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Entomophagy and ethno-therapeutic practices of insects among the Bodo community of Bodoland Territorial Region, Assam, India

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Abstract

Entomophagy is a common practice among the Bodo community of Assam, Northeast India. A survey was conducted in villages of four districts of Bodoland Territorial Region (BTR) that are inhabited by Bodos. The study documented 32 species of insects belonging to 19 families and 8 orders consumed by the Bodo people residing in BTR. It was also recorded that certain edible insects are used by Bodo tribes for therapeutic purposes viz. *Tarbinskiellus portentosus, Apis indica, Samia ricini, Lethocerus indicus, Oecophylla smaragdina, Vespa* sp. and *Ruspolia baileyi* for treating weakness, cold, cough, fever, stomach related problems, cuts, wounds, etc. Further, the proximate contents of six insect species that are most frequently consumed by the Bodos were also determined. Result indicates that these insects have great nutritional value. Therefore, insect eating is a healthy practice, providing nutritional and therapeutic values to the consumers, in addition to its savoury taste. Thus, entomophagy needs to be encouraged, especially among the young generations so that this age-old practice does not get lost.

Key words : Entomophagy, Bodo community, Entomo-therapy, Nutritional Value

Insects represents the most abundant and diverse form of life on earth. Entomophagy has been practiced around the world since ages. About 1900 species of edible insect were identified worldwide[9]. In North east region of India, different communities use insects as food for their nutritious content as well as for medicinal purposes. People eat the eggs, larvae, pupae and adults of insects. It is more prevalent among the tribal communities. Insects are used by tribal people as a regular element of their diet and not just as a last resort

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during times of scarcity[14]. Insect eating is also very popular among the Bodo community living in Bodoland Territorial Region (BTR), Assam. Insects are considered as excellent source of proteins, fats, vitamins, minerals and rich in essential amino acids[2,3]. Therefore, if the practice of eating insect is highly popularised and accepted globally, it can be helpful in solving the problems of malnutrition[12].

The study area, BTR is an autonomous region in Assam, North east India comprising of four districts viz., Kokrajhar, Chirang, Baksa and Udalguri. Earlier, it was known as the Bodoland Territorial Area Districts (BTAD). BTR lies between 26º7'12'' N to 26º47'50'' N Latitude and 89º47'40'' E to 92º18'30'' E Longitude. The area is inhabited by several ethnic communities such as Assamese, Bodo, Bengali, Rabha, Koch-Rajbongshi, Nepali, Santhal, Garo, *etc*. Among these, Bodos are the predominant inhabitants of the region. The Bodos have been eating insects and using them as medicine since ancient times. Some common insects consumed by Bodo community are grasshoppers, silkworms, termites, beetles, ants and variety of aquatic insects. They collect edible insects from natural habitats for food as well as for therapeutic purposes. Narzari and Sarmah[12] reported that people of Bodo community consume certain insect species at the time of festivals, while some others are employed therapeutically or utilized to make traditional medicines. This knowledge remains confined to them as it is only transferred by mouth from one generation to next.

At recent times, due to rapid modernisation and urbanisation, using insects as food and for therapeutic uses is gradually eroding and therefore proper documentation is required in order to prevent the practise of entomophagy from dying out.

Hence, the aim of this present study is to explore and document various edible insects that Bodo population in BTR, Assam, India, consumes and also to study their therapeutic uses.

The present survey was conducted from February, 2019 to March, 2022 (excluding the months of lockdown period) in rural areas of 4 districts of BTR viz, Chirang, Kokrajhar, Baksa and Udalguri (Fig. 1). Frequent field visits were made to remote villages inhabited by Bodos and local markets of the area in each district. Data were collected from the local people of the villages, both male and female through standard bilingual questionnaire as well as personal interview. Local healers are also considered for data collection as village people depends on them for healing ailments. Questionnaires contain set of questions regarding varieties of edible insects, season and method of their collection, mode of intake and insects of therapeutic uses.

Specimen collection and identification :

Insect specimens were collected during season of their availability with the help of local people who are skilled at insect collection. Collections were made from different habitats such as paddy fields, gardens, water bodies, backyard, etc using nets, beating trays, traps or by digging and hand picking. Some insects were also collected from the local markets in the area. The collected specimens were then identified with the help of available literature[8], books, published taxonomic keys[5,13],

internet, *etc.*

Estimation of proximate content :

Among the reported insects, 6 most commonly eaten and widely available species were selected for estimation of proximate content. Some of the insects were procured from their natural habitats while some were bought from local marketplaces. They were degutted, weighed and dried under the sun. The dried samples were then grinded into powder, which were subjected to proximate analysis.

Estimation of moisture content :

3gm of sample was dried for 3 hours at 105°C in a Universal hot air oven with digital temperature controls. The sample was placed in a desiccator to cool before being weighed. The weight discrepancies represent moisture loss and are reported as a percentage of the oven dried sample[1].

W1 = Weight (gm) of sample before drying

W2 = Weight (gm) of sample after drying

Moisture%= $W_1 - W_2/W_1$ X 100

Estimation of protein content :

The micro Kjeldahl method was utilised in order to provide an estimate of the crude protein. After placing 1 g of the sample in a digestion flask, 20 ml of concentrated sulphuric acid, 9.6 g of potassium sulphate, and 0.4 g of copper sulphate were added. The mixture was then cooked on low heat until the frothing stopped. The solution was brought to a rapid boil until it became transparent. After letting the solution cool down, 60 ml of distilled water were added to it. As soon as possible, the flask was attached to the digesting bulb on the condenser. The tip of the condenser was then submerged in standard acid, and 5-7 drops of mix indicator were added to the receiver. The flask was heated while being spun in order to completely mix the contents and the process was repeated until all of the ammonia was distilled. After removing the receiver, the tip of the condenser was given a thorough cleaning. The surplus standard acid that was distilled was titrated against the standard solution of sodium hydroxide. The nitrogen percent was calculated by the following formula.

Nitrogen%= (Sample titre-Blank titre) X Normality of HCl X 14 X 100/ Weight of sample X 1000

Protein percentage was estimated by conversion of nitrogen to protein

Protein%= Nitrogen% X 6.25 (Conversion factor)

Estimation of ash content :

The ash content was determined by method of AOAC[1]. 5 g of the sample were placed in a silica crucible, and the lid was only partially covered while it was heated over a Bunsen flame. After the production of vapours had stopped, the crucible and lid were put into a muffle furnace and heated at 550 ° C for 24 hours. After the heating process was finished, the crucible was covered with a lid to prevent the loss of fluffy ash, and it was then cooled in a desiccator. When the sample started to turn grey, the weight was recorded. Ash percent was calculated out by the following formula

Ash%= Weight of ash/ Weight of sample X 100

Estimation of fat content :

Determination of fat in the sample was done by the AOAC[1] method. After weighing the sample at 30 g, it was then wrapped in filter paper. The sample was initially collected in a thimble designed for extraction, and then it was moved into a soxhlet. A bottle holding 250 ml of petroleum ether was prepared and then put on the heating mantle. Approximately 14 hours were spent heating the sample at a rate of 150 degrees drop per minute. The vacuum condenser was utilised in order to evaporate the solvent. We incubated the bottle at temperatures ranging from 80 to 90 ° C until the solvent had entirely evaporated and the bottle had become fully dry. The bottle was moved to a desiccator that had a lid that was only partially closed, and the cooling process was permitted to continue. A new weight was determined for both the bottle and its dried contents. The fat% was estimated by the formula

Fat %= Weight of fat / weight of sample

Estimation of total solids :

The method described by James[11] was followed for estimation of total solid. The total solid was estimated by subtracting the moisture percent from 100.

Total solids %= 100 - Moisture%

Estimation of carbohydrates :

The total carbohydrate was calculated by the arithmetic difference method by subtracting the sum of the weights including ash, protein and lipid from the total solids

Total carbohydrates %= Total solids% - [Protein % + Ash% + Fat %]

The present survey explores the different types of insect's species consumed by the Bodo community residing in 4 districts of BTR, the details of which are shown in Table-1. A total of 32 edible insect species from 19 families and 8 orders were reported in the current study. Result revealed that maximum number of species (eleven) belong to order Orthoptera, followed by six species to Hymenoptera, three each to Hemiptera, Lepidoptera, Coleoptera, Blattodea, two to Odonata and one belonging to order Mantodea. Insects that are consumed by Bodo people include crickets, termites, ants, grasshoppers, wasps, water giant bug, beetles, larvae and pupae of silkworm, etc. It was found that Bodo people have their own traditional way of eating these insects. The unwanted parts of the insect's body are discarded and then insects are fried, roasted or smoked for consumption. Some are also cooked with herbs or fried and mashed with chilly, onion, garlic to make chutney, while some species are also found to be consumed raw, such as *Vespa affinis, Parapolybia varia, Polistis olivaceus, Apis indica and Apis dorsata*. In addition, the developmental stages i.e., eggs, larvae, pupae, nymph or adult, at which they are consumed differ from insect to insect (Table-1).

During this survey, it was observed that insects have also been used for therapeutic purposes by the Bodo community of this region. *Tarbinskiellus portentosus, Ruspolia baileyi*, *Samia ricini* are fried or

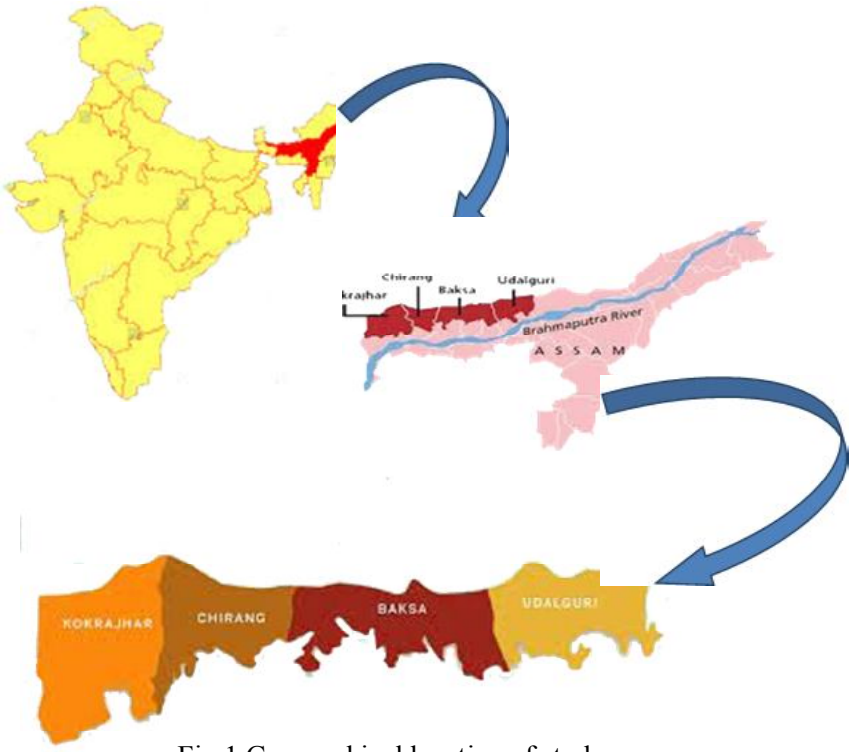

Fig.1 Geographical location of study area

roasted and consumed to treat weakness. Larvae and pupae of *Samia ricini* are also consumed by the pregnant women as nutritious food. Honey obtained from *Apis indica* is mixed with tulsi leaves and taken to cure fever, cold and cough. Fried or roasted larvae of *Vespa sp*. are eaten for treating cold, cough, stomach related problems. People eat fried eggs of *Oecophylla smaragdina* in order to treat low pressure, stomach ache, dysentery. The whole insect (*Oecophylla smaragdina*) is crushed into paste and applied externally on cuts and wounds. In Table-2, the names of insects are listed in detail, along with their parts used, method of usage, and therapeutic applications.

The proximate compositions of 6 most frequently consumed insect species were estimated and shown in Table 3. The maximum moisture content was found in *Ruspolia baileyi* followed by *Samia ricini*, *Oecophylla smaragdina, Tarbinskiellus portentosus, Lethocerus indicus, Dytiscus marginalis.* The high amount of ash and protein content were observed in *Lethocerus indicus* (10.61% and 62.50% respectively). The fats are high in *Tarbinskiellus portentosus* and the fibre content is high in *Oecophylla smaragdina*. The maximum amount of carbohydrate was estimated in *Ruspolia baileyi* which is 50.47% followed by *Oecophylla smaragdina* (25.96%), *Samia ricini* (17.69), *Dytiscus marginalis* (17.48%), *Lethocerus indicus* (12.1%) and *Tarbinskiellus portentosus* (9.71%).

Table-1. Edible insects consumed by Bodo people of BTR, Assam

Scientific name	Order	Family	Common name	Bodo name	Season wise Availability	Form or Stage of Consumption	Mode of consumption
Tarbinskiellus portentosus	Orthoptera	Gryllidae	Cricket	Khusanggra	Throughout the year	Adult	Wings, legs discarded. Fried or roasted; chutney with chilly, onion
Schizodactylus monstrosus	Orthoptera	Schizodact-ylidae	Dune cricket	Khusanggra	Throughout the year	Adult.	Wings, legs discarded. Roasted or fried and mashed with chilly, onion
Acheta domesticus	Orthoptera	Gryllidae	House cricket	Khusanggra	Aug- Nov	Adult	Wings, legs discarded. Fried in oil or roasted; chutney with chilly, garlic, onion
Gryllotalpa africana	Orthoptera	Gryllotal-pidae	Mole c ricket	Sosroma	Throughout the year	Adult	Wings discarded. Fried or roasted
Ruspolia baileyi	Orthoptera	Tettigoni-idae	Bush cricket	Guma gwthao	Sep- Dec	Adult	Wings, legs discarded. Fried, smoked, or roasted; chutney with chilly, onion
Phlaeoba infumata	Orthoptera	Acrididae	Short-Horned Grassho-pper	Guma-Daosri Jagra	May- Sep	Adult	Wings, legs discarded. Fried or roasted
Chondracris rosea	Orthoptera	Acrididae	Short-Horned Grassho-pper	Guma Nareng	May- Sep	Adult	Wings, legs discarded. Fried or roasted
Choroedocus robustus	Orthoptera	Acrididae	Short-Horned Grassho-pper	Guma Khusep	May- Sep	Adult	Wings, legs discarded. Fried or roasted
Eupreponotus inflatus	Orthoptera	Acrididae	Short-Horned Grassho-pper	Guma Nargi	May- Sep	Adult	Wings, legs discarded. Fried or roasted

Oxya fuscovittate	Orthoptera	Acrididae	Short-Horned Grassho-pper	Guma-Daosri Jagra	May- Dec	Adult	Wings, legs discarded. Fried or roasted
Mecopoda elongate	Orthoptera	Tettigoni-idae	Long-Horned Grassho-pper	Guma Khufri	May- Sep	Adult	Wings, legs discarded. Fried or roasted
Mantis inornate	Mantodea	Mantidae	Praying mantis	Guma Gangu	May- Sep	Adult	Wings and legs discarded. Fried, smoked or roasted
Ictinogomphus rapax	Odonata	Gomphidae	Dragon fly	Gandola	May-July	Nymph	Fried or roasted
Crocothemis servilia	Odonata	Libellulidae	Dragon fly	Gandola	May-Oct	Nymph	Fried or roasted
Lethocerus indicus	Hemiptera	Belosto-matidae	Giant water bug	Gangjema	Throughout the year	Adult	Wings, legs discarded. Fried or roasted; chutney with chilly, garlic, onion
Laccotrephes ruber	Hemiptera	Nepidae	Water scorpion	Lanjai gwlao	June- Oct	Adult	Wings, legs discarded. Fried or roasted
Diplonychus rusticus	Hemiptera	Belosto-matidae	Water bug	Amphou Dabla	May-Oct	Adult	Wings, legs discarded. Fried or roasted
Oecophylla smaragdina	Hymeno-ptera	Formicidae	Weaver ant	Khwjema	March-August	Eggs, Larvae	Roasted or fried with onion, chilly
Apis indica	Hymeno-ptera	Apidae	Indian honey bee	Maou bere	Throughout the year	Eggs, Larvae	Raw or fried
Apis dorsata	Hymeno-ptera	Apidae	Giant honey bee	Berema	Throughout the year	Eggs, Larvae	Raw or fried
Vespa affinis	Hymeno-ptera	Vespidae	Vespa bicolor	Handilore bere	June-Oct	Larvae	Fried, roasted or taken raw
Parapolybia varia	Hymeno-ptera	Vespidae	Lesser paper wasps	Mwsou salai bere	June-Oct	Larvae	Fried, roasted or taken raw

Polistis olivaceus	Hymeno-ptera	Vespidae	Paper wasps	Jotha bere	June-Oct	Larvae	Fried, roasted or taken raw
Samia ricini	Lepidoptera	Saturniidae	Eri silkworm	Endi Amphou	Throughout the year	Larvae, pupae	Roasted, fried with onion or cooked with roselle leaves
Antheraea assamensis	Lepidoptera	Saturniidae	Muga silkworm	Amphou latha	Throughout the year	Larvae, pupae	Roasted, fried with onion or cooked with roselle leaves
Bombyx mori	Lepidoptera	Bombycidae	Mulberry silkworm	Amphou latha	Throughout the year	Larvae, pupae	Roasted, fried with onion or cooked with roselle leaves
Dytiscus marginalis	Coleoptera	Dytiscidae	Diving beetle	Singkhouri	Throughout the year	Adult	Wings discarded. Fried or roasted, mashed with chilly, onion
Phyllophaga spp.	Coleoptera	Scarabaeidae	June beetle	Burbila	April-June	Adult	Wings discarded. Fried or roasted
Orycetes rhinoceros	Coleoptera	Scarabaeidae	Rhinoceros beetle	Jeljer	Throughout the year	Larvae	Fried
Microtermes obesi	Blattodea	Termitidae	Termite	Wuri	May-July	Adult	Wings discarded. Fried
Periplaneta americana	Blattodea	Blattidae	Cockroach	Thao-amphow/ Ganggoma	Throughout	Adult the year	Wings, legs discarded. Fried, roasted or smoked.
Macrotermes bellicosus	Blattodea	Termitidae	Termite	Gunjet	Throughout the year	Larvae, Adult	Fried or smoked

Table-2. Showing therapeutic uses of insects by Bodo people of BTR

Scientific name	Common name	Bodo name	Parts used	Mode of usage	Therapeutic uses
Tarbinskiellus portentosus	Cricket	Khusanggra	Adult	Roasted or fried and consumed.	Protein supplement, to cure weakness.
Apis indica	Honey bee	Maou bere	Honey	Honey mixed with tulsi leaves and consumed	To cure fever, cold, cough.
Samia ricini	Eri silkworm	Endi amphou	Larvae, Pupae	Fried, roasted or curry	To treat weakness, as nutritious food at the time of pregnancy.
Lethocerus indicus	Giant water bug	Gangjema	Adult	Fried, roasted or smoked and consumed	As protein supplement.
Oecophylla smaragdina	Weaver ant	Khwjema	Eggs	Fried eggs consumed	To treat low pressure, stomach ache, dysentery.
Oecophylla smaragdina	Weaver ant	Khwjema	Whole insect	Ants are crushed into paste and applied externally	To treat cuts, wounds.
Vespa sp.	Wasp	Bere	Larvae	Fried or roasted larvae are consumed	To treat cold, cough, stomach related problems.
Ruspolia baileyi	Cricket	Guma gwthao	Adult	Fried or roasted adult are consumed	As protein supplement, to treat weakness.

Table-3. Showing proximate nutrient content (%) of g/100g dry matter of some most frequently consumed insects

Name of insect	Moisture (%)	Ash (%)	Protein (%)	Fats (%)	Fiber (%)	Carbohydrates (%)
Tarbinskiellus portentosus	5.20	8.69	56.51	19.89	5.17	9.71
Lethocerus indicus	4.06	10.61	62.50	10.73	6.03	12.1
Ruspolia baileyi	6.80	2.33	30.25	10.15	1.60	50.47
Oecophylla smaragdina	5.27	4.13	47.12	17.52	12.25	25.96
Dytiscus marginalis	3.97	5.03	60.77	12.75	6.27	17.48
Samia ricini	5.89	3.07	55.18	18.17	10.21	17.69

Fig. 2. A. *Tarbinskiellus portentosus* B. *Ruspolia baileyi* C. *Ruspolia baileyi* (Fried) D. *Gryllotalpa africana* E. *Lethocerus indicus* F. *Dytiscus marginalis* G. *Oecophylla smaragdina nest* H. *Oecophylla smaragdina* (eggs, larvae) I. fried eggs, larvae of *Oecophylla smaragdina* J. *Samia ricini* (larvae) K. *Samia ricini* (Pupae) L. Fried larvae of *Samia ricini* M. *Phyllophaga spp.* N. *Periplaneta americana O. Vespa affinis* P. *Polistis olivaceus* Q. Rearing of *Samia ricini* R. Bodo woman selling larvae of *Samia ricini*

The present survey documents the edible insects consumed by the Bodos and certain insects that are used for therapeutic values. Earlier reports revealed that large numbers of insects' species are consumed by Bodo people as food[6, 9, 10, 12, 15]. In this present study, 32 species of insects were explored belonging to 19 families and 8 orders which are consumed by the Bodo tribes of BTR, Assam.

The therapeutic uses of *Tarbinskiellus portentosus, Apis indica, Samia ricini, Lethocerus indicus, Oecophylla smaragdina, Vespa sp*. and *Ruspolia baileyi* were recorded in the study. Fried eggs of *Oecophylla smaragdina* are consumed to treat low pressure and stomach related issues such as stomach ache, dysentery as reported earlier by Das and Singh[6] and Sharma[14]. The formic acid of ants is helpful in treating scabies, malaria, stomach problems, blood pressure anomalies, *etc*[4]. Honey extracted from *Apis indica* mixed with tulsi and consumed for curing cold, cough, fever. Dutta *et al*.,[7] have reported the use of eggs, larvae and honey product of *Apis indica* among the people of Moridhal Panchayat of Dhemaji district, Assam to cure whooping cough. Larvae of *Vespa* sp. are fried or roasted and then consumed to treat cold, cough and stomach related problems. Tribal people of Dimoria Development Block are also reported to used whole insect (*Vespa orientalis*) in treatment of cold, cough and stomach problems[14]. In this study, *Tarbinskiellus portentosus, Lethocerus indicus* and *Ruspolia baileyi* are found to be used as protein supplement and to treat weakness. Larvae and pupae of Eri silkworm are fried, roasted or prepared curry with roselle leaves and given as nutritious food to pregnant women. Das and Singh[6] also documented the consumption of silkworm by the Bodo women of Baksa district at the time of pregnancy and after childbirth.

The proximate analysis of most frequently consumed insects by Bodo people of BTR were estimated. The protein content was found to be fairly high (more than 50%) in *Lethocerus indicus* (62.50%), *Dytiscus marginalis* (60.77%), *Tarbinskiellus portentosus* (56.51%), *Samia ricini*(55.18%) *and slightly lesser protein content in Oecophylla smaragdina* (47.12%), *Ruspolia baileyi* (30.25%). The protein content of insects in this study corresponds to the result of Narzari and Sarmah[12]. Narzari and Sarmah analysed the proximate compositions of 20 species of insects that are taken as food by the Bodo tribes. In our study, fat content was found to be highest in *Tarbinskiellus portentosus,* followed by *Samia ricini, Oecophylla smaragdina, Dytiscus marginalis, Lethocerus indicus* and *Ruspolia baileyi*. It is observed that carbohydrate content was found to be lesser as compared to protein in all species except for *Ruspolia baileyi*. According to the findings of the current study, edible insects taken by the Bodos of BTR, Assam are very nutritious and can provide consumers with good supply of proteins and fats.

The Bodo people have their own unique traditional knowledge about the method of collecting these insects, how to prepare them, and eat them. This knowledge is passed on orally among the family members from one generation to next.

It's interesting to learn that certain insects are ingested during festive season, for instance, weaver ants are consumed during spring festival known as Bwisagw, which the Bodos celebrate during the month of April. At villages, the nest of ant is collected with the help of stick and kept in bucket containing water for some time, so that ants die or move out leaving behind the eggs in water. The eggs are then collected and fried. Fried eggs of ants are often consumed as snacks with 'Zou' or 'Jumai' (rice beer) during this festival.

Grasshoppers are collected mainly during the time of rice harvesting. Bodo women catches the insect with swift movement of hand from the rice stalk and stitched them together using rice stalk or a long grass (Fig. 2B). The grasshoppers are then fried or made bathwn (chutney) and consumed with 'Jumai' or rice. The village people can easily identify the holes of crickets. They pour water into the hole until the insect come out and get hold of them, which are then fried or roasted for consumption.

Bodo women from rural areas are found to be engaged in selling of certain insects such as pupae and larvae of silkworms, water bugs, etc. at local markets for earning money. It was also found that silkworms, which are most favoured insects among the Bodos are reared by Bodo women in their home for large production and sell them in local markets which help them to earn money. The selling of by-products obtained from insects such as honey, silk also provide income for them. Thus, for Bodo people, insects not only serve as source of food, but are used in therapeutic purposes and also provide them with source of income for their livelihood.

Entomophagy has been practiced among the Bodos since ancient times. Bodo people use large variety of insects as food as well as for therapeutic purposes. These edible insects also provide economy to them. Bodo women from villages sell certain insects such as larvae and pupae of silkworm, water bugs, crickets, etc. in local markets to earn money. They also rear silkworms in their home to earn livelihood. The young ones of the family acquire the knowledge regarding the way of insect collection, preparation, consumption and therapeutic uses verbally from their elders.

Due to modernization, the practice of eating insects is getting lost among the young generations. Therefore, there is need for proper documentation on edible insects from ethnic communities having knowledge about this practice. Also, insects are highly nutritious and therefore can be included in regular diet. However, more detailed studies are needed to be carried out for evaluating the nutritional and medicinal value of these edible insects. Also, further studies and documentation on conventional insect rearing and their sustainable use are necessary in order to conserve these insects for benefits of humans well as protection of insect biodiversity which in turn will contribute in environmental conservation.

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Conflict of interest :

The authors declare no conflicts of interest.

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