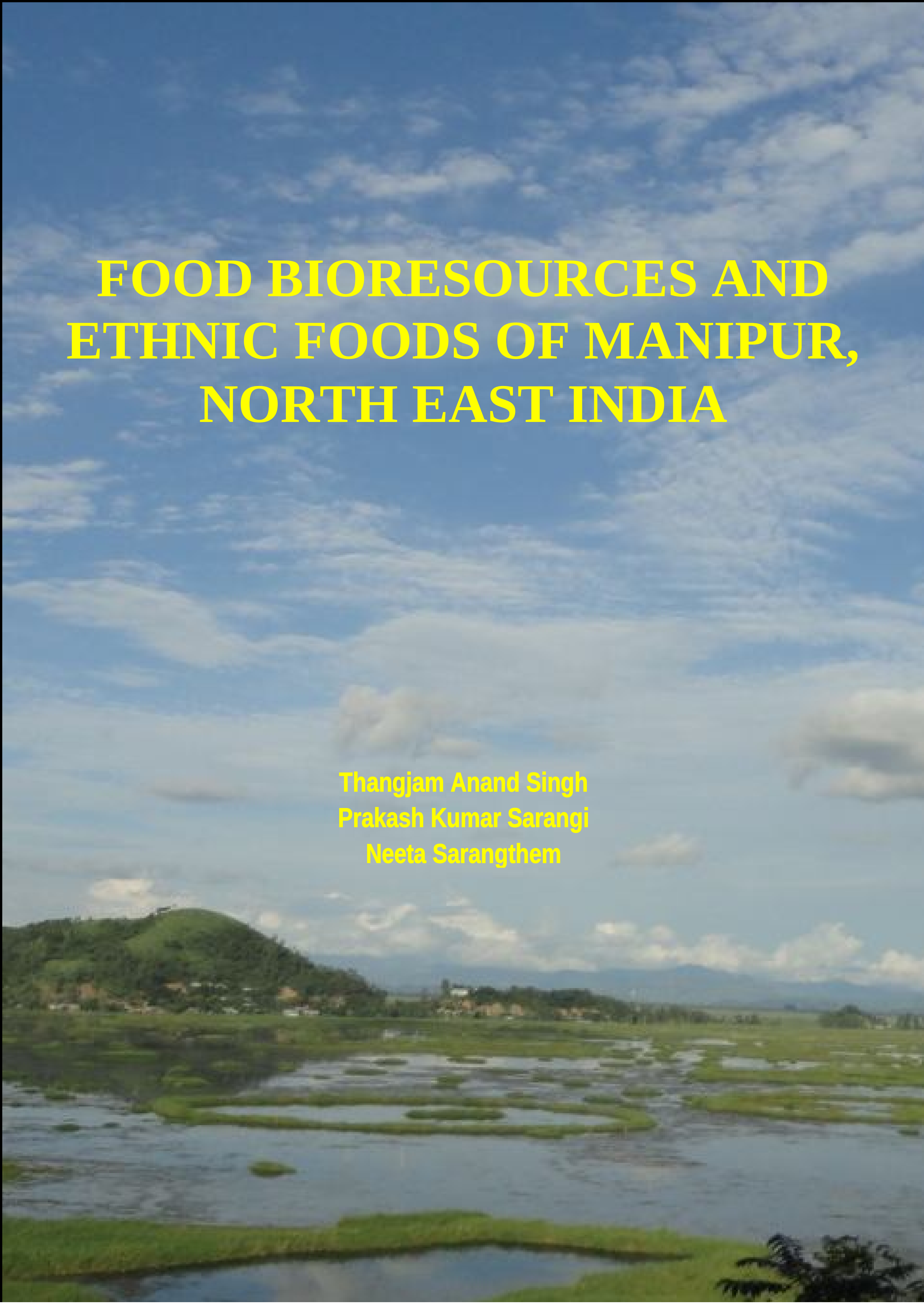

FOOD BIORESOURCES AND ETHNIC FOODS OF MANIPUR, NORTH EAST INDIA

Thangjam Anand Singh
Prakash Kumar Sarangi
Neeta Sarangthem

FOOD BIORESOURCES AND ETHNIC FOODS OF MANIPUR, NORTHEAST, INDIA

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Edited By:

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First Impression: 2019

FOOD BIORESOURCES AND ETHNIC FOODS OF MANIPUR, NORTHEAST, INDIA

ISBN : 978-81-944069-0-7

Rs. 650/- ($18)

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Published by:
Empyreal Publishing House

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Edible insects consumed by different ethnic people in Manipur and its potential use in food and feed

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Abstract

Edible insects, the ethnic food are rich sources of protein, vitamins and minerals. It has been reported for having more nutritional contents than the other conventional foods. Looking into the fact of high nutritional profiles, it will substitute the protein source in present day crisis of insufficient protein in diet. More than 300 ethnic groups inhabited in the world consumed insect as their conventional food, among Indian states, the state of Manipur is not behind, with 30 ethnic groups being consumed. A total of 41nsect species belonging to 8 orders under 24 families and 36 genera were recorded as edible insect in Manipur. Utilization of protein rich edible insect, silk worm pupae in particular in the form of Protein concentrate powder has been conducted in human food and animal feed to value added the products as nutrient supplement.

Keywords: Edible insects, fish feed, Manipur, silkworm pupa, pupae protein concentrate

Introduction

The practice of eating insects, entomophagy, is rooted in human evolutionary history (Fontaneto et al., 2011). They have been found to play a major role in the history of human nutrition in many parts of the world. Over 1500 species of edible insects have been recorded in 300 ethnic groups from 113 countries (MacEvilly, 2000). Some important groups include grasshoppers, caterpillars, beetle grubs, winged termites, bees, worms, ant brood, cicadas, and a variety of aquatic insects. Many species of insects have served as traditional foods among indigenous peoples and the insects have played an important role in the history of human nutrition (Defoliart, 1995). The insects are high in protein and many are rich sources of vitamins and minerals. Edible insects have been reported to have more nutritional content than the other conventional foods (Lokeshwari and Shantibala, 2010). It is estimated that, in 2050 the world population would be more than 9 billion people, resulting in an additional need for food specially protein. Conventional protein sources will be insufficient and there will be need for alternative sources. In this context, promoting the idea of insect as food to help increase consumer is suggested (Vantomme, 2015). Insects are also being discussed as an innovative ingredient for animal feeds, including feed for conventional livestock, fish and pets. As a result, insect base animal feeds are high in protein especially when processed and transformed into insect flour (van Huis et al., 2013). Although insect based feeds appear to be a viable option, further studies are needed regarding the nutritional, environmental and economic benefits of using them to reduce and replace conventional animal feeds (Gasco & van Huis, 2018).

Entomophagy depends upon insect palatability, taste, availability and suitability, nutritional value, food taboo restrictions, local traditions and religious customs (Chakravorty, 2011). This phenomenon is well observed where there is availability of insects around the dweller. Being a distinctive part of the Indo-Burma biodiversity hotspot region, the state of Manipur enjoys a rich diversity of insect fauna. There is a long traditional history of association of insects with the varied ethnic people of the state. The insects have been in use in varied ways such as for edible, medicinal, industrial and cultural purposes, among which insects are more popular as edible items. The 30 ethnic communities inhibiting the state have distinct identity, culture and food habit. Hence, the paper aims to signify the practice of entomophagy prevalent among the different tribes of Manipur. Further, the presented research work aims to focus the potential uses of edible insect for nutrients supplement in human and animal food for sustainable value addition for the benefit of the society as whole.

Utilization of different edible insects by ethnic inhabitants of Manipur

Almost all the 30 different ethnic groups inhibited in Manipur consumed insect as food. A total of 41 insect species belonging to 8 orders under 24 families and 36 genera were recorded as edible insect in Manipur (Table 1).The species composition in different orders comprises as follows, 1 species each in Dictyoptera and Isoptera, 4 species each in Lepidoptera, 7 species in Orthoptera, 5 species in Coleoptera, 7 species in Odonata, 7 species in Hymenoptera, and 10 species in Hemiptera. Some important insect species consumed by each ethnic community is presented in Figure 1.Study revealed that five ethnic groups namely Meitei, Tarao, Tangkhul, Chothe and Thadou consumed 28-30 species in comparison to 9-26 species consumed by other ethnic groups. Depending on the type of insect species, insects are prepared into different form such as curry, roasting, frying and even in raw form. Hard bodied insects are eaten in roasted or fried form whereas soft bodied insects are eaten as curry or raw. All the species of bee and wasps are customary cuisine of the Tangkhul community relating with their culture. Spring season, the main season of bee species was mainly coincided with the special festival of Tangkhul community such as “the Siroy lily festival” where the bee larva and pupae cuisine is the special and compulsory and also sold in a very high price. Hence, edible insects are culturally important traditional food of ethnic people in various part of Manipur. Therefore, for wider aspect and utilization of this nutrient rich unconventional food item, attempt has been to produce as value added products like pupae protein concentrate (PPC) for human food and animal feed.

Table-1: List of documented Edible insect species of Manipur

SL.NO.	COMMON NAME	SCIENTIFIC NAME	ORDER: FAMILY
1.	True water beetle	*Hydrophilus olivaceous* (Fabricius)	Coleoptera: Dytiscidae
2.	True water beetle	*Cybister confuses* Shp.	Coleoptera: Dytiscidae
3.	Rhino beetle	*Oryctes rhinoceros* (L.)	Coleoptera: Dynastidae
4.	Weevils	*Crytotrachelus* sp.	Coleoptera: Cucurlionidae
5.	Beetle	*Anoplophora glabripennis* (Motchulsky)	Coleoptera: Cerambycidae
6.	Giant water bug	*Belostoma indica* Lep & Serv.	Hemiptera: Belostomatidae
7.	Water bug	*Diplonychus rusticus* (Fabricius)	Hemiptera: Belostomatidae
8.	Water bug	*Ranatra virepes virepes* Stal.	Hemiptera : Nepidae
9.	Water bug	*Hydrometra greeni* Kirkaldi	Hemiptera: Hydrometridae
10.	Nepas	*Laccotrephes maculatus* F.	Hemiptera: Nepidae
11.	Bug	*Corius sp.*	Hemiptera: Denidoridae
12.	Stink bug	unidentified species	Hemiptera: Pentatomidae
13.	Stink bug	unidentified species	Hemiptera: Pentatomidae
14.	Bug	*Udonga montana* Distant	Hemiptera: Pentatomidae
15.	Backswimmer	*Notonecta* sp	Hemiptera: Notonectidae
16.	Rice grasshopper	*Oxya hyla hyla* Serville	Orthoptera: Acrididae
17.	Mole cricket	*Gryllotalpa orientalis* Beauvois	Orthoptera: Gryllotalpidae
18.	Grass hopper	*Mecapoda elongata* Linn.	Orthoptera: Tettigoniidae
19.	Grasshopper	*Shistocerca gregaria*	Orthoptera: Tettigoniidae
20.	Locust	*Gryllus* sp.	Orthoptera : Acrididae
21.	Grasshopper	*Acridium melanocorne*	Orthoptera: Acrididae
22.	Dragon fly	*Pantala flavescens* (Fabricius)	Odonata: Libellulidae
23.	Dragon fly	*Acisoma panorpoides* Rambur	Odonata: Libellulidae
24.	Dragon fly	*Crocothermis servillia* Drury	Odonata: Libellulidae
25.	Dragon fly	*Orthetrum triangulare* (Selys)	Odonata: Libellulidae
26.	Dragon fly	*Rhyothemis variegata* (Linnaeus)	Odonata: Libellulidae
27.	Dragon fly	*Diplocodes trivalis* (Rambur)	Odonata: Libellulidae
28.	Dragon fly	*Rhyothermes* sp	Odonata: Libellulidae
29.	Preying mantis	*Heirodula* sp.	Dictyoptera :Mantidae
30.	Honey bee	*Apis millifera*	Hymenoptera: Apidae
31.	Honey bee	*Apis cerana indica* Fabr	Hymenoptera: Apidae
32.	Honey bee	*Apis dorsata*	Hymenoptera: Apidae
33.	Wasps	*Vespa basalis*	Hymenoptera: Vespidae
34.	Wasps	*Vespa tropicalis*	Hymenoptera: Vespidae
35.	Yellow jacket wasps	*Vespula vulgaris* (Linnaeus)	Hymenoptera: Vespidae
36.	Paper wasps	*Prophelis sp.*	Hymenoptera: Vespidae
37.	Silk moth	*Bombyx mori*	Lepidoptera : Bombycidae
38.	Silk moth	*Samia cynthia ricini*	Lepidoptera : Saturnidae
39.	Silk moth	*Antheraea proylei*	Lepidoptera : Saturnidae
40.	Bamboo worm	*Omphisa fuscidentalis*	Lepidoptera : Pyralidae
41.	Termite	*Odontotermes* sp.	Isoptera : Termitidae

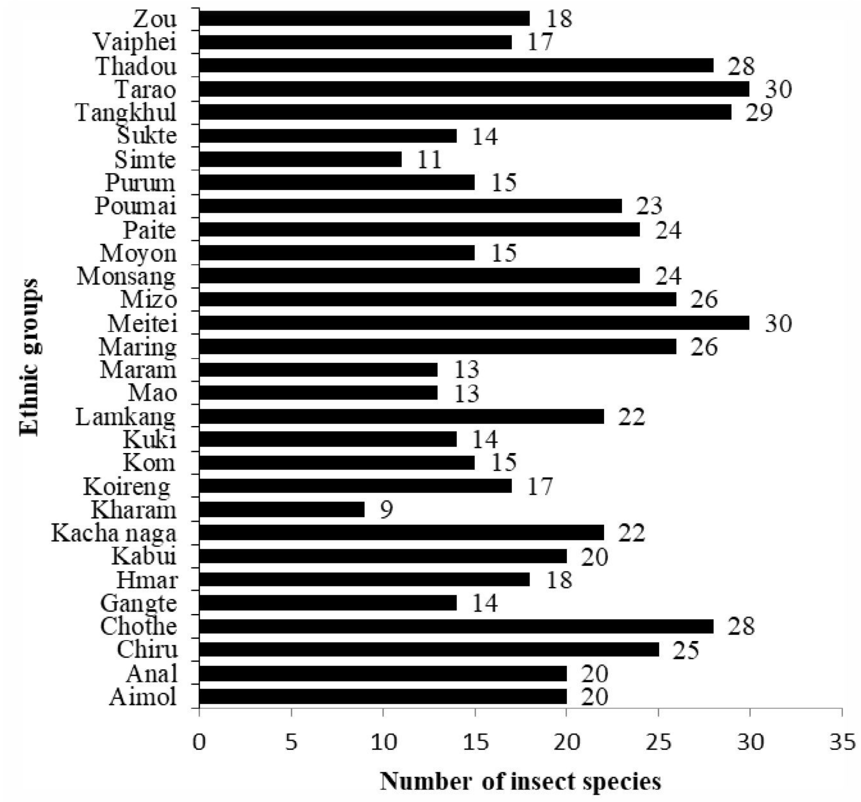

Figure1: Utilization of different edible insect species among 30 different ethnic inhabitants.

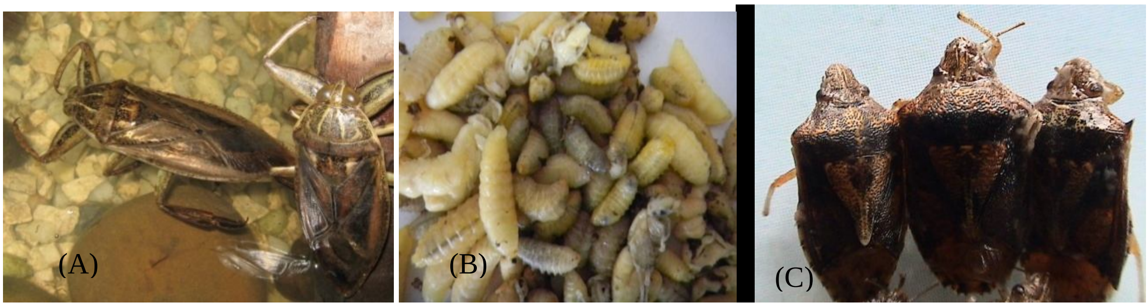

Figure 1a: Important edible insects (A) *B. indica* (B) Pupa of wasps, *V. basalis* (C) Stink bug,*U. Montana*

A. Utilization of Edible insect, *Bombyx mori* silkworm pupae for preparation of Pupae Protein Concentrate (PPC):

Generally, insect-based food is not socially supportive. Entomophagy is practised mainly by tribal communities in the states of Kerala, Odisha, Jharkhand, Karnataka, Tamil Nadu, Chhatisgarh, Madhya Pradesh and North East India (Gahukar, 2018). Thus, conversion of silkworm pupa material into edible quality pupae protein concentrate (PPC) and its value added products will be valuable items for protein supplement in human diet. An ideal product will be PPC which is white or near-white with a protein content of about 80 per cent and less than 1 per cent of fat, which is odour-less and at the same time, possesses a bland taste. PPC of desired nutritional quality would make an excellent supplement to the dietary of all sections of the population and especially to the vulnerable groups in areas where protein malnutrition is extensively prevalent.

Fresh spent silkworm pupae were collected and dried in the oven till constant weight is achieved. There is more than 80% reduction in the weight of the pupa after drying (Figure 2). Silkworm pupa protein concentrate (PPC) was prepared in laboratory using different solvents (ethanol, hexane and hexane + ethanol) and various techniques so as to obtain a standard PPC.

Table-2: Nutritional profile of *Bombyx mori* pupae powder

Sample	Protein (%)	Carbohydrate (%)	Lipid (%)	Moisture content (%)	Ash content (%)
Bombyx mori	22.1±0.23	4.16±0.43	29.02±0.34	3.32±2.56	5.51±0.02

Table-3: Characteristics of silkworm pupa protein concentrate

Solvent extract used	colour	Texture	Odour	Protein content (%)	Lipid content (%)
Ethanol	Cream	Granular	Odourless	82.5±0.07	0.52±0.03
Hexane	Light cream	Amorphous	Pungent	88.4±0.05	0.45±0.04
Hexane and ethanol	Light cream	Amorphous	odourless	93.6±0.05	0.25±0.08

In its crude form, the spent silkworm pupa has good nutritional quality (Table 2). The PPC obtained by running soxhlet with ethanol is less amorphous with irregular texture. It is darker in colour with a slight smell of ethanol. It also takes a longer period for PPC preparation. The PPC obtained running with hexane takes comparatively shorter period (4hrs as compared to 2 days in ethanol). The PPC thus obtained is more amorphous and lighter in colour but possesses a characteristic off smell (Table 3). Hence, there arises a need to remove the off smell, so the PPC obtained by running with hexane is again run with ethanol as solvent for around 4 hrs. Thus, an amorphous, white and odourless PPC is obtained. Thus, the protein concentrate recover can be used as protein supplement and value added product as such.

***In-vitro* digestion of PPC**

In-vitro analysis of the PPC with Pepsin digestibility, Trypsin digestibility and Pepsin - Trypsin digestibility showed gradual increases in digestibility, maximum being the combine digestibility with 51.17%, indicating good amount of protein digestible capability (Figure 3).

B. Utilization of pupae protein concentrate of silkworm pupa in fish feed formulation as nutrient supplement

The preference of particular species of insect mainly depends on taste and custom but biomass of the insect is also an important factor. Considering the consuming preference of silkworm as important edible insect among all the northeast ethnic groups in term of wide acceptability and biomass availability, it is selected as a valuable edible insect to be utilized in value added products for nutrient supplement. Being a leading state in the field of sericulture, Manipur produces all the four traded species of silkworm viz. *Samia cynthia ricini* (Eri), *Bombyx mori* (Mulberry), *Antheraea assamensis* (Muga) and *A. proylei* (Tasar) with a total annual production of 615.45 MT (2017-18). During the course of silk production, large biomass of silkworm pupa is also discarded as seri-waste every year (about 70% of silkworm cocoon biomass). The spent pupae are also complete nutritional package rich in protein (~41%), micro nutrients such as Iron (111 mg/100gm), Magnesium (622 mg/100gm), Calcium (~30.51 mg/100gm) etc and high antioxidant property (IC_{50} %, 68µg/ml, eri pupae) (Lokeshwari et al., 2019). Thus, seri-pupae are considered as nutritional goldmine that can be used for animal feed, especially in aquaculture, pet food industry or poultry feed.

Figure 2: (A) Cocoon of *B.mori* (B) reeling of silk fibre (C) spent pupa with a thin cover (D) spent pupa (E) drying of pupa (F) pupae protein concentrate

Fish being one of the culturally important cuisines in Manipur, huge demand of about 52,000 MT is required annually in the state (Anonymous, 2018). Only 32,000 metric tons (MT) of fish is produced annually having shortfall of about $2/5^{th}$ portion of fish requirement in the state. To fill up the huge gap, fish is being imported annually from other states like Andhra Pradesh and West Bengal to meet the deficiency of 20,000 MT in various forms such as fresh/frozen, dried and semi-fermented. However, availability of fish feed is a limiting factor in aquaculture development despite of having huge scope and absolutely dependent to outside state for feed supply. Concerted efforts are required in fish production to ensure nutritional security of the people. Geo-physical handicap on the national highways, high transportation cost are some of the factors affecting feed import to the state. Fish farming will be sustainable only when fish feeds are formulated using locally abundant feed ingredients. Low cost nutrient rich feed can be prepared using local ingredients such as protein rich seri-pupa (65-75%), mustard oil cake, rice brand, aquatic biomass of plants and incorporation of vitamins and minerals. As outside import dependent fish feed cost covers 60-80% of the total production cost where protein cost accounting about 15% of feed cost in livestock farming, therefore, utilization of protein gold mine, waste silkworm pupae in the low cost feed formulation will be convenient and cheaper than the conventional protein feed sources such as groundnut cake, fishmeal and soybean meal which does not permit profit maximization in aquaculture ventures. Above all, fishmeal is the only conventional animal protein source for fishery and that fish meal is scarce and expensive (Karimi, 2006). Henceforth, efficiency of, varying proportion of PPC of spent silkworm pupae waste incorporated fish feed formulations with locally available agro-byproducts such as Rice Bran (RB), Mustard oil cake in addition with mineral and vitamins fish feed formulation were evaluated.

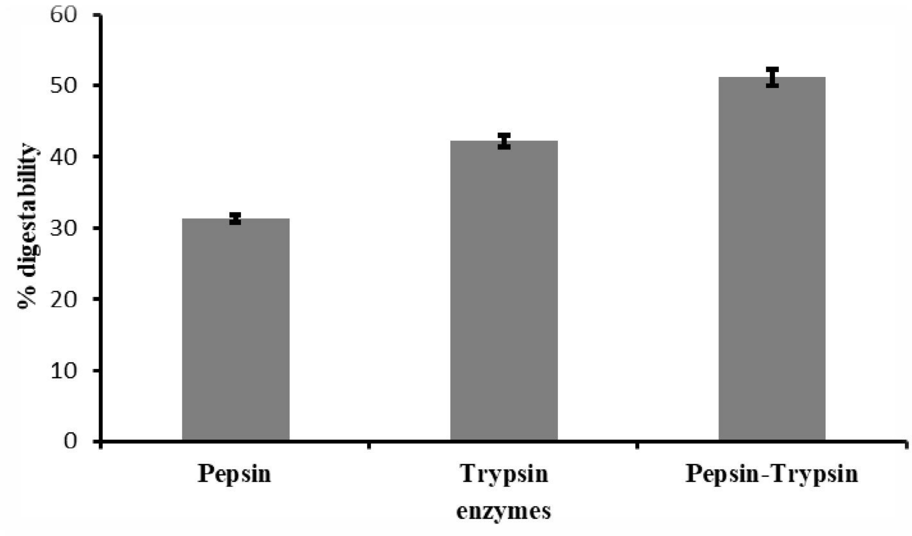

Figure-3: Protein digestibility percentage of PPC z

Formulation of silkworm pupae (PPC) incorporated different feeds and efficacy evaluation

Three different experimental feed formulations and one conventional control feed were prepared 1) T1=RB + (MOC: SWP; 1:1); 2) T2=RB + (MOC: SWP; 1:2); 3) T3=RB + (MOC: SWP; 1:3) and 4) C =RB + MOC; 1:1 as control. In all the diets (control and tests) binder mix (Tapioca flour + Maida + Rice Flour; 6+3+1) and Vitamins & minerals mix were incorporated @ 5% and 2% respectively.

Determination of feeding efficacy of three formulated feeds against the control feed were evaluated with carp fingerlings (*Labeo rohita*) of 15-16gm in weight at the Aquatic laboratory of Institute of Bioresources and Sustainable Development, Imphal, Manipur. Twelve FRP Tanks were stocked with 10 fingerlings per tank (at a stocking density of 6000/ha) and fed with the control and test feed formulations for 120 days @ 5% of the body weight maintaining triplicates. Before supplying each feeding to the tank, faecal matter and uneaten feed were siphoned out and 20% water exchange was done daily. At every ten days interval, sampling was conducted to record fish growth and to adjust the feed quantity. At the end of the experiment, all the fish was collected, counted and weighed and feed conversion ratio (FCR), periodic weight gain, relative growth rate, protein efficacy ratio (PER), specific growth rate (SGR) and survival rate were determined to find out the best formulation.

At present, only conventional feed consisting of rice bran and mustard oil cake (50:50) is used in fish culture and use of formulated fish feed is still in a nascent stage due to high cost involved. Production of low cost fish feed is a necessity for increasing the productivity to meet the requirement of the state. Silkworm pupae meal (SWPM) is a protein-rich feed ingredient of animal origin with a high nutritional value. On dry matter (DM) basis its crude protein content ranges from 50% to more than 80% (defatted meal). Waste silkworm pupae (SWP) generate vast resources of nutrients for livestock and fish farming and considered to be one of the unconventional top class proteins (65-75%) and lipid feed. Among many alternative protein sources, SWP are considered as an important dietary protein source for fish culture. Therefore, with the scope to utilize the seri-pupa waste of the state, present study evaluated efficacy of three different fish feed formulations (T1, T2 & T3) incorporated with silkworm pupae at varying level on carp fingerlings (*L. rohita*). Defatted silkworm pupae waste (DSPW) was incorporated at 25%, 50% and 75% as replacement of MOC respectively. The feeding experiments were conducted for three months and their efficacy was compared against the control feed (C) which is farmer’s conventional feed where no DSPW is incorporated (rice bran: mustard oil cake @ 1:1) (Figure 4). Among the test feeds, T1, where MOC and SWP are incorporated at same ratio, showed non-significant difference on growth rate with C. However, T3 showed significant effective growth rate indicating more than double the size (36.60±0.56gm) then the initial day (16.66±0.56gm) at the end of 90days experiment. Relative Growth Rate (RGR) of different formulated feeds indicated that with respect to the proportion of DSPW incorporation, approximately 45-

50% increase in relation to the proportion of SWP incorporated in feed formulations (Figure 5). Hence, experiment on the *in-vitro* utilization of DSPW as protein supplement along with mustard oil cake (MOC) and rice bran in fish feed revealed double the relative growth rate of fish in three months compare to control feed. Sasmal et al, (2018) also revealed that used of different proportion of silkworm pupae as protein sources (25%, 30%, 35%, and 40%) with rice bran, mustard oil cake-based control diet (25% protein), showed the best performance in the fish with the diet having 40% protein level incorporation. Specific growth rate (SGR), feed conversion (FCR), protein efficiency ratio (PER) and protein and lipid deposition in the muscle showed highest with the maximum incorporation of silkworm pupae. In an earlier study conducted by Nandeesha, et al. (2000), it was shown that feeding common carp with diets containing upto 30% silkworm pupae resulted in progressive increase in growth with increasing level of pupae as compared to a fishmeal based 30% protein diet and the highest weight was recorded at 30% of pupae incorporation. Further, it was also mentioned that the cost of production was lowest with silkworm pupae incorporated feed than control without silkworm pupae. Therefore, these types of low cost fish feed formulation with locally available materials will be cheaper than the conventional protein feed sources in maximizing aquaculture ventures. Hence, silk industry waste of Manipur can be an alternative low-cost protein supplement for effective fish feed formulation of the state.

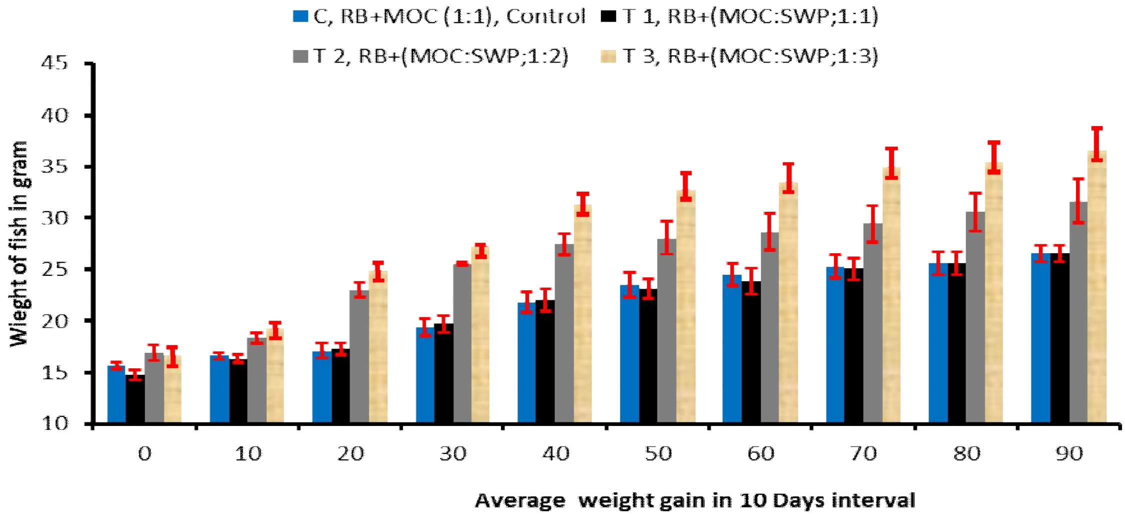

Figure-4: Efficacy of three different seri-pupae fish feed formulations against control feed on the growth of *Labeo rohita* fingerlings.

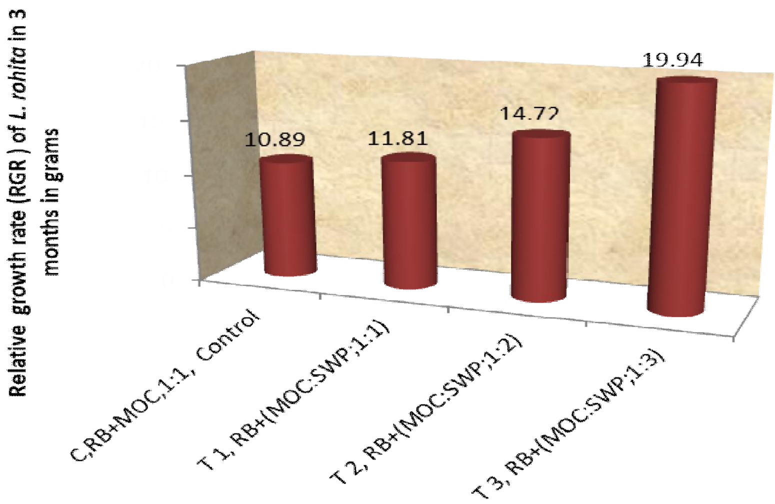

Figure-5: Relative Growth rate of carp fingerlings fed with three different feed formulations and conventional control feed.

Conclusion

In India, entomophagy is more prevalent in North-East India where insects are readily available. North-east India can be treated as epicentre of entomophagy. Eventually, more research is needed to understand the prevailing entomophagy in the North East region where indigenous communities enjoy nutritious food with insects as sustainable ingredient in main dish or as supplement. More down line studies on production of value added products are needed at this hour. In this juncture, researchers are required to go in collaborative work with food industries and entrepreneurs. Once the hope of incorporating the benefits of edible insects into the food resources is successful, it will definitely combat malnutrition and undernourishment.

Acknowledgement

The authors are also thankful to the Institute of Bioresources and Sustainable Development for providing working facilities. Second author is thankful to the Central Agricultural University for allowing conducting the work and to the NMHS, MoEF &CC, and Government of India for providing financial assistance.

References

1. Anonymous (2018) The Indian express November, 9th, 2018, https://indianexpress.com/article/north-east-india/manipur.
2. Chakravorty J, Ghosh S, Meyer-Rochow VB (2011) Practices of entomophagy and entomotherapy by members of the Nyishi and Galo tribes, two ethnic groups of the state of Arunachal Pradesh (North-East India). J Ethnobiol Ethnomed 7: 5
3. Defoliart, G, R (1995) “Edible insects as minilivestock,” Biodiversity and Conservation, vol. 4, no. 3, pp. 306–321.
4. Fontaneto D, Tommaseo-Ponzetta M, Galli C, Risé P, Glew RH, Paoletti MG (2011) Differences in fatty acid composition between aquatic and terrestrial insects used as food in human nutrition. Ecol. Food Nutr.50:351–367. doi: 10.1080/03670244.2011.586316.
5. Gahukar,R, T (2018) Entomophagy for nutritional security in India:potential and promotion Current Science vol 115 No.6,2018, 1078-1084p.
6. Gasco, L., Finke, M., & van Huis, A (2018) Can diets containing insects promote animal health? J *Insects as Food and Feed,,4*(1), 1-. https://doi.org/10.3920/JIFF2018.x001
7. Karimi, A (2006) The effects of varying fish meal inclusion levels (%) on performance of broiler chicks. Int. J. Poult. Sci., 5: 255-258.
8. Lokeshwari, R.K and Shantibala, T (2010) A Review on the Fascinating World of Insect Resources: Reason for Thoughts. .Psyche Volume 2010, Article ID 207570, 11 pages doi:10.1155/2010/207570
9. Lokeshwari, R.K., Shantibala, T., Singh, K, M., Hazarika B.N (2019) The nutritional goldmine waste: the spent pupae of mulberry, eri and oak tasar silkworms for combating malnutrition. Int. J of Environment, Ecology, Family and Urban Studies (IJEEFUS) Vol. 9, Issue 2, Apr 2019, 129-138
10. MacEvilly C (2000) Bugs in the system. Nutr. Bull.; 25:267–268.
11. Nandeesha, M.C., Gangadhara, B., Varghese, T.J. & Keshavanath, P (2000) Growth response and flesh quality of common carp, *Cyprinus carpio* fed with high levels of non-defatted silkworm pupae. Asian Fish Sci 13: 235-242.
12. Sasmal, S., Sharma, R.L., Sahu, M.K., Singh, R. & Toppo S (2018) Efficacy of silkworm pupae as a supplementary feed for fingerlings of Indian major carp rohu, *Labeo rohita* ham. International Journal of Agriculture Sciences; Volume 10, Issue 5, pp.-5413-5414: 0975-9107
13. van Huis, A., van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G., Vantomme, P (2013) Edible Insects: Future Prospects for Food and Feed Security. FAO, Rome. pp. 1–2.
14. Vantomme, P (2015) Way forward to bring insects in the human food chain. Journal of Insects as Food and Feed, 1(2), 121–129. doi:10.3920/JIFF2014.0014

About the Book

This book ***FOOD BIORESOURCES AND ETHNIC FOODS OF MANIPUR, NORTHEAST, INDIA*** is primarily aim at documenting the rich heritage of foods of ethnic people of State of Manipur, India. The State of Manipur which have about 90% hilly region and less than 10% valley area with altitude ranges from 180 msl to 2800 msl covering tropical, subtropical and alpine type of climate with average rainfall of 1200 cm of rainfall per annum. The forest cover is about 60%; limiting agricultural areas to less than 30% of the land mass. The dependence on natural forest for food and other needs leads to identification and consumption of wild edible plants and unconventional foods like insects, frogs, snakes etc. The valley had vast wetland areas which provide ample scope for fishing from wild.

The seasonal foods particularly, wild edible plants and fishes were processed and stored for yearlong consumption during offseason. The traditional processing were simple like fermentations, sun drying, roasting, boiling etc were commonly practiced. Here, traditionally salt was consider a luxurious item thus it was consciously missing during fermentation and other traditional processing. In this book various food bioresources of Manipur were documented with its nutritional medicinal and social values along with perceived values. Apart from farm produces, wild edible plants, aquatic plants, wild edible macrofungi, bamboo shoots, fish, insects and meat and milk were detailed in depth. It is believed that this book will help immensely to those foodies looking for exotic foods, researchers, anthropologist and lastly to the future generation who were alienated from their traditional foods due rapid urbanisation and fast life style.

Empyreal Publishing House

ISBN 978-81-944069-0-7

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