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Ethnotherapeutic practice of entomophagy species by the ethnic community of Tangkhul, Mao and Poumai community of Manipur, NER India

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Abstract

Insects are important bioresources as they supply numerous tangible and intangible benefits to humans. Day-to-day livings of many communities in the world are associated with insects as food, medicine, social beliefs, livelihood and other aspects. Many communities from immemorial time traditionally practice insects as food (entomophagy). People consumed insects for delicacy and nutritional purposes. However, some entomophagy species have medicinal value and many traditional healers used them for the treatment of various health ailments like sore throat, mouth ulcers, jaundice, body ache, wound healing, etc. In India, such traditions are widely practised in Northeast India more than other states of India. The focus of this research is on the traditional knowledge of entomophagy species having medicinal properties and social beliefs that are practised by the Tangkhul, Mao and Poumai ethnic community of Manipur, northeast region of India. Review literature was conducted through published journal paper, books and other electronic resources along with questioner's survey. The present study recorded nine entomophagy species and four species having social beliefs according to the local people. This traditional knowledge is inherent from generation to generation, and to conserve such precious indigenous knowledge, proper documentation is necessary. The documented information on the ethnic therapeutic knowledge of the important entomo-therapeutics species of the local community can be transferred to modern pharmacology.

Keywords: Ethno-entomophagy, Traditional belief, Traditional knowledge, Therapeutic value, Manipur

Introduction

Insects are the largest group of organisms on planet, comprising three-quarters of all life, classified under phylum Arthropoda, class Insecta [1]. Insects are beneficial to both the environment and human beings. Throughout the world, more than 2 billion people consume insects on regular basis. Insect's consumption is not a novel concept, although it has been practising for its flavour since immemorial time. It also provides numerous health benefits as it contains various nutrients. FAO has been working on edible insects in various countries since 2003, owing to their numerous benefits [2]. Globally, at least 1000 insect species are used as therapeutically [3], and among those some insects are used only for therapeutic purposes and some are used for both therapeutic and food purposes. Many local healers around the world use insects for the treatment of various diseases. The use of insects as folk medicine has been commonly practised in China, Brazil, Mexico, India, Africa, Tibet, Japan, Spain, Turkey, South America and South Korea [4–13]. From China

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alone, approximately 300 insect species under 70 genera, 63 families and 14 orders are reported as medicinal [14], likewise hundred more or less therapeutic insect species are reported from other countries. Honey products for the treatments of wounds and infections; venom extract from bees, wasps and ants for cancer, tuberculosis, flu and colds; and maggots for wound healing and infection reduction are examples of insects in traditional medicine [15]. Some ethnic communities of India, like Assam, Arunachal Pradesh, Chhattisgarh, Kerala, Manipur, Madhya Pradesh, Nagaland and Tamil Nadu, have engaged in this activity. A few authors have also reported on the medicinal effects of insects [3, 10, 16, 17]. Even in the Ayurvedic system of medicine also, roughly 15–20% of its materia medica were derived from animal products including insects [18]. Ten different species of insects from Satpura, Madhya Pradesh, are used in curing 16 ailments such as pneumonia, fever, gastritis, piles, healing of wounds, to cure weakness, liver disorder, dog bite, hydrophobia, snakebite and various diseases in children [19]. Some entomophagy species from Attapadi Hills of Western Ghats are informed to have medicinal values [20]. In Kerala, insects and insect resources like honeybee, honey, termites, ant, wasp, mole cricket and black beetle are used for the treatment of various diseases including ulcer, rheumatics, anaemia, malaria, asthma, etc. [21]. Traditional healers from Tirunelveli District and Kothagiri area of Nilgiris District, Tamil Nadu, also used insects as medicine [22, 23]. Such practice has also been reported from Assam [24–26], Arunachal Pradesh [27, 28], and Nagaland [17]. From Manipur also [29–31] reported the ethno-therapeutic insects use by some communities on Manipur but still yet to explore more as Manipur has diverse ethnic community.

A number of communities around the world have its own beliefs on the action and presence of insects around. People believe that the bite of the local black ant on newborns will stimulate to walk early [32] and ingest of the California harvester ants (*Pogonomyrmex californicus*) for visionary and shamanic ends development [33], and they act as a season and weather indicator [34]. Looking into such significance on edible insects research, the authors illuminate the therapeutic capabilities and traditional beliefs of some entomophagy species of Tangkhul, Mao and Poumai communities of Manipur, India. Moreover, contributions in this field of research from Manipur are very limited and so far cover only for some community like Meitei [30], Chothe, Kabui and Rongmei [29]. Therefore, the present manuscript aims to contribute some traditional information on edible insects that also have therapeutic properties and social believes towards the presence and action of insects of the selected communities of Manipur.

Study area

Manipur is a part of the Indo-Burma biodiversity hotspot covering an area of 22,325 square kilometres. The state is located between 23.8°–25.7° North latitude and 93.5°–94.8° East longitudes, with an altitude ranging from 780 m above sea level in the valley area to over 1500 m in the hilly areas. The hilly area covers almost 90% of the total geographical area of the state. The study areas cover the Ukhrul and Senapati districts, Manipur (Fig. 1). Ukhrul District is located in the north-eastern corner of Manipur, between 24°29′ and 25°42′ North latitudes and 94°30′ and 94°45′ East longitudes approximately. It shares an international border on the east by Myanmar (Burma) and on the north by Nagaland State, Senapati District, and Kangpokpi District on the west, and Kamjong District on the south. Tangkhul is the main tribe in the Ukhrul District of Manipur, and they are highly cultured people. Senapati District is located in the northern part of Manipur, between 24.37° and 25.37° North Latitude and 93.29° and 94.15° East Longitude. It is bordered by the Kangpokpi District on the south, on the east by Ukhrul District, on the west by Tamenglong District, and on the north by Kohima, and Phek District of Nagaland State. Poumai, Mao, Maram, Thangal and Zeliangrong are the major communities in the Senapati District. The ethnic communities who reside in and around the hilly terrain rely on natural resources for their livelihood. Among the wild resources, the communities are using various insects as traditional food and medicine since time immemorial.

Methodology

To review these studies, the authors follow mixed method study, i.e. primary data and secondary data collection. We have conducted a random survey to collect the primary data, based on the availability or responses of the villagers. The villagers were interacted with the help of a local guide. The local people were interacted during September 2019–March 2020 to acquire knowledge on edible insects through a random questionnaire survey following Kapesa et al. [31] methods. The targeted communities are among the major tribes of Senapati (Mao and Poumai) and Ukhrul (Tangkhul) districts of Manipur. Four villages from each community were randomly selected as per recommended by the village head or chief, among which 13–20 persons of different age groups comprised of village elders, homemakers and the youth of the villagers were interacted who are willing to share their knowledge. Villagers were interviewed individually or in group through questionnaires

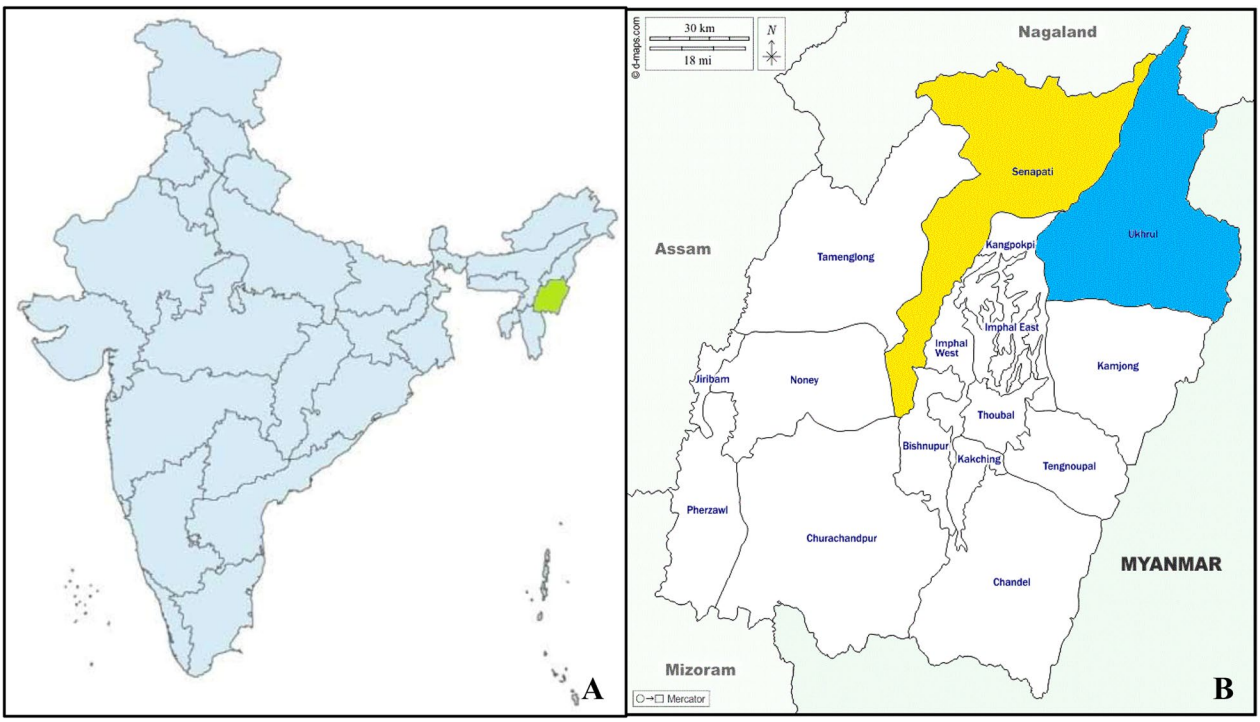

Fig. 1 Study site: **A** India map highlighting Manipur, **B** map of Manipur representing Senapati and Ukhrul districts

as well as shown images of various insects for proper identification. The questionnaires include utilization of the insects resources (food or therapeutic), vernacular name, season availability, stages and mode of consumption, etc. For ethical protocol, we inform the head or chief of the villagers; if necessary, we draw an application for their permission. Furthermore, secondary data collection, i.e. literature surveys, was undertaken to gather necessary information through published journal article, book and other sources. More than 4000 relevant articles were retrieved from DeLCON DBT-E Library Consortium search engine by using the key words entomophagy and ethno-therapeutic of insects, out of which only a few related articles were used for compiling in the Introduction section. Furthermore, the search is restricted by regions, such as India and Northeast India. In addition, key words of concerned species (e.g. *Apis mellifera*) combined with nutritional properties were used to review the nutritional attributes. The present review article uses 47 articles from the entire relevant search, that emphasizes on entomophagy, ethno-therapy, nutritional qualities and based on regions, out of which 20 articles are from Northeast India. The compiled information was about the ethno-therapy practices of the listed species by the other community of Northeast India and their nutritional characteristics.

Entomophagy species with therapeutic properties

Northeast India has rich traditional knowledge based on bioresources. Usually, the floras are mainly used as medicine for various kinds of treatment. Besides flora, many ethnic communities use fauna for the same purpose. Insects make up the majority of the faunal diversity and are used to cure a variety of important ailments. The practice of entomo-therapeutic varies by community, and Northeast India has its own traditional therapeutic practice that was passed down from their forefather's knowledge orally. From the present studies, nine species are listed as entomophagy therapeutic species used by the Tangkhul, Mao and Poumai communities. The listed species are described below and are depicted in Table 1. Some images of the documented entomophagy therapeutic species are shown in Fig. 2.

Apis mellifera Linnaeus, 1758 (Hymenoptera: Apidae)

Apis mellifera (European honeybee) is locally called as Leikovo by the Mao tribe, Vou by the Poumai tribe of Senapati District, Manipur, and Kaha/Shileng/Chirang by the Tangkhul people of Ukhrul District. *Apis mellifera* is one of the economic and ecologically important

Table 1 List of the recorded entomophagy therapeutic species

Sl. no.	Scientific name	Order: family	Habitat	Season availability	Stages, product, mode of consumption and processing
1	*Apis mellifera* Linnaeus, 1758	Hymenoptera: Apidae	Under the soil or in hollow wood	Monsoon and winter	Food: larva, pupa: fried Therapy: honey: coughs, sore throats, and mouth ulcers; raw insect juice: cure mouth ulcers
2	*Apis dorsata* Fabricius, 1793	Hymenoptera: Apidae	Rocky cliffs	Monsoon	Food: larva, pupa: fried Therapy: honey: coughs, sore throats, and mouth ulcers
3	*Darthula hardwickii* Gray, 1832	Hemiptera: Aetalionidae	Tree trunks (various tree species)	Spring	Food: adult, nymph: frying after discarding wings Therapy: jaundice: drink the decoction of the crushed roasted insect
4	Unidentified sp. (Longhorn beetles)	Coleoptera: Cerambycidae	Trunk and branches of *Albizia* sp	Autumn	Food: larva, pupa: fried or the larvae are boiled in a small amount of water by adding ginger, garlic, and salt preferably with chilly, and cooked until the water evaporates Therapy: larva: cough: make soup by adding salt, ginger, and garlic
5	*Notobitus* species	Hemiptera: Coreidae	Various plants		Food: adult: fried Therapy: adult: cough
6	*Tipula* species	Diptera: Tipulidae	Aquatic and terrestrial	Summer	Food: larva: fried Therapy: larva: speed up the healing process after surgery and to relieve body aches: soup or the cooked larva is served for quick recovery
7	*Rhynchophorus* species	Coleoptera: Curculionidae	*Phoenix* species	Monsoon	Food: larva: fried Therapy: larva: cough: soup of the larva by adding ginger, garlic and salt
8	*Vespa soror* du Buysson, 1905	Hymenoptera: Vespidae	Soil (underground)	Autumn	Food: larva, pupa: cooking or fried Therapy: improves eyesight, strengthens the body
9	Unidentified sp. (Pink Oak borer)	Lepidoptera	Trunk or branches of *Quercus* species	Autumn	Food: larva, pupa: cooking or fried Therapy: body ache and cough: soup of the larvae

bee species. It is usually found in underground or in hollow wood, and the honey is collected during the monsoon and winter seasons. The Mao, Poumai and Tangkhul tribes usually domesticate this species. Honey was traditionally utilized by the Mao and Poumai tribes to heal coughs, sore throats and mouth ulcers in young children. The Tangkhul people, on the other hand, used raw insect juice to cure mouth ulcers. Eggs, larvae, pupae and honey are consumed by the different communities of Assam, Arunachal Pradesh, Nagaland and Manipur [10, 30, 35, 36]. The Galo and Nyishi communities of Arunachal Pradesh also use the honey of *A. mellifera* for the treatment of coughs, fever, stomach pain, stomach cleanser, skin disease or irritations [27]. The Ao and Sema people of Nagaland extensively used the eggs, larvae, pupae and hives to treat stomach ailments, relieve flatulence, combat toxicity and eliminate worms [10]. This species contains various nutritional properties such as crude protein (21.0%), ether extract (12.30%), ash (2.20 (%), crude fibre 2.00 (%), dry matter

Fig. 2 Image of entomo-therapeutic species **A** *Darthula hardwickii*, **B** *Tipula* sp. **C** *Rhynchophorus* sp. **D** Pink oak borer

91.30 (%), moisture 3.82 (%), and nitrogen-free extract 73.6 (%). It also has vitamins and minerals properties, viz. vitamin A 12.44 (ug/100 g), vitamin B2 3.24 (mg/100 g), vitamin C 10.25 (mg/100 g), calcium 15.4 (mg/100 g), phosphorus 125.5 (mg/100 g), iron 25.2 (mg/100 g) and magnesium 5.23 (mg/100 g) [37].

Apis dorsata Fabricius, 1793 (Hymenoptera: Apidae)

Apis dorsata (giant honeybee) is recognized as Lei-chu by the Mao tribe and Laih-che by the Poumai tribe. It inhabits in rocky cliffs during the monsoon season. *Apis dorsata* is larger than *A. mellifera*, but looks very similar [38]. Honey is used for the treatment of cough, sore throat, and mouth ulcers in young children. Generally, this species is raise at home for honey production. This species is also reported as entomophagy by the people of Assam, Nagaland and Arunachal Pradesh [36, 39, 40]. The Adi and Apatani people consumed it as chutney, fried, raw or baking [36]. According to Senthil Kumar et al. [10], a tonic made from the larva and pupa of *A. dorsata* is useful to alleviate weariness and sunburn. From the nutritional point of view, presences of both the essential and non-essential amino acids were reported. It also contains fatty acids like MUFA and PUFA, as well as minerals such as calcium and potassium [41].

Darthula hardwickii Gray, 1832 (Hemiptera: Aetalionidae)

Darthula hardwickii (Treehopper) (Fig. 2A) is known as Tostiikhe/Pheziiro by the Mao, Ziireipaopoa by the Poumai, and Mikzur by the Tangkhul tribe. It lives on trunks of various trees and is usually found during the spring season. This species is uses as a food as well as for therapeutic purposes. The nymph and the adult stages are consumed by frying after discarding wings. This insect is rarely encountered these days. For the therapeutic purpose, people of the Mao tribe crushed the insect into powder and its decoction is used for the treatment of jaundice [31]. The Tangkhul people also employed this species for health reasons. They collected it just only for personal consumption. This species is also reported as edible in Nagaland State and said to heal diabetes and high blood pressure and is used as an appetizer by the Ao tribe [42].

Longhorn beetles (Coleoptera: Cerambycidae)

The longhorn beetles larvae, locally call as Movu lepro (Movu = *Albizia* plant and lepro = longhorn beetle larvae), are one of the locally consumed species with medicinal benefits by the Mao people among all the other species of longhorn beetles. This species prefers to inhabit in the trunk and branches of *Albizia* sp. The Mao people make soup of these larvae by adding salt,

ginger and garlic and are used as a remedy for the treatment of cough. The Poumai people also consumed this species but not for medicinal purposes. They called this species as Kha yu/Peh. Traditionally, the larvae are boiled in a small amount of water by adding ginger, garlic and salt preferably with chilly and cooked until the water evaporates.

Notobitus species (Hemiptera: Coreidae)

Notobitus species (leaf-footed bug) are locally called as Ushingsha achouba/Lenghik by the Tangkhul people. It inhabits in various plants. The adult stage is consumed by frying and used as medicine. It is believed to be used for the treatment of cough by the Tangkhul people. Among the genus *Notobitus*, *N. meleagris* is reported as edible by Chakhesang community of Nagaland [40, 43]. It is also reported for curing stomach ache, and roasted bugs are eaten for quick healing in Nagaland [17].

Tipula species (Diptera: Tipulidae)

Tipula species (Cranefly) (Fig. 2B) is a very large insect genus in the fly family Tipulidae. The adults *Tipula* are frequently mistaken as "giant mosquitoes". It is commonly called as Depfuchu by the Mao and Khaongaoboubou by the Poumai. The larval stage of this species is aquatic habitat, whereas adults in terrestrial nature and occurred during the summer season. People sometimes collect insects while digging the soil for cultivation. The larva stage of this species is fried and consumed. Both the Mao and Poumai tribes use this insect for medicinal purposes [31]. It is used to treat patients who had undergone surgery, to speed up the healing process and to relieve body aches. The Angami community of Nagaland consume the boiled or fried larvae of these insects [40]. The larvae of this species are considered as pests in many countries due to their feeding pattern on agricultural crops, pastures and cereals.

Rhynchophorus species (Coleoptera: Curculionidae)

Rhynchophorus species (Palm weevil) (Fig. 2C), known as Changhashiikhe by the Mao and Khanei (palm) ka by the Tangkhul people. It is hosted in the *Phoenix* species. Generally, they are usually available during the monsoon season and people used to fry the larval stage to eat. Besides being edible, the Mao people used the larvae for the treatment of cough by making soup. They boil the larvae by adding ginger, garlic and salt. In some parts of Cameroon, people cookbook this species as cuisine "coconut larvae". Indigenous peoples in various regions of the world have long semi-cultivated or "farmed" all of these species [44]. Entomophagy practice of *Rhynchophorus* species, such as *R. ferrugineus* and *R. phoenicis*, has been documented from Assam and Nagaland, respectively. They consumed it as chutney and baking [39, 40]. The larvae of *R. phoenicis* are used as diet supplement in Assam [39] which also contained certain minerals (in milligram) like potassium 26.65, sodium 773.49 m, calcium 60.81, magnesium 127.16, zinc 10.57, iron 65.23, copper 1.26, manganese 1.16 and essential amino acids [45].

Vespa soror du Buysson, 1905 (Hymenoptera: Vespidae)

Vespa soror (Asian giant hornet) is known as Leikhina by the Mao tribe and Laikhivou by the Poumai tribe. It inhabits under the soil (underground) and occurs during the autumn season. The larval and pupa stages are consumed by cooking or frying. It is believed that it imparts medicinal value like improving eyesight and strengthening the body. This species is usually semi-domesticated and sold in the market in high price. The people of Nagaland consume all the stages of these insects [40].

Pink oak borer (Lepidoptera)

The Pink oak borer (Fig. 2D) is locally known as Liivo by the Mao, Voie by the Poumai and Phong/Fongsar by the Tangkhul tribes. They feed and inhabit on a specific deciduous *Quercus* species. Ordinarily, they are only available throughout the autumn season. The larvae stage of this species is cooked or fried. People of the Tangkhul tribe sometimes used to consume it in raw form. This oak borer larva has a distinct and pleasant odour. It is collected from the forest mostly for personal consumption and occasionally sold in the market at a very high price. The local people of the Mao and Poumai drink the soup of these larvae for the treatment of body ache and cough, while the Tangkhul people claimed that the raw consumption of these larvae is effective for cancer treatment.

Insects in traditional beliefs

Many communities believed that insects signify omens in human life by their presence or actions. *Mecopoda elongate* (Katydid/grasshopper), commonly called as Khao by the Tangkhul, is mostly found in the paddy fields during the summer and autumn seasons. The whole body of the adult stage is roasted and consumed. The Tangkhul people believe that when this insect enters the house, they gave a signal that the rat had eaten the paddy/rice. If a particular black bug is seeing inside the house, it indicates a bad omen to the family. The Mao people believe that if there is wetness in the termatorium of *Odontotermes* spp. during the summer, it means rain is on its way in the next several days. Likewise, the presence of a huge swarm of *Darthula hardwickii* indicates the impending drought in the coming year [31]. Research in social beliefs of insects is very limited. Further, the respondents are hesitant to share such beliefs, as people considered it as orthodox in the modern culture.

Discussion

Insect-based traditional knowledge therapy is practised globally but not widespread like plant resources. Moreover, depending on the availability of species, the style of practice varies from community to community. The entomo-therapeutic species recorded from the present study are *Apis mellifera*, *A. dorsata*, *Darthula hardwickii*, Pink oak borer, *Rhynchophorus* species, Longhorn beetles, *Notobitus* species, *Tipula* species and *Vespa soror* which are used for the treatment of sore throat, mouth ulcers, jaundice, body ache, wound healing, cough and other ailments. Chanu et al. [30] reported 39 entomo-therapeutic insects from the Meitei community of Manipur, out of which 14 species were entomophagy species. Additionally, Ayekpam et al. [29] and Singh [46] also identified 5 and 11 medicinal insect species, respectively, used by the local people of Manipur. Aside from Manipur, a few other Indian states also have used insects for therapeutic purposes. In Kerala, the people of Attapadi Hills of Western Ghats used entomophagy insects like *Apis cerana indica*, *A. dorsata*, *A. florea*, *Oecophylla smaragdina*, *Periplanata orientalis*, *Bombyx mori*, *Vespa orientalis*, ant, mole cricket and black beetle which have been used to treat diseases including ulcer, rheumatics, anaemia, malaria, asthma, etc. [20, 21]. Chakravorty et al. [27] recorded 21 therapeutic insects' species from Nyishi and Galo communities of Arunachal Pradesh that have medicinal characteristics for the treatment of various disorders in humans and domestic animals. The Wangcho community from Arunachal Pradesh use four Hemipteran species as entomo-therapeutic, particularly for the treatment of cold and cough [28]. The Adi community of Arunachal Pradesh widely use honey in treating coughs, abdominal discomfort, headache, etc. [34]. From Assam, Ronghang and Ahmed [39], Dutta et al. [25], Borah and Prasad [26], Das and Singh [24] reported 10, 9, 13 and 6 edible insects, respectively, with medicinal value. Doley et al. [47] additionally documented 7 species of edible insects like *Vespa orientalis*, *Apis cerana indica*, *Samia cynthia ricini*, *Antheraea assamensis*, *Dorylus orientalis*, *Oecophylla smaragdina*, *Eumenes petiolata* and *Schistocerca gregaria* for various treatments by the Mishing community. Pongener et al. [42] reported five species used by the Ao tribe from Nagaland as traditional medicine for curing various diseases. Additionally, Mozhui et al. [17] reported fifty medicinally important insect's species for various treatments of human ailments like gastrointestinal, dermatological and respiratory diseases. Form the surveyed communities, only four entomophagy species have social beliefs, namely (*Mecopoda elongate*, Odontotermes spp., black bug and *Darthula hardwickii*). The documented species forecast weather and indicate omens to the villagers. Megu [34] has also recorded some insect's species, which linked with the myths and beliefs of the Adi community of Arunachal Pradesh. Insects like giant water bug, cicada, sting bug, termite, moth, butterflies, beetles, etc., are recorded for various indications such as weather forecast, fruit ripening, messenger of evil spirit, for entertainment, etc.

Conclusion

Here, we have documented nine insect species that are used as food as well as therapeutic agent for the treatment of cough, mouth ulcers and jaundice, and strengthen the body and many more. Modes of preparation by the villagers for consumption of insects were simply frying, roasting or cooking the insect by adding little water and cooking it until the water gets evaporated, while for therapeutic purposes, mostly people consume the soup or decoction of the insects. The information obtained on therapeutic use of edible insects was from few elderly of the villages. Even if the elderly and middle-age people are still consuming insects as food and medicine, its practices as therapeutic are reduced among the younger generation. The main factors of reduction in such practices may be because of not transferring the traditional knowledge to the next generation, a change in the food habits, changes in the land use system, deforestation and involvement of the locals in other income-generating activities for their livelihoods. On the other hand, one of the main factors is improper road communication that hinders visiting the remote area of the region and transfer of knowledge from one village to another village.

These days, most of the people are aware of insect's benefits as food and nutrition beside ecological benefits and from its drawback as a pest in agriculture and forest sector. The interested or concerned insect species can be reared for mass production instead of over harvesting from its natural habitat. Therefore, it can generate income by exporting it in different foods and feed industries and in pharmaceutical industries by identifying the pharmacological compounds, which will help in modern medicine. Further, scientific validation of such species is necessary for the production of certified goods. In order to carry out such activities, positive awareness among the society needs to be spread. Such activities can be conducted by different groups of government and non-government agencies by conducting capacity building, workshop, etc.; importantly, such knowledge has to be educated to the younger generation, so that more research in this area can be explored and using modern educational system and technique, insect's base product can be manufactured, which will help in income generation for the locals.

It seems that this practice is fading and needs to be recorded for conservation. Moreover, explore on

entomo-therapy practice, especially in Manipur, is limited and needs to focus on the primary documentation from the diverse communities of the region. Additionally, exchange of traditional knowledge through documentation will help in spreading valuable awareness among different communities, likewise among different regions of the country.

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Author contributions
WDD, KK and RB contributed to writing—original draft. PKM and YR performed review and editing and supervised the study. All authors read and approved the final manuscript.

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