) (Same recipe as above)	Oral	20.0		
55	Mammals	*Hystrix indica* (V) (Kerr, 1792)	Hystricidae	LC	Indian crested porcupine	Sojaru/Jhink	Meat	Stomach Irritation (GIA)	Boil (Soup) (After removing the skin, the meat is sliced into small pieces. Salt, cumin powder, and mustard oil are added, and then it is boiled in water until soft before being given to the patient)	Oral	10.90	16.36	In Uttarakhand, fat treats rheumatism and body pain; dried stomach and intestine are used for stomach disorders [66]. In Arunachal Pradesh, Tangsa and Wancho tribes use dried stomach for malaria, gallbladder stones, and gastritis [27]. In Assam, flesh treats pneumonia [157]; dried alimentary canal is used for premenstrual pain [37]
							Meat	Rheumatism (SMSD)	Boil (Soup) (Same recipe as above)	Oral	16.36		

No	Category	Scientific name	Family	IUCN Status 3.1	English name	Local name Bengali/ Santali	Part/ product used	Ailments treated	Preparation method	Application mode	FL	FC	Published use reports from India
56	Mammals	*Herpestes edwardsii* (V) (É. Geoffroy Saint-Hilaire, 1818)	Herpestidae	LC	Indian grey mongoose	Beji/Chemeng	Meat	Viral or Bacterial Disease (ID)	Boil (Soup) (After removing the skin, the meat is sliced into small pieces. Salt, cumin powder, and mustard oil are added, and then it is boiled in water until soft before being given to the patient)	Oral	21.81	21.81	In Mizoram and Arunachal Pradesh, meat is utilized for the treatment of measles, and hypersensitivity to pork [91]. Among the Ao tribe in Nagaland, cooked penile tissue is consumed for male impotence. In Assam, meat is consumed to address anemia and is believed to have anticancer properties [37]. In Kerala, animal fat is applied in the management of rheumatic conditions [53]. In Odisha, meat is used for the treatment of asthma and rabies [23]. In Sikkim, boiled meat is utilized as a remedy for tuberculosis and fever. In Tamil Nadu, meat is used to treat snake envenomation [2]
57	Mammals	*Homo sapiens sapiens* (V) (Linnaeus, 1758)	Hominidae	LC	Human	Manush/Horo or Monami	Urine	Wound Healing (DID)	Raw (Raw urine is collected during urination in a container or pot and used topically for wound healing)	Topical	41.81	96.36	In Arunachal Pradesh, the Tangsa and Wancho tribes use urine for toothache, cuts, burns, and conjunctivitis [27], while the Nyishi tribe treats pathogenic eye infections [170]. In Assam, urine serves as an antiseptic for wounds [37], and the Karbi tribe uses fresh urine for skin diseases [149]. In Darjeeling, breast milk is applied for eye infections [93]. In Goa, urine is also used for eye infections [94]. In Tamil Nadu, saliva is applied for acne, and urine is used for rashes [54]
							Milk	Eye Irritation (EA)	Raw (Breast milk is harvested from a lactating mother and applied drop by drop to the eye of a child until relief of symptoms)	Topical	94.54		
							Milk	Conjunctivitis (EA)	Raw (Same recipe as above)	Topical	21.81		

The table summarizes medicinal animals, parts/products used, diseases treated, modes of preparation, and routes of administration documented in the study area

* NE—Not Evaluated, LC—Least Concern, NT—Near Threatened, VU—Vulnerable. V vertebrates, IV invertebrates, LC least concern, NE not evaluated, NT not threatened, VU vulnerable, FC frequency of citation, FL fidelity level. *The local names of the animals are given in Bengali and Santali Language

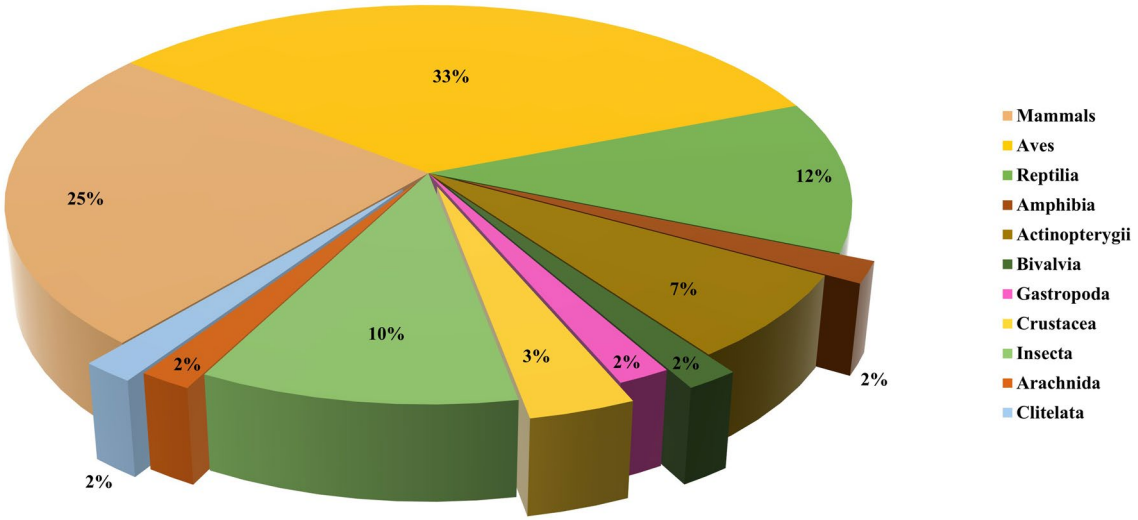


Fig. 3 Percentage distribution of animal categories and taxonomic classes traditionally utilized by indigenous communities in the study area. The pie chart illustrates the proportion of different animal species used, categorized by their taxonomic classification

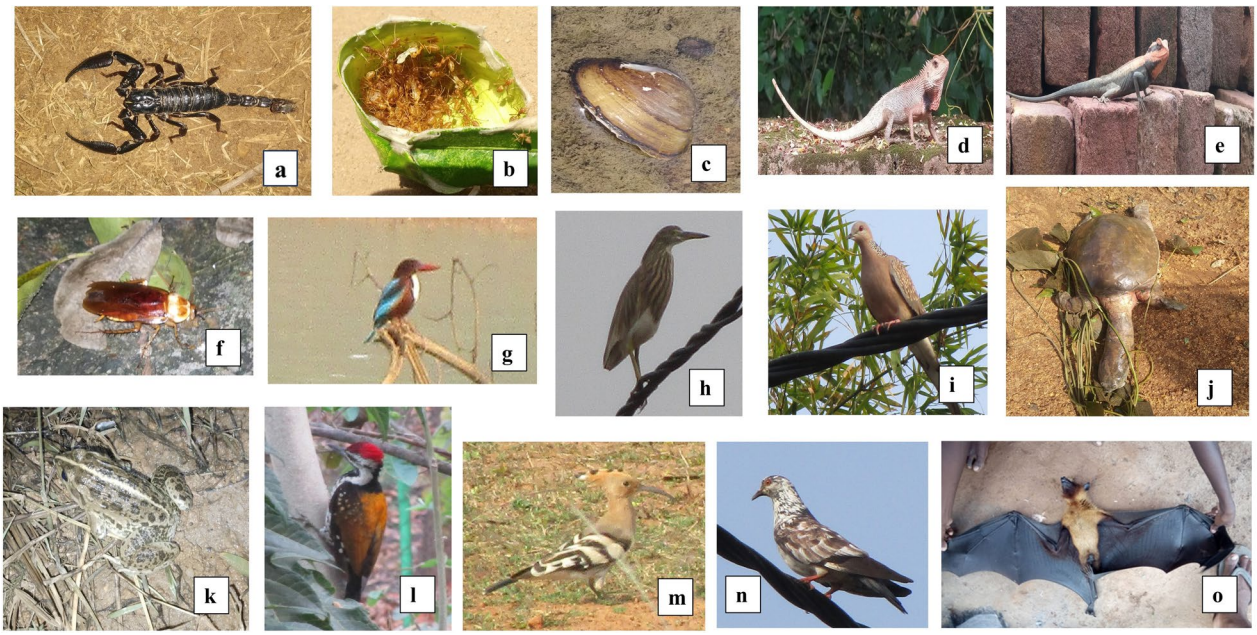


Fig. 4 Ethnozoologically important animals photographed **a**–**o** during the study period. **a** *Heterometrus sp.* **b** *Oecophylla smaragdina.* **c** *Mytilus edulis.* **d** *Calotes versicolor.* **e** *Psammophilus dorsalis.* **f** *Periplaneta americana.* **g** *Halcyon smyrnensis.* **h** *Ardeola grayii.* **i** *Spilopelia chinensis.* **j** *Lissemys punctata.* **k** *Hoplobatrachus tigerinus.* **l** *Dinopium benghalense.* **m** *Upupa epops.* **n** *Columba livia.* **o** *Pteropus giganteus*

a culturally specific practice that has not been reported elsewhere in India (Table 3).

Fat, particularly from species like *Hoplobatrachus tigerinus*, is widely used across India for treating joint pain and inflammation [66, 88, 89], while the use of its meat for managing eczema demonstrates a unique regional adaptation. In Kerala and Tamil Nadu, fat from species like *Varanus bengalensis* and *Lepus nigricollis* is applied topically to manage rheumatism and burns [53, 54]. The practices in Jhargram are consistent with these traditional uses, yet they exhibit innovation through the creation of combined formulations. For instance, scorpion (*Heterometrus* sp.) tail oil is prepared by mixing

Table 4 Category of ailments and their informant consensus factor (ICF) in the study area of Jhargram district

Symptom and ailment categories	Taxons	Use citations	ICF = Nur-Nt/Nur-1
ID (Infectious disease)	1	12	1.00
EA (Eye ailments)	5	262	0.99
HC (Hair care)	2	40	0.97
RSD (Respiratory system diseases)	13	409	0.97
ENT (Eye, nose, throat problems)	2	34	0.97
GH (General health)	32	983	0.97
CSCD (Circulatory system/cardiovascular diseases)	11	315	0.97
DID (Dermatological infection/diseases)	18	505	0.97
FVR (Fever)	7	166	0.96
NA (Neurology ailments)	3	51	0.96
GUA(Genito-urinary ailments)	15	313	0.96
GIA (Gastro-intestinal ailments)	22	376	0.94
SMSD (Skeleto-muscular system disorders)	28	465	0.94
ORT (Ortho)	12	151	0.93

Ailment categories, abbreviations of reported diseases, and corresponding informant consensus factors are provided

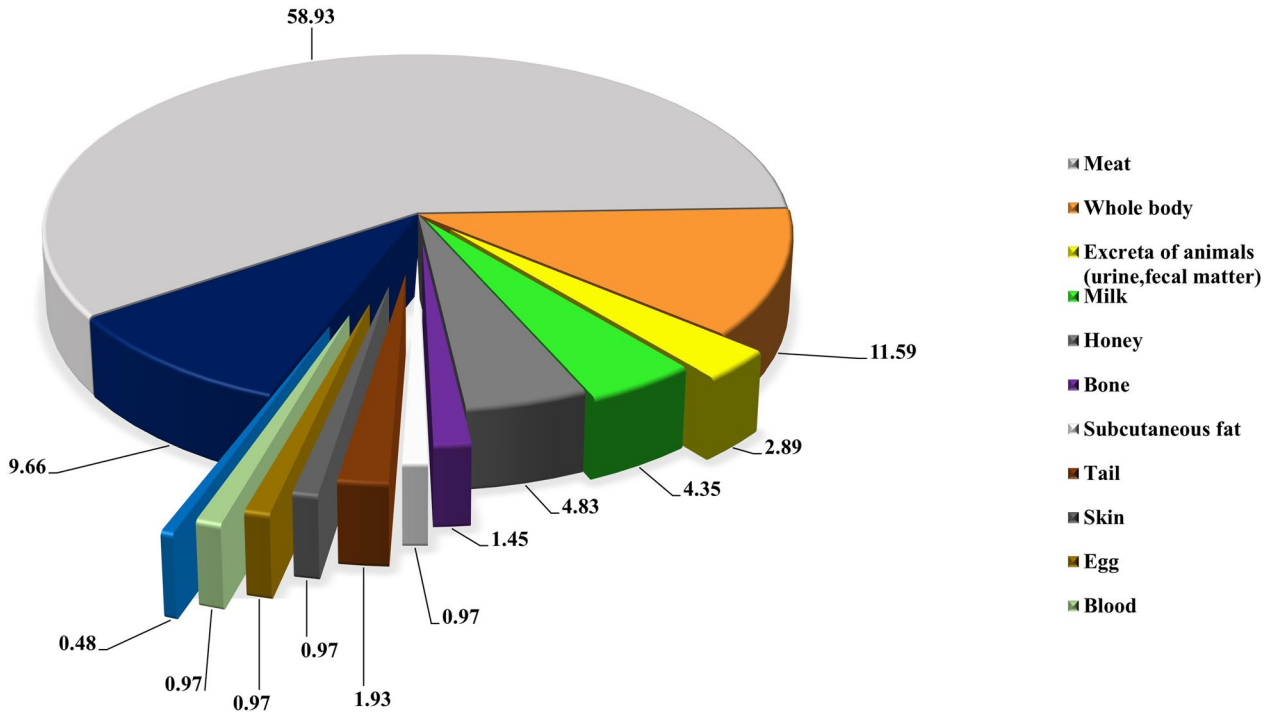


Fig. 5 Percentage distribution of specific animal parts and products used in zootherapy in Jhargram

scorpion derivatives with Bengal monitor fat, creating a potent remedy for joint pain and skin disorders.

Moreover, the meat of *Lepus nigricollis* in Jhargram is used for muscle recovery, blood loss, cholesterol balance, and as an aphrodisiac, broadening its utility compared to its primarily topical applications in Rajasthan [20].

The use of whole insect, water scavenger beetle (*Hydrophilus* sp.) for tetany, and raw skin of fish, Tilapia (*Oreochromis mossambicus*) for treating burn, stood entirely novel practices in our study, though insects were documented for other medicinal purposes in different states of India [2, 18, 27, 88, 90, 91] (Table 3). Excreta, including

fecal matter and urine, are known for their medicinal roles in other Indian regions. However, in Jhargram, the fecal matter of *Periplaneta americana* is transformed into a paste and consumed to treat gastrointestinal issues—a unconventional approach. Moreover, fecal matter of *Passer domesticus* is dissolved in water and applied anally for treating infant constipation (Table 3).

Milk from domesticated mammals like *Bos indicus*, *Capra aegagrus hircus*, and *Ovis aries* is a cornerstone of traditional health practices in India. In Kerala, Assam, and Uttarakhand, cow and goat milk are consumed for enhancing physical strength and treating malnutrition [37, 53, 66]. Similarly, in Jhargram, cow milk is used to address cardiac health and muscle pain, highlighting an expansion of its therapeutic repertoire. Goat milk, widely used in Andhra Pradesh for rhinitis and in Tamil Nadu for eye infections [54, 92], is employed in Jhargram for treating nausea, headache, and eye disease. Sheep milk is particularly noteworthy in Jhargram for its role in treating glossitis and stomatitis, unique applications not reported elsewhere in India.

Among the lesser-described applications observed in Jhargram, human-derived products such as urine and breast milk exhibit distinctive and unconventional uses that enrich the ethnomedical landscape. For example, human urine, widely recognized for its antiseptic and wound healing properties in regions like Assam, Tamil Nadu, and Arunachal Pradesh [27, 37, 54], is applied topically in Jhargram to treat infected wounds, reflecting continuity with broader practices while emphasizing its local utility for severe infections (Table 3). Similarly, breast milk, employed traditionally for eye infections in Darjeeling and Goa [93, 94], finds a comparable use in Jhargram, where it is applied to alleviate eye irritation and conjunctivitis in children.

The study found that traditional remedies lacked standardization in dosage and duration, with quantities and frequency varying based on experience until recovery. The same animal species and parts were used in different doses for similar conditions. One of the primary challenges associated with traditional medicine is the lack of standardization and quality control, as highlighted in previous studies [46]

Modes of preparation of animal parts or products for zootherapeutic uses

This study identified 12 distinct modes of preparation employed in traditional animal medicine practices for therapeutic purposes (Fig. 6). Cooking emerged as the most common method, accounting for 31.4% of the total documented preparations, followed by soup preparation (19.32%), roasting (14.1%), and raw use of animals (11.59%). Other documented techniques included oil extraction and utilization (4.35%), powdering (4.35%), heating of animal products (3.38%), extraction of byproducts (2.9%), application of pastes (2.9%), frying (2.41%), boiling (2.41%), and sucking (0.97%). Notably, the consumption of cooked, raw, boiled, or roasted animal preparations (whole animals or specific parts) is a common

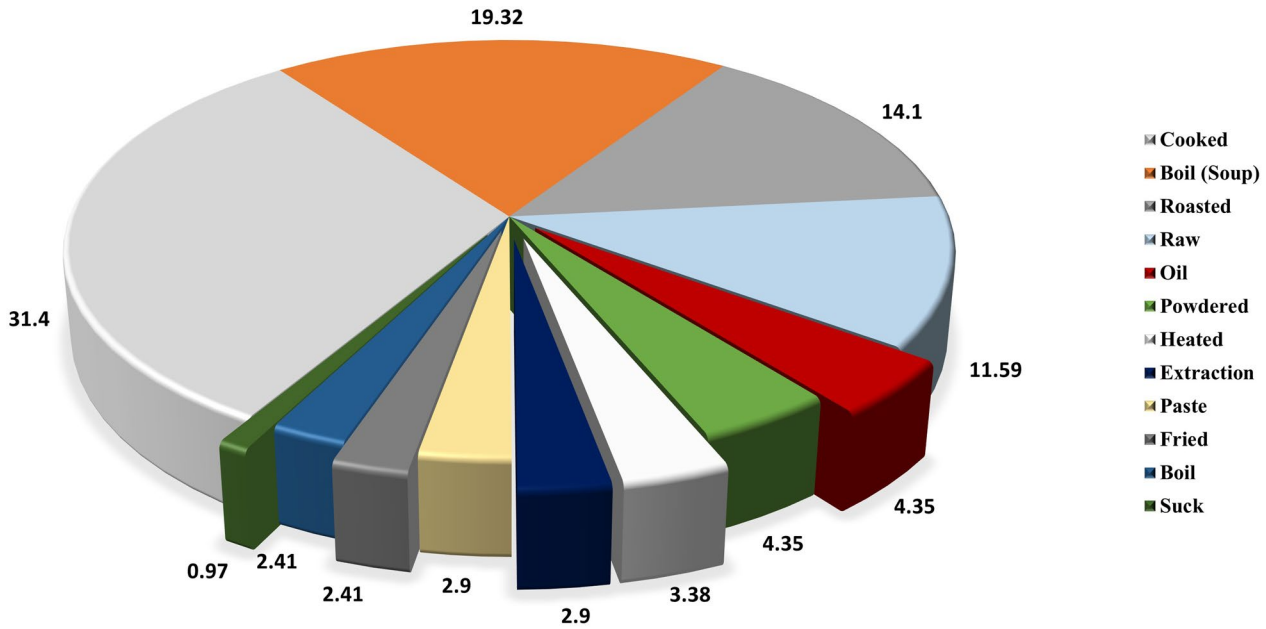


Fig. 6 Percentage distribution of modes of preparation for remedies using medicinal animals and their products in the Jhargram

practice observed across various tribal communities in India [2, 24, 26, 37, 43, 54, 95].

Routes of administration of animal parts or products for zootherapeutic uses

Traditional medicine is administered through various routes. In our study, oral administration was the most common method, observed in 81.64% of medicinal therapies (Fig. 7). Topical application accounted for 17.39%, while inhalation and anal routes were the least common, each representing 0.48% of the documented practices. This finding corroborates previous research, in which the oral route has been consistently reported as the most frequent method for delivering traditional medicines [37, 43, 46, 58]. Topical application emerged as another significant route for treating different ailments, especially muscle and bone-related diseases [20, 26, 53, 54]. Inhalation and anal application were rarely observed (0.48% each) in this area.

Quantitative indices

Informant consensus factor (ICF)

The results of the informant consensus factor (ICF) calculation in our study (Table 4) reveal values ranging from 0.93 to 1.00, indicating a high degree of agreement among the informants. The highest ICF value of 1.00 was recorded for infectious diseases (ID), with 12 use citations for a single taxon. This perfect consensus reflects the significant reliance on specific animal-derived remedies for treating infectious diseases. The second highest ICF value (0.99) was observed for eye ailments (EA), with 262 use citations for 5 taxa. Hair care (HC) also showed a high ICF value of 0.97 (40 use citations for 2 taxa), closely followed by respiratory system diseases (RSD) with an ICF value of 0.97 (409 use citations for 13 taxa). Similarly, general health (GH) and circulatory system/cardiovascular diseases (CSCD) both had an ICF value of 0.97, indicating substantial informant agreement for treatments in these categories.

Lower ICF values, such as those for gastrointestinal ailments (GIA) (0.94, 376 use citations for 22 taxa) and skeletal-muscular system disorders (SMSD) (0.94, 465 use citations for 28 taxa), reflect greater variability in the choice of animal-based remedies. The lowest ICF value of 0.93 was observed for orthopedic problems, with 151 use citations for 12 taxa. This relatively lower agreement could result from differences in cultural practices, localized knowledge, or a broader range of treatments available for these conditions.

The high ICF values observed across most categories demonstrate significant agreement among informants, indicating a robust and well-established foundation of shared traditional knowledge within the community. As there is a correlation between the effectiveness of traditional remedies and the ICF values, these results can serve as a valuable tool in identifying animal species for future research [96, 97]. This result is consistent with previous studies that have reported similarly high levels of informant consensus for ailments that are both prevalent and culturally significant [54, 97–99].

In contrast, lower values in certain categories may point to a diversity of opinions or variability in knowledge transmission among informants. This observation is similarly supported by earlier research, which attributes such variability to differences in cultural practices, localized knowledge systems, or limited communication regarding specific treatments [48, 56, 58]

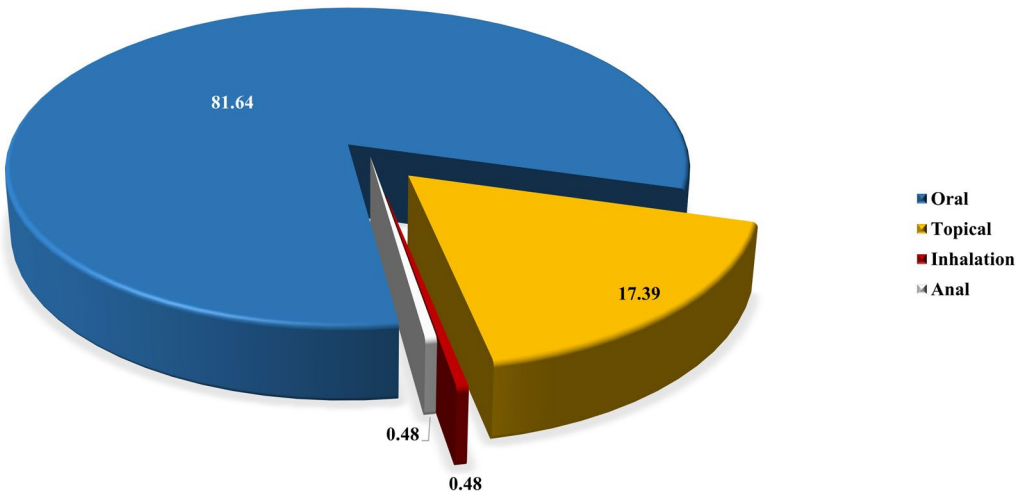


Fig. 7 Percentage distribution of application/administration routes for medicinal preparations derived from animal parts and products

Fidelity level

The fidelity level is calculated to determine species that are most frequently used to treat certain disease [2, 49, 53]. The FL in this study revealed significant variation in respondent consensus, with 12 species scoring above 80% and 33 species scoring between 50 and 80%. These findings highlight the diversity and reliability of traditional medicinal knowledge in the community. *Apis cerana* and *Homo sapiens* both achieved the highest FL of 94.54%, reflecting its key role in treating eye irritation and cough respectively which is consistent with its traditional applications in regions such as Uttarakhand and Sikkim [2, 66]. Similarly, *Gallus gallus domesticus* demonstrated an FL of 87.27%, valued for addressing malnutrition, consistent with postpartum recovery practices in Darjeeling and Purulia of this region [64, 93]. Another species with a high FL, *Palaemon* sp., scored 92.72%, primarily for treating general weakness.

Wild or less commonly utilized species also showed significant FL values. *Chamaeleo zeylanicus* achieved an FL of 87.27%, used to treat neonatal skin discoloration. *Bellamya bengalensis* scored 81.81%, for treating conjunctivitis, emphasizing its specialized ophthalmic application. Moreover, *Oceophylla smaragdina* had an FL of 81.81%, used to treat cough and cold. Another notable example is *Spilopelia chinensis*., which scored 81.81% for its use as aphrodisiac.

Among the 33 species with FL values between 50 and 80%, *Lissemys punctata* stood out with an FL of 70.90%, where its shell is used for fontanelle strengthening. *Centropus sinensis*, with an FL of 63.63%, is utilized for treating malnutrition. Lower FL species, such as *Rattus rattus* at 45.45% for indigestion and *Fowlea piscator* at 9.09% for wound healing and skin disease, reveal more niche or localized applications within the community.

This broad spectrum of FL values reflects the depth of traditional medicinal practices and underscores the need to document and preserve such knowledge amidst socioeconomic and cultural changes. The observed variations in FL values suggest a nuanced understanding within the community regarding the effectiveness of different animal species for specific ailments [2, 56, 97]. According to several previously reported studies, species with high FL values often represent well-established and reliable therapeutic options within traditional medical systems, while lower FL values may indicate less-defined or infrequently cited uses, potentially reflecting emerging trends or localized innovations in animal-based medicine [2, 54, 56, 97, 100, 101].

The findings of this study demonstrate that in many instances, the same animal species are utilized to treat multiple ailments, a pattern that is consistent with traditional medicinal practices observed across various regions worldwide [37, 66, 102, 103]. Conversely, certain ailments are sometimes addressed using different animal species. This practice of employing diverse animals or remedies for the same condition is often appreciated as it offers flexibility based on the availability and accessibility of these resources [37, 104]

Frequency of citation

The frequency of citation (FC) index was calculated to evaluate the local importance of animal species used in traditional medicinal practices among the Jhargram community (Table 3). *Homo sapiens sapiens* recorded the highest FC value (96.36%), underscoring its critical role in treating wounds and health issues. Similarly, the honey bee (*Apis cerana*, FC = 94.54%) was one of the most frequently cited species, reflecting its widespread use in managing respiratory ailments and other conditions. Other highly cited vertebrates included *Gallus gallus domesticus* (FC = 90.90%), *Ovis aries* (FC = 81.81%), and *Columba livia* (FC = 90.90%), highlighting their extensive use and cultural importance in treating a range of ailments, including general health, musculoskeletal disorders, and respiratory problems.

In contrast, less frequently cited species such as *Herpestes edwardsii* (FC = 21.81%) and *Hydrophilus* sp. (FC = 14.54%) played more specialized roles in traditional healthcare, often tied to specific ailments or rare conditions. Despite their lower citation frequencies, their inclusion in the medicinal repertoire underscores their situational importance within the community.

The preference for vertebrates over invertebrates among the most frequently cited species mirrors worldwide ethnomedicinal practices, where mammals, birds, and reptiles are widely utilized as sources for traditional remedies. This trend has been documented in various countries, including India [27, 55, 105], South America [106–108] and Africa [109, 110] underscoring the significant cultural and medicinal roles these animal groups play in traditional healthcare systems.

Species with high FC values, such as honey bees and domesticated mammals, reflect their abundance, efficacy, and cultural relevance. In contrast, species like *Hydrophilus* sp., with lower FC values, likely highlight niche-specific uses or limited awareness rather than diminished therapeutic importance.

Use value

The use value (UV) of the documented zootherapeutic species highlights their relative importance based on informant citations (ΣUvi) and the number of informants (Ni). In the current study, UV values ranged from 1.0 to 5.69, indicating varying levels of reliance on these species for traditional medicinal practices (Table 5). The species

Table 5 Use value of medicinal animals used to treat diseases in Jhargram district

Sl. no	Scientific name	ΣUv_i	N_i	UVs
1	*Apis cerana*	296	52	5.69
2	*Ovis aries*	215	51	4.22
3	*Lissemys punctata*	167	41	4.07
4	*Columba livia*	191	50	3.82
5	*Bos indicus*	172	48	3.58
6	*Bellamya bengalensis*	150	45	3.33
7	*Anas poecilorhyncha*	136	41	3.32
8	*Lepus nigricollis*	105	33	3.18
9	*Gallus gallus domesticus*	154	50	3.08
10	*Capra aegagrus hircus*	123	43	2.86
11	*Varanus bengalensis*	109	39	2.79
12	*Anguilla bengalensis*	108	42	2.57
13	*Vulpus bengalensis*	57	23	2.48
14	*Phalacrocorax fuscicollis*	86	35	2.46
15	*Scylla serrata*	94	39	2.41
16	*Pteropus giganteus*	82	36	2.28
17	*Sus scrofa cristatus*	62	28	2.21
18	*Hoplobatrachus tigerinus*	56	26	2.15
19	*Mytilus edulis*	86	40	2.15
20	*Periplaneta americana*	45	22	2.05
21	*Corvus splendens*	60	31	1.94
22	*Athena brama*	38	20	1.9
23	*Hirudinaria sp*	55	30	1.83
24	*Bubalus bubalis*	22	12	1.83
25	*Cuculus micropterus*	64	35	1.83
26	*Reticulitermes sp*	67	37	1.81
27	*Oecophylla smaragdina*	81	45	1.8
28	*Amauronis phoenicurus*	56	32	1.75
29	*Heterometrus sp*	54	32	1.69
30	*Puntius sophore*	40	24	1.67
31	*Hystrix indica*	15	9	1.67
32	*Centropus sinensis*	61	37	1.65
33	*Homo sapiens*	87	53	1.64
34	*Upupa epops*	41	25	1.64
35	*Xenochrophis piscator*	13	8	1.62
36	*Bombyx mori*	59	37	1.59
37	*Rattus rattus*	46	29	1.59
38	*Ptyas mucosa*	11	7	1.57
39	*Calotes versicolor*	25	16	1.56
40	*Passer domesticus*	47	31	1.52
41	*Anthus rufulus*	39	26	1.5
42	*Funumbulus palmarum*	24	16	1.5
43	*Ardeola grayii*	57	40	1.43
44	*Ergretta garzetta*	57	40	1.43
45	*Channa punctatus*	51	36	1.42
46	*Ardea alba*	59	42	1.4
47	*Psammophilus dorsalis*	18	13	1.38
48	*Halcyon smyrnensis*	44	34	1.29
49	*Viverricula indica*	30	24	1.25
50	*Streptopelia decaocto*	50	42	1.19
51	*Spilopelia chinensis*	50	42	1.19
52	*Dinopium benghalense*	38	34	1.12
53	*Hydrophilus sp*	8	8	1
54	*Palaemon sp*	51	51	1
55	*Oreochromis mossambicus*	10	10	1
56	*Chamaeleo zeylanicus*	48	48	1
57	*Herpestes edwardsii*	12	12	1

with the highest UV was *Apis cerana* (5.69), extensively used for its medicinal properties, followed by *Ovis aries* (4.22), *Lissemys punctata* (4.07), *Columba livia* (3.82), and *Bos indicus* (3.58). Similar to our study, *Apis cerana* has been reported with higher UV values in several other studies [46, 97, 107]. The higher UV values for certain species emphasize their critical role in traditional healthcare, driven by their ability to address multiple health conditions through different preparations [58, 97, 111]. Conversely, species such as *Hydrophilus sp., Palaemon sp., Oreochromis mossambicus, Chamaeleo zeylanicus, and Herpestes edwardsii* had UV values of 1.0, indicating limited or specialized use. Previous studies have observed that low UV values often reflect specialized medicinal applications or cultural preferences, indicating that traditional knowledge of these species may fade away [46, 97].

Jaccard index

The Jaccard Index (JI) analysis provides critical insights into the overlap of animal species used in traditional medicinal practices across various regions (Table 6). Comparisons with distant countries revealed limited similarities, with Mauritius exhibiting the highest JI (10), likely due to shared tropical ecosystems and similar faunal resources. Ethiopia, on the other hand, recorded the lowest JI (2.7), reflecting distinct ecological and cultural contexts that influence species selection and use. Among neighboring countries, Nepal (JI = 16.9) and Bhutan (JI = 11.1) demonstrated moderate overlap, potentially due to shared biogeographic zones, cultural affinities, and comparable faunal assemblages. Conversely, Myanmar (JI = 3.9) showed lower overlap, which may be attributed to ecological differences and the limited number of species documented in ethnozoological studies from that region. Within India, Kerala exhibited the highest JI (27.3), followed by Tamil Nadu (24.18) and Goa (22.95), indicating significant ecological and cultural congruence in traditional medicinal practices. These values highlight extensive use of similar faunal resources, influenced by

Table 6 Jaccard similarity index (JI) for animal-based traditional medicine uses across different geographical areas

Sl no	Previous study area	Total documented species (previous study) (A)	Total documented species (present study) (B)	Number of shared species (C) [A∩B]	Jaccard index (JI)	References
Distant Countries						
1	Northwest Ethiopia	19	57	2	2.7	[58]
2	Tropical island of Mauritius	31	57	8	10	[99]
3	Western Cape Province, South Africa	65	57	6	5.17	[110]
4	San Juan, Argentina	7	57	2	3.23	[171]
5	Jeju Island, Korea	40	57	8	9	[49]
Neighboring countries						
6	Myanmar	22	57	3	3.9	[172]
7	Bhutan	43	57	10	11.1	[173]
8	Central Punjab, Pakistan	54	57	18	19.4	[174]
9	Nepal	33	57	13	16.9	[175]
Different States of India						
10	Sikkim	41	57	9	10.11	[2]
11	Uttarakhand	41	57	12	13.95	[66]
12	Uttar Pradesh	21	57	06	8.33	[160]
13	Maharashtra	42	57	10	11.2	[153]
14	Tamil Nadu	56	57	22	24.18	[54]
15	Kerala	69	57	27	27.3	[53]
16	Rajasthan	24	57	10	14.08	[20]
17	Assam,	42	57	11	12.5	[37]
18	Manipur	21	57	11	16.42	[154]
19	Meghalaya	13	57	5	7.6	[176]
20	Arunachal Pradesh	26	57	8	10.7	[170]
21	Goa	18	57	14	22.95	[94]
22	Madhya Pradesh	18	57	05	7.14	[88]
23	Tripura	25	57	12	17.14	[159]
24	Odisha	43	57	13	14.94	[23]
Districts of West Bengal, India						
25	Duars	13	57	05	7.7	[164]
26	Darjeeling	26	57	11	15.3	[93]
27	Purulia	29	57	12	16.21	[67]
28	Jhargram	23	57	12	17.6	[148]

The table includes comparisons between distant countries, neighboring countries, various states of India and districts within West Bengal, India

comparable environmental conditions and shared knowledge systems. In contrast, states such as Madhya Pradesh (7.14) and Meghalaya (7.6) displayed limited similarity, potentially due to distinct ecological zones, localized traditions reported in ethnozoological studies from these regions. In West Bengal, district-level comparisons revealed moderate overlap between Jhargram (JI = 17.6) and Darjeeling (JI = 15.3), indicative of shared traditional knowledge and faunal utilization. However, Duars (JI = 7.7) exhibited lower similarity, likely due to localized practices and a smaller number of species included in prior documentation. The high JI often reflects shared geological zones, ecological conditions, faunal composition, and cultural practices, along with universal therapeutic uses of animal species. In contrast, low JI may indicate differences in geological zones, local knowledge, medicinal beliefs, and ecological factors influencing species selection for healthcare [51, 52].

Conservation status of animals

Our study identified several animal species utilized by local communities for medicinal purposes that are listed on the IUCN Red List under the categories of Vulnerable (VU) or Near Threatened (NT). The VU category

included Tilapia (*Oreochromis mossambicus*) and the Indian flapshell turtle (*Lissemys punctata*), while the Indian mottled eel (*Anguilla bengalensis*) and the Bengal monitor lizard (*Varanus bengalensis*) were identified as Near Threatened in the IUCN Red List [112]. A significant proportion of the species surveyed in this study are listed as Least Concern (LC) by the IUCN, indicating a relatively stable population. Examples include the Bengal snail (*Bellamya bengalensis*), Rock agama (*Psammophilus dorsalis*), Red junglefowl (*Gallus gallus domesticus*), and Bengal fox (*Vulpes bengalensis*).

The use of these species for medicinal purposes reflects their cultural importance. However, this approach raises concerns about the long-term population sustainability. While the focus on least concern (LC) species suggests a lower immediate threat, continuous monitoring is essential to ensure sustainable practices and to prevent future conservation challenges.

The medicinal value of animal products must be evaluated. If found ineffective, communities should be informed about the need to protect threatened species and preserve biodiversity. Previous studies have reported the importance of such evaluations in ensuring the sustainability of traditional medicine and biodiversity conservation [20, 108]. Strengthening socioecological systems is essential for species survival and the sustainability of traditional practices. Collaboration between conservationists and indigenous communities is necessary to develop strategies that protect both species and knowledge systems. A balance between traditional knowledge and modern conservation practices is required to safeguard biodiversity and improve local health and well-being.

Novelty of data

While many practices in Jhargram align with those documented in other regions, this study also identifies several innovative and region-specific uses of animal parts and products, contributing significantly to the field of zootherapy. Notably, some species have been associated with entirely new applications that have not been previously reported in Indian ethnomedicinal literature. These findings are presented as novel based on an exhaustive review of the existing ethnomedicinal literature available to date. While absolute certainty regarding the novelty of these uses cannot be claimed, the diversity of species involved—from invertebrates, reptiles, birds, and fish—supports the uniqueness of these applications. Among these, *Hydrophilus sp., Mytilus edulis, Oreochromis mossambicus, Fowlea piscator, Psammophilus dorsalis, Halcyon smyrnensis, Dinopium benghalense, Centropus sinensis, Amaurornis phoenicurus, Ardeola grayii, Ardea alba, Streptopelia decaocto, Phalacrocorax fuscicollis,* and *Anthus rufulus* have been identified with new applications that are, to the best of our knowledge, novel in the Indian context (see Table 3 for details). For instance, the whole body of *Hydrophilus* sp. is consumed raw along with banana to treat tetany, an application not documented elsewhere in India; similarly, the powdered shell of *Mytilus edulis* is employed to address malnutrition during pregnancy and post-pregnancy, an addition to its known applications for general nutrition in other regions. An example among fish is the use of *Oreochromis mossambicus*. Its skin is applied raw to burns, a practice believed to reduce pain and promote healing, representing a unique approach to burn care in ethnomedicine. Among reptiles, *Fowlea piscator* is utilized for its meat to treat rheumatism and promote wound healing, demonstrating its medicinal value beyond common dietary use. Moreover, *Psammophilus dorsalis* is notable for its oil, extracted from the whole body and applied topically to alleviate joint pain, offering an innovative use of reptilian resources in traditional medicine.

Among birds, the meat of *Halcyon smyrnensis* is roasted and consumed to treat tetany and typhoid, uses that are unprecedented in the Indian ethnomedicinal context; similarly, *Amaurornis phoenicurus* is uniquely prepared as a cooked remedy for digestive issues and muscle pain, while the syrinx of *Phalacrocorax fuscicollis* is ground into a paste for respiratory diseases like asthma, a novel application in traditional medicine. In addition to that the use of *Anthus rufulus* meat in boiled soup form for skin care represents a previously unrecorded therapeutic approach.

Our study identifies novel species and innovative uses for familiar ones, including species previously documented in Indian ethnomedicinal literature now recognized for new therapeutic applications in this region. For instances, the *Apis cerana* (honey bee), renowned for the medicinal properties of its honey, has been widely utilized for respiratory and digestive issues. However, its application for promoting cardiac health, as documented in this study, is a significant addition to its therapeutic repertoire. Equally intriguing is the innovative use of *Periplaneta americana* fecal matter to alleviate indigestion and constipation. The study also revisits the therapeutic applications of *Bellamya bengalensis*. While the use of water from soaked shells as eye drops for conjunctivitis is known [113], this research identifies a specific and undocumented use of shell water as a natural cleanser to enhance lens clarity and vision. This novel practice illustrates the nuanced understanding of local communities regarding the bioactive potential of molluscs.

A particularly remarkable finding pertains to the novel use of *Anguilla bengalensis*; fresh blood from this species

is applied to the scalp to prevent hair loss and topically to ankle scratches to promote wound healing. Interestingly, similar practices are observed in Nagaland, where the fresh blood of *Anguilla bengalensis* is consumed to treat general weakness and asthma [114]. Another example is the use of *Channa punctatus*, which is cooked and consumed to enhance sexual health and vitality. Similarly, a notable practice involves *Chamaeleo zeylanicus*, where the powdered tail is mixed with breast milk and administered orally to newborns to treat skin discoloration. This culturally unique practice in neonatal care represents an entirely novel application of chameleon derivatives.

Similarly, the powdered shells of *Lissemys punctata* and *Scylla serrata* are applied topically to the fontanelle of newborns to strengthen it. Another intriguing example involves *Athene brama*, which serves as a dual remedy for enhancing night vision. Both the meat and powdered head of the bird are consumed, reflecting a culturally significant practice likely inspired by the owl's exceptional nocturnal vision, an adaptation to low-light environments. This distinctive application is unreported in other regions of India.

The documentation of these novel therapeutic uses highlights the depth of indigenous knowledge and its adaptability to local health challenges. By uncovering previously unreported roles of these species in traditional medicine, this study makes a significant contribution to the expanding field of ethnobiological research. It not only enhances the understanding of species utility but also underscores the importance of ongoing efforts to document, preserve, and explore traditional practices for their potential biomedical applications. The findings emphasize that the cultural and ecological specificity of such knowledge systems offers great promise for modern pharmacological advancements.

Recent scientific insights into the pharmacological properties of animal parts and products

Recent scientific studies have provided empirical support for the traditional ethnomedicinal uses of various animal parts and products, as evidenced in this study and prior research. For instance, In vitro studies have highlighted honey's rich flavonoid content, known for its antibacterial, antioxidant, and anti-inflammatory properties. Flavonoids in honey mitigate inflammatory processes by modulating enzymes like COX, LOX, and iNOS and controlling inflammatory mediators such as nitric oxide and cytokines. Structure–activity relationship studies show that flavonoids prevent inflammatory cascades, reinforcing honey's therapeutic potential [115, 116]. In our study, live leech therapy was employed for skin disease A recent study found that leech therapy combined with Panchatikta Ghrita is a safe, cost-effective, and effective treatment for psoriasis, without the serious side effects of corticosteroids [117]. Another randomized controlled trial comparing leech therapy with antifungal clotrimazole cream for dermatophytosis showed significant therapeutic effects in both groups, with no adverse events [118]. The outcomes are attributed to bioactive compounds in leech saliva, such as hirudin, hyaluronidase, and fibrinases and collagenase. These compounds are believed to contribute to their anti-inflammatory, antimicrobial, and wound healing effects [119]. A recent study reported the significant antioxidant potential of weaver ants and termites, two insect species commonly consumed by tribal communities in India. Termites exhibited stronger antioxidant activity and higher levels of phenolic compounds, making them effective in combating oxidative stress. On the other hand, weaver ants, particularly the adult form, demonstrated remarkable flavonoid content, which is known for its antioxidant and health-promoting properties. Weaver ant broods also showed substantial levels of phenolics and flavonoids, suggesting their nutritional and therapeutic value [120]. Similarly, bioactive peptides derived from fish bones have demonstrated notable photoprotective properties. These peptides, obtained through enzymatic treatment and ultrafiltration, were effective in reducing oxidative stress, lipid peroxidation, and proinflammatory cytokines in experimental models. Additionally, fish bone nanoparticles have shown superior calcium bioavailability in murine models compared to traditional calcium carbonate, highlighting their potential as an innovative calcium source [121, 122] Tilapia skin is used to treat burns in Jhargram. Recent studies on tilapia skin acellular dermal matrix (TADM) highlight its potential in healing large-area acute skin wounds. Composed mainly of type I collagen, TADM mimics the extracellular matrix, supporting cell infiltration, angiogenesis, and tissue repair [123]. Urine has been recognized in traditional medicine across various cultures for its purported therapeutic properties. In modern research, this ancient belief has been supported by the discovery of urine-derived stem cells (USCs), which hold significant promise for treating urological disorders [124]. These studies not only provide a scientific basis for the medicinal value of animal-derived products but also encourage further investigation into their safety and efficacy, bridging the gap between traditional knowledge and modern pharmacology.

Environmental and public health challenges in ethnomedicinal animal use

The use of animal-based traditional medicine in Jhargram, though culturally significant, poses environmental and public health challenges, including biodiversity loss, habitat degradation, zoonotic risks, and weak integration

with modern healthcare. Tackling these issues is vital for preserving both biodiversity and the sustainability of traditional practice

Environmental challenges

Globally, zootherapeutic practices have been linked to the overharvesting of animal species, causing population declines and ecological imbalances [14, 125] In India, similar patterns are evident, with species such as *Apis cerana, Lissemys punctata*, *Varanus bengalensis* commonly used for their medicinal properties [37, 43, 54]. In Jhargram, the use of *Chamaeleo zeylanicus* and *Lissemys punctata* exemplifies the community's dependence on wildlife for healthcare. Both species face ecological pressures due to habitat loss and unregulated harvesting, with *Lissemys punctata* classified as vulnerable by the IUCN. Likewise, *Anguilla bengalensis* and the *Varanus bengalensis* are categorized as near threatened and are exploited for their medicinal properties, exacerbating their vulnerability. Besides this, the use of bird species such as *Athene brama* and *Columba livia* for medicinal purposes has raised concerns about declining local avian biodiversity. These practices indicate toward the conflict between traditional healthcare and conservation efforts. Studies from different regions of India have reported similar issues related to the overuse of faunal resources for traditional medicine [20, 114].

The widespread use of species classified as least concern further raises concerns about localized depletion, especially in areas with high dependency on these resources [126]. Rapid urbanization and agricultural expansion in Jhargram have reduced forest cover and fragmented critical habitats [127], disrupting migratory routes and food availability for wild animals. This kind of habitat fragmentation isolates populations, reducing genetic diversity and increasing the risk of local extinctions [128, 129].

Human–wildlife conflicts, particularly with elephants, are a significant environmental concern in Jhargram [130–132]. The region lies along a migratory route for elephants, leading to crop damage, property loss, and occasional injuries or fatalities [130]. These conflicts are exacerbated when traditional practices bring people closer to wildlife. Addressing these conflicts requires integrated conservation strategies that balance community needs with wildlife protection, ensuring sustainable use of faunal resources while minimizing such conflicts.

The lack of effective enforcement of policies regulating wildlife use for medicinal purposes exacerbates these challenges, as unregulated harvesting continues to threaten already vulnerable species. While policies are in place, their proper implementation is often difficult [133]. Addressing these challenges requires a community-based conservation approach that includes regulating wildlife use, enhancing habitat protection, and ensuring stronger enforcement of policies to guarantee sustainable practices. Educational campaigns promoting sustainable resource use and alternative medicinal practices can play a critical role in reducing reliance on endangered species while preserving cultural traditions. Collaboration between local communities, conservation organizations, and policymakers is essential to develop strategies that balance conservation efforts with the healthcare needs of the community.

Public health challenges

The use of animal-based traditional medicine in Jhargram, while deeply rooted in local cultural and therapeutic practices, presents significant public health challenges that require comprehensive analysis. One critical issue is the absence of scientific validation for many of these remedies, which raises concerns about their safety, efficacy, and reliability, as reported by previous studies [134, 135]. Traditional treatments, such as the use of fat or meat from *Varanus bengalensis* and *Hoplobatrachus tigerinus* for various ailments, rely on orally transmitted indigenous knowledge but remain largely unverified by clinical trials or pharmacological studies. This gap in evidence-based research limits their broader acceptance and utilization in clinical settings while posing potential risks to public health. Similar challenges have been documented in other regions of India, where remedies involving animal products, such as snake fat and pangolin scales, have been found to lack sufficient scientific evidence to support their claimed therapeutic properties [134, 136].

Another pressing concern is the potential for zoonotic disease transmission through the use of animal-based remedies. Several previous studies have reported similar risks, emphasizing that traditional animal medicinal practices can act as vectors for zoonotic diseases [39, 134, 137, 138]. Moreover, the improper handling and preparation of these materials significantly increase the risk of such zoonotic disease outbreaks, as this has been observed in previous studies from rural areas where unregulated use of animal products led to exposure to diseases such as brucellosis and salmonellosis [139, 140]. These risks are exacerbated by the lack of standardized hygiene practices during the preparation and administration of remedies, often carried out in unsanitary conditions without proper sterilization. Without regulatory frameworks to ensure quality control, these remedies pose significant public health threats.

Moreover, the use of traditional remedies for severe or chronic conditions can often delay timely access to modern healthcare, potentially exacerbating health outcomes, worsening health outcomes. While these remedies may

provide temporary relief for minor ailments, they are frequently inadequate for addressing complex conditions [16]. For instance, treatments used for asthma, tetany, renal stones, or gallstones may result in delayed or insufficient medical intervention, potentially aggravating these conditions. Previous studies have documented that dependence on traditional remedies for illnesses such as tuberculosis or cancer can delay access to allopathic treatments, resulting in poorer prognoses and adverse health outcomes [141–143].

The erosion of ethnomedicinal knowledge further complicates these public health challenges. As socioeconomic changes and urbanization reshape rural communities, younger generations in Jhargram are becoming increasingly disconnected from traditional practices. This loss of intergenerational knowledge transfer not only undermines the continuity of these traditions but also reduces the availability of cultural and therapeutic practices refined over generations. Similar trends have been observed across India and other countries, where rapid cultural and economic changes, urbanization, the expansion of modern education, and easy access to modern medicine have significantly reduced the transmission of traditional knowledge [37, 144–146]. The aging of traditional practitioners, without sufficient transfer of expertise to younger generations, further underscores the urgent need for preservation efforts [147].

Addressing these challenges requires a comprehensive approach. Systematic research is essential to validate the safety and efficacy of animal-based remedies, bridging traditional knowledge with modern science. Educational initiatives can raise awareness about zoonotic risks, hygiene practices, and the limitations of ethnomedicine. Regulatory frameworks must standardize traditional remedies while conserving biodiversity. Collaborative efforts among local practitioners, public health authorities, and conservationists can integrate traditional and modern healthcare systems, preserving Jhargram's rich traditions while ensuring public health and well-being.

Conclusion and future direction

This study contributes to the growing body of knowledge on the indigenous use of animal-based therapies, specifically among the ethnic communities in Jhargram, West Bengal, India. While previous studies [90, 148] have explored similar practices in this region and adjacent areas, our research represents a more comprehensive and systematic effort to document this knowledge.

Our study offers a comprehensive documentation of traditional knowledge regarding animal-derived remedies, emphasizing both well-established and novel uses by local communities. This knowledge reflects a profound understanding of the medicinal potential of local fauna; however, it is increasingly at risk due to factors such as urbanization, cultural shifts, and the growing availability of modern healthcare. To preserve this valuable knowledge, it is crucial to integrate ethnobiology and traditional medicinal practices into educational curricula, fostering awareness and understanding among younger generations. Furthermore, promoting entrepreneurship centered around the sustainable use of these remedies can provide economic incentives while safeguarding cultural heritage. Expanding clinical studies to validate the medicinal properties of these remedies will be essential for ensuring their safe application and reinforcing their potential role in complementing modern healthcare. Further research is required to incorporate this traditional knowledge into conservation and management strategies, thereby ensuring its continued contribution to both biodiversity conservation and public health.

The current body of research on the ethnomedicinal uses of animal parts and products is promising, but there are several key areas that warrant deeper investigation to unlock their full potential. Combining traditional knowledge with cutting-edge scientific techniques will be crucial in advancing our understanding of animal-derived remedies. One promising direction is the application of high-throughput screening technologies to rapidly identify bioactive compounds within animal products. This could enable the discovery of previously unknown therapeutic agents and expedite the process of drug development. Moreover, next-generation sequencing and proteomics could be used to map the molecular profiles of animal-derived substances, providing insights into their modes of action at the cellular and molecular levels. These techniques could help identify specific biomarkers that correlate with the medicinal properties of different animal parts, paving the way for precision medicine.

To ensure the safety and efficacy of animal-derived remedies, future studies must include comprehensive in vivo models that replicate human physiology more accurately. These systems would allow for a more detailed understanding of the pharmacokinetics animal-based treatments, including their interactions with human metabolism and immune systems. Furthermore, the development of advanced computational models could assist in predicting the therapeutic potential and toxicity of animal-derived products before they undergo clinical trials, reducing the risk of adverse effects. Given the ecological concerns surrounding the sustainability of harvesting animal parts, future research should also prioritize the exploration of alternatives, such as synthetic biology and biotechnological production of animal-derived compounds. This could help mitigate the over-exploitation of animal populations while ensuring a

consistent and ethical supply of bioactive substances for medicinal purposes.

Moreover, the integration of ethnobiology education and entrepreneurial applications into local communities' development is essential for the long-term sustainability of both traditional practices and scientific advancements. Ethnobiology education, integrated into local and formal educational systems, ensures the preservation and transfer of traditional ecological knowledge. This knowledge is invaluable for understanding the sustainable use of natural resources and can guide future scientific research and conservation efforts. By incorporating ethnobiology into curricula at various educational levels, from schools to Universities, local communities can be empowered to retain and further develop their knowledge systems while contributing to the global scientific community.

Community-based workshops and training can help disseminate knowledge among younger generations, ensuring that traditional practices are passed down in a culturally relevant and scientifically informed manner. Collaboration with local Universities or research institutions to offer specialized training on ethnobiology and its applications in fields such as medicine and agriculture could also increase local engagement with and respect for their traditional practices. The entrepreneurial application of ethnobiological data can open new avenues for local economic development. By identifying the bioactive potential of plants, animals, and other natural resources used in traditional medicine, local communities can create sustainable, marketable products, providing a source of income for local people while maintaining sustainable harvesting practices. Establishing community-based enterprises focusing on the cultivation, processing, and commercialization of ethnobiologically significant resources can improve local livelihoods and promote sustainable practices in natural resource management. Involving indigenous knowledge holders in these enterprises ensures that both traditional wisdom and modern innovations are integrated, creating a harmonious balance between cultural preservation and economic growth. As these advancements unfold, animal-derived products may play a pivotal role in future of personalized medicine, offering new treatment options for diseases that are currently difficult to manage.

Abbreviations

CSCD	Circulatory System/ Cardiovascular Diseases
DID	Dermatological Infection/Diseases
EA	Eye Ailments
ENT	Ear, Nose, and Throat Problems
FL	Fidelity Level
FVR	Fever
GIA	Gastro-Intestinal Ailments
GH	General Health
GUA	Genito-Urinary Ailments
HC	Hair Care
ID	Infectious Disease
IUCN	International Union for Conservation of Nature
LC	Least Concern
NA	Neurological Ailments
NE	Not Evaluated
NT	Near Threatened
ORT	Orthopedic Issues
RSD	Respiratory System Diseases
SMSD	Skeleto-Muscular System Disorders
VU	Vulnerable

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Author contributions

R. A. was responsible for investigation, data collection, and data curation. S.K.D. contributed to the writing of the original draft and performed data analysis. A.B. was responsible for GPS mapping, geographic data collection, analysis and interpretation. K.S. was involved in the conceptualization, methodology, writing of the original draft, and data analysis.

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Availability of data and materials

Data will be made available upon request.

Declarations

Ethics approval and consent to participate

This study adhered to the ethical standards for ethnobiological research, conducted in Jhargram. The study's purpose and objectives were clearly explained to all participants prior to data collection. Oral informed consent was obtained, with participation entirely voluntary, and participants retained the right to withdraw at any time without any consequences. Confidentiality and anonymity were rigorously maintained throughout the study. The research was conducted in compliance with the ethical guidelines of the International Society of Ethnobiology (ISE) (http://www.ethnobiology.net/), ensuring the responsible documentation and protection of traditional knowledge.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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