CHAPTER-I

INTRODUCTION

Insects are specialized group of animals belonging to the largest animal phylum Arthropoda in Animal kingdom. They are the most diverse and abundant form of life that organize a main component of the total faunal biodiversity on earth. Insect diversity represents the variety and variability of insect species. Diversity of insects is a good criterion for judging the health of an ecosystem. Nutritional status assessment of insects provides the data necessary to study the effects of nutrition on health and to develop effective public health plans to prevent and cure nutrition-related diseases. Most of the insects found in the study area are edible that provide food and livelihood to the ethnic people in the study area. Moreover, the use of insects as a source of food for human population is a subject of interest among small groups of researchers and entrepreneurs. One problem currently faced by this movement is the needs to identify specific insects that can be raised and processed in a manner that is economically and environmentally sustainable.

The number of insects is so diverse and large that with ordinary knowledge and within limited space of framework, it is not possible to study them all together. So, only edible insect species amongst the vast insect biodiversity have been selected for the study. Insects are one of the most successful diverse groups in the animal kingdom because they are able to live in and adapt to diverse habitats of air, water and land, possessing the high reproductive capacity and they can live on different kinds and qualities of food. Insects have the wide range of adaptation and they can adjust in any environmental conditions, prevailing at high temperature and altitude. The preference of
the present study was made on the basis of utility and availability of the edible insects in a particular study area where the people extensively eat insects in their normal meal.

Entomophagy is the consumption of insects by humans, is practised in many countries around the world but predominantly in parts of Asia, Africa and Latin America yet it has not been fully used and developed as a food source. It has the potential of great interest as a possible solution due to their many advantages: (i) they are an important source of protein, fat, carbohydrate and other nutrients; (ii) their use as food has ecological advantages over conventional livestock and, in the long run, economic benefits; (iii) Their rich species diversity and large populations bring diversity in diet menu (Seni A., 2017) The high cost of animal protein, which is beyond the reach of the poor, has greatly encouraged entomophagy.

According to United Nations Department of Economic and Social Affairs report, the human population is expected to grow from 7.3 billion in 2015 to 9.7 billion in 2050. Meat production is expected to double in the same period, as demand grows from rising wealth. The United Nations is trying to persuade people to eat more edible insects to help fight world hunger. Raising insects for food would avoid many of the problems associated with livestock. Increasing world population pressure will create serious problem of food security in coming future. Food and Agriculture Organization of the United Nations (2013) states that insects have a high nutritional value, their cultivation is environmentally friendlier compared to other animal protein sources that comes with great socio-economic benefits for a lot of people in the poorer regions of the globe. Many fishes, toads, frogs, turtles, snakes and lizards, birds and some mammals including man also consume insects as a major part of their diet. Thus, insect diversity acts as important role in maintaining a sustainable ecosystem (Ane and Hussain, 2016).
There are number of generalizations about insects that are associated with their
diversity such as small size, short generation times, high reproductive rates and large
population size. Unlike other higher organisms, insects are considerably less expensive
to breed and harvest. Besides, they are readily available almost everywhere on the
earth. Insects are used as alternative source of protein as most of the insects can be
farmed at relatively low economic and environmental costs, farming insects use up to
50-90% less land per kg protein, 40–80% less feed per kg edible weight and produces
1000–2700 g less greenhouse gas emissions per kg mass gain than conventional
livestock (Vantomme et. al., 2014). As a result, insects are considered as a potential
unlimited resource for man and nature. In developed countries, where food security is
not a main concern; insects are suggested as a possible solution of health problems
related to food and environmental sustainability.

In some developing countries, some members of the rapidly growing upper and
middle classes of urban society consider insects as “nostalgia food” which reminds them
of earlier simpler days in the rural countryside. Insect as food is an idea which is not
fully acceptable in practical terms among the modern societies across the world. Its
beneficial effects are already been debated at the highest platform available. For many
ethnic groups and indigenous societies little is known about the extent to which insects
are being used as food items or what role they play in nutrition and local medicinal
practices. Moreover, there is a current demand of edible insects and their products in and
around the country to earn economy. Investigation towards this end is made possible
through visits to the study sites through personal interviews with these indigenous
people. Through the present study a clear picture about the diversity of edible insects
and their role in the field of nutrition are attempted to find out.
Insects play a remedial role of ecological services which are fundamental to the survival of the humankind. They play an important role as pollinators in plant reproduction, in improving soil fertility through waste bioconversion, and in natural bio control for harmful pest species. They provide a variety of valuable products to human beings such as honey and silk and medical applications. Some edible insect species such as Honeybees, Eri silkworm and Muga silkworm have long been considered valuable for their products in the study area. Such edible insects are reared by the ethnic people in the study area for food and livelihood. The increased demand for edible insects puts pressure on the source populations because new technologies are now used to harvest insects more efficiently and to store them safely for longer periods, facilitating the harvesting of greater amounts of insects. Eating insects is prominent in most of the tropical areas of the world owing to the fact that (a) insects tend to be larger in size there, which facilitates their harvesting; (b) insects often congregate in large numbers so large quantities can be collected in a single harvest; and (c) a variety of insects are available all year round (van Huis et al., 2013).

The known number of edible insect species is only a fraction of the already discovered insect species. The small relative number of insect species consumed is perhaps based on availability and personal dietary preferences and traditional habit. People follow three main ways for harvesting edible insects 1) wild harvesting, (2) semi-domestication of insects and (3) farming. Semi-domestication and farming have the potential to provide a more sustainable food supply. Farming insects can produce much greater volumes of insects with fewer adverse impacts on the natural environment compared to wild harvesting of the same volume of insects. The harvested insects come from all trophic levels in ecosystem, although most of the terrestrial edible insect species are
herbivores and most species of edible aquatic species are predators. Insect farming has been recommended as a good alternative to conventional livestock farming for future food production.

Each country is assessed in terms of whether insects are wild harvested, semi-domesticated (habitat manipulation to increase production) or farmed, and whether they are used for subsistence or commercial purposes (Yen, 2015). Today, most edible insects are harvested in the wild and farming of insects for direct human consumption has begun only recently (FAO, 2013). Eating insects is prominent in most of the tropical areas of the world owing to the fact that (a) insects tend to be larger in size there, which facilitates their harvesting; (b) insects often congregate in large numbers so large quantities can be collected in a single harvest; and (c) a variety of insects are available all year round (van Huis et al., 2013). The current scientific literature assumes that there are 1.4 million species of insects and they are really an intrinsic part of the Earth’s ecosystem (Kulshrestha and Jain, 2016).

Insects are important because of their diversity, ecological role and influence on agriculture, human health and natural resources (Okrikata, & Yusuf, 2016). Diversity of insects is a combination of insect species richness (the number of species present) evenness or equitability (and the distribution of individuals among the species). Insect diversity is an important factor in the balance of environmental conditions (Yi et al., 2012). Insects are regarded as decomposers for the breakdown of waste materials, plant materials (both leaf litter and woody materials), and dead animals. Insects are the major herbivores in most terrestrial ecosystems and consume large proportion of plant biomass (Price, 2002). During the summer months, productivity of plants also increases which results in the increase of insect diversity and richness. It has been found that
higher plant diversity may increase the availability of alternate resources, including alternate hosts within a functional group for herbivores as well as vegetative and floral resources of species that require both (Khadijah et al., 2013).

The ant, namely blackweaver ant (Polymachis dives) is widely distributed in China, Bangladesh, India, Malaysia and Sri Lanka and mainly used as an nutritional ingredient. They are also processed into various tonics or healthy foods (Shen et al., 2006). In India, a large numbers of edible insects are used as food by different ethnic tribes. A total number of 255 species of edible insects were so far recorded from different parts of India (Chakravorty, 2014). Among the ethnic people of India, the tribes of Arunachal Pradesh consume about 158 numbers of edible insects. Again, the tribes of Manipur and Nagaland consume 16 to 40 insect species. The ethnic people of Karbi Anglong and Dhemaji district in Assam also consume 16 to 40 numbers of edible insects. In Assam of the North East region, the Ahom community consumes silkworm pupae in the nature stage, whereas other tribes (Garo, Naga, Bodo, Missing, Rabha, Kachari, etc.) prefer these insects in pre-pupae form or adult of eri or silkworm (Sarmah, 2011).

Insects are found in various types of habitats such as crop fields, forest, bushes, vegetation, swampy areas and open field. Nature is the home of insects and generally bushes, grasslands and forest provide shelter and food for terrestrial insects and natural ponds, ditches, streams and river provide shelter and food for aquatic insects. Edible insects survive on the foliage of vegetation; roots of plants or vegetables and live on the twigs and trunks of trees or thrive in soils. Most of the insects are crop dwelling insects which are available in crop season. Grasses, bushes and trees give protection and food for insects during non-crop seasons. It is very easy to eat larvae or eggs of insect, but
fairly difficult to eat adult insect because it requires some preparation for processing. For processing adult insects, first of all, wings, legs, head and gut contents are removed and rinsed in water after that, they are fried or cooked with various ingredients.

Most of the edible insects are seasonal and a few are available throughout the year. Many terrestrial edible insects are available during crop harvesting period. The consumption of diverse species of insects reflects the diversity of edible insect species. The seasonal availability of the edible insect species in Arunachal Pradesh of India indicated that the maximum number of edible Coleopterans occurred during June to September (pre monsoon and monsoon) and then got reduced during winter and early spring. Seasonal trends were also observed in some Odonata and Orthopterans, which were most abundant in September and October (late summer). Insects belonging to the Hemiptera and Hymenoptera were found to be restricted to the period lasting from November to February (winter). Some edible insects like certain bugs and ants were found to be available (and used) throughout the year (Chakravorty et al., 2011).

The medicinal value of some edible insects is a belief of some aged people of the study area and this concept is passed on to certain individuals from one generation to another generation by the word of mouth. Edible insects are not only regarded as a tasty food commodity of high nutritive value, but also considered to possess health-enhancing properties. In many parts of the world, different sections of the society have been using insects in medico-entomological drugs to this day in their lives. A number of studies have in recent years drawn attention to the therapeutic value of certain species of insects. Domestic insect rearing proves to be an attractive choice to some of these people because a useful protein supplement can be grown at home without requiring a
lot of space. Sometimes, tasteful paste of insects adding various spices is common food item of most of the tribal people of the study area.

Insects have been used since centuries to cure human diseases. This report of entomotherapy is clearly seen in the book of Li Shizhen’s Compendium of Materia Medica, which is one of the largest and most comprehensive books on Chinese medicine (1368-1644). This book listed approximately 300 medicinal insect species (distributed in 70 genera, 63 families and 14 orders) that have been used as entomotherapy (Jung, 2016). High crude fibre in insects is known to promote digestibility and enhance health benefits such as reduction of the risk of gastrointestinal cancers. The crude fibre content in this insect could be due to chitin found normally in insects which can reduce serum cholesterol and serve as a haemostatic agent for tissue repairs (Goodman, 1989).

It is seen that insect eating is mostly prevalent amongst rural tribal people of North east India. Rural communities of the North- Eastern India have a long cultured history of eating insects (Borgohain. et al., 2014). In the northeastern region of India, particularly the tribal communities of Manipur, Assam and Nagaland, use silkworms’ late instar larvae and pupae, chiefly the Philosomia ricini (Eri silkworm) and Bombyx mori (mulberry silkworm) as food. A total of 40 different species of insects are consumed by ethnic tribes of Karbi Anglong and Dhemaji district of Assam and most common among them are 5 different varieties of silkworms pupae and the tribe, Karbis, Rengma and the Nagas are found to be the highest number of insect (32 insect species) consumers (Ronghang and Ahmed 2010) and (Doley and Kalita, 2011). Entomophagy is a common practice among rural and urban Bodos in Assam, India (Narzari and Sarmah, 2015).
Different ethnic groups in North east India consume edible insects such as *Dorylus orientalis, Acheta domestica, Lethocerus indicus, Odontotermes obesus, Apis indica, Vespa orientalis, Hydrochara rickseckeri, Heiroglyphus bannian, Neoconocephalus palustris, Philosomia ricini, Anthera assama* and *Bombyx mori* (Borkakati, 2005). The ethnic people in the study area consume crickets, mole crickets, grasshoppers, water giant bug (*Bellostoma*), water scavengers, termites, June beetle, eggs of red ants, beetle, larvae and pupae of *Eri* and *Muga*, larvae of wasps etc. Most of the larvae of aquatic insects are actually live under water until they are ready to emerge into adults that then live near the water, but not in the water. No negative impacts were found among the insect consumers in the study area, rather they are seen to be well-fed. Therefore, there lies the significance of the present study in the Baksa, Assam.

About 98% people of the study area are rural people of whom more than 80% people are poor. They basically depend upon forest resources and agricultural products. Agriculture is the main occupation of the ethnic people of the study area. Besides agricultural activities, hunting, fishing, weaving and collecting edible insects are an old practice of tribal people of the studied geographic zone. During rice harvesting time, farmers of the study area collect short horned and long horned grasshoppers from paddy field for consumption. In addition, they also collect larvae or eggs of the paper wasps and lesser paper wasps from paddy field. The tribal ethnic people like Bodo, Rabha, Madahi, Sarania, and Adibashi in the study area are mostly non-vegetarian and rice is their prime food. Most of the tribal people inhabited in rural areas of the Baksa regularly take local beer (*Jumai* or *Junga*) with fried insects.

The tribal people of study area do not have to spend anything for consuming wild edible insects except physical labour for collection. But, they involve both
physically and economically for rearing and harvesting domesticated species such as Eri silkworm and honey bees. Some edible insects are reared and bred for human food to sell in the markets and thereby it acts as a source of income for local people in the study area. The ethnic tribal people are well experienced in their traditional knowledge on insect collection and ethnic food preparations. Based on the usual local perception the tribal people can quickly find out which insects are edible or which are not as well as where to find, how to catch them and proceed the preparations for consumption. These skills have been traditionally passed down from generation to generation. This indigenous knowledge has, however, gradually declined with changing socio-economic conditions and increasing pressure of commercialization to cope with fast growing modern cultures.

The study area, Baksa is rich in diversity and abundance of edible insects. Though, lots of works have already been done in diversity of edible insects in and around the World, but no intensive investigation on edible insects has been done till today in the study area. The current study was designed for the very first time to document the diversity and abundance of insects in Baksa, Assam. Also, regarding nutritional composition of edible insects, people of the study area are totally unaware. Therefore, an attempt has been made to evaluate nutritional composition of some commonly consumed insects occurring in the Baksa, Assam. The tribal people eat most of the insects besides eating other molluscan species i.e. snails. Most of the ethnic people in the Baksa district extensively eat pre-pupal stage of *Philosamia ricini* and adult stage of *Lethocerus indicus* and *Hydrophilus olivaceus* irrespective of caste and creed of the people. A few non-tribal people in the study area also habitually consume insects as their food.
In the study area, people usually consume harmful insects that act either as pest or vector of germs. Most of the grasshopper species attack at the juicy stage of our paddy and crops and destroy in the milky stage of our rice. Crickets attack Rabi and summer vegetables and damage vegetables. Mole cricket also attacks crops and winter vegetables in seedling stage. Termites also damages valuable household materials. The cockroach eaten by some tribal people in the study area is also treated as household pest. Thus, the most of the edible insects consumed in the study region are either agriculture pests or house hold pests. Thus, the habit of insect eating amongst the ethnic groups of the study area helps in reducing pesticide use of farmers.

The ethnic tribal people in the study area prefer insect species to utilize as food for their palatability, and easily availability. The habit of insect eating has been an indigenous practice among the ethnic tribal people in Baksa, Assam. There are claims by the consumers that the insects provide essential nutrients to the human diet. There is need therefore to understand whether these insects actually provide any nutrients required by the body for a healthy growth. In addition, information is needed in order to understand whether the edible insects are available and sustainable in the study area. Considering these facts, the present study was conducted to document the diversity and nutritional status of common edible insects consumed by some group of people in the district of Baksa, Assam.

Food-habits of the tribal are unique and they eat food in the name of ethnic identity. The tribal people in the study area are mostly flesh-eaters and they usually consume insects with local beer not only in religious festivals and rituals (death, birth and marriage etc.), but also in daily basis of as normal diet. There are ample scopes for insect farming in the study area. Some insect species are traditionally used as
therapeutic measures along with food of ethnic groups of the study area. The goal of the present study is to fill up the knowledge gap of diversity and nutritional composition of edible insects consumed in the study area. The present study would certainly provide a better understanding about the diversity and nutritional status of edible insects.

**Aims and Objectives of the study**

The main aim of the present research is to find out the diversity and nutritional status of some commonly consumed insects found in Baksa district, Assam. As far as Baksa District, Assam is concerned, no work has been carried out there on diversity and nutritional composition of edible insects till now, and so the present investigation is undertaken with the following objectives.

- To explore and document the insects consumed by different ethnic people in the district of Baksa, Assam
- To find out the diversity and abundance of edible insects in the study area.
- To evaluate the macro-nutrients composition and mineral contents of selected insects commonly consumed by certain groups of people in the study area.