CHAPTER-2

REVIEW OF LITERATURE

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In the ever expanding field of ethnomedicinal plant research, the flow of information from indigenous knowledge holders has contributed in identifying valuable plants with associated active phytochemical. Due to the fact that medicinal plant resources in Northeast India is so closely linked to traditional and rural communities, the attainment of this research goals depends on the co-operation and participation of local people especially traditional healers who own this knowledge. This thesis for that reason explores the contributions through indigenous knowledge around ethno-medicinal plants and fresh knowledge generated through use of scientific methodology. This together can help towards achieving the set goals of this study. According to the needs of this study, the focus of the literature review is primarily on research in the areas of 'ethnomedicinal plants' and their 'phytochemistry'.

2.1. Ethnomedicinal research in Goalpara District of Assam, India

In Northeast India, the tribal communities have a history of utilising ethnomedicinal plants, mainly for medicine, but also for food. Goalpara district of Assam state in Northeast India has a reputed history of using medicinal plants for treatment of various ailments. Goalpara district of Assam, India is home to upto 1,008,959 people according to Assam Census (2011), many of whom practice farming and partially rely on government schemes or grants for income. A total of 86.31% populations in Goalpara district resides in rural areas and have poor access to medical facilities. There is however, in tranquil, a rich cultural heritage and intense sense of community living, together with well-built traditional leadership and a valuable set of indigenous knowledge base. The set of knowledge is extremely valuable to the people as their entire lives and dependency for food and medicine are mostly based on natural resources from their surrounding vegetation. Goalpara district has a predominant well-established tradition on ethnomedicine. Despite this, scientific publications dedicated to ethnomedical plants of this area are scanty. In an early review of ethnomedicinal plants of Goalpara district Basumatary *et al.* (2004) through their field survey listed 33 species belonging to

22 genera used by the Bodo communities. By 2008, this list grew to around 427 species of dicotyledonous plants of which 120 species of medicinal plants when Nath (2008) carried out an extensive survey in almost all parts of the district covering different habitats, forest types. Additional he also studied the morphological and palynological features of some of the common medicinal plants of this district. Again in the year 2014 a total of 17 medicinal plant species belonging to 16 genera and 12 families were listed from this region based on their use in the treatment of cough related problems or other bronchial disorder (Deka and Nath 2014). Following this Swargiary *et al.* (2019) documented on a total of 47 plant species found distributed in more than 6 habitats. Of this, species belonging to 45 families were used for treatment of various ailments by the local communities of Goalpara district. From the early 2004's onwards, scientist working in the region published a body of work on medicinal plants of Goalpara district. This primarily began as a record of medicinal plants from the area but rapidly stretched to include analysis of phytochemicals and ailments cured through the use of medicinal plant species. As such Barman *et al.* (2022) conducted histological and phytochemical analysis of four ethnomedicinal plants used for treatment of skin diseases. Their investigation led to the discovery of various bioactive compounds and important phytochemicals like alkaloids, terpenoids, tannins, phenolics and flavonoids in medicinal plant species.

2.2. Ethnomedicinal research in Assam

In Assam, wild herbs contribute to the well-being of humans in tangible ways throughout their use as medicines or a nutritious resource of food, and intangibly by uplifting the culture of the tribal people. The quest and documentation of ethnomedicinal plants used by the traditional healers in Assam started in Goalpara district back from 2004 onwards (Basumatary *et al.* (2004). After 2 years Saikia *et. al*. (2006) carried out a survey research and listed 85 species of ethnomedicinal plants used by Assamese people in treatment of skin diseases and in cosmetic preparations. Parallely in the same year Saikia (2006) described about 20 species of medicinal plants and their use in traditional healing by tribal communities of Gohpur in Sonitpur district of Assam. Two years later

Das *et. al.* (2008) found 107 species of plants with medicinal properties in Cachar district of Assam. Later towards 2010 the use of ethnomedicine by Tai, Ahom in Dibrugarh district was documented by Kalita and Phukan (2010). According to them 24 species of ethnomedicinal plants were used by the tribe in treatment of 17 commonly occurring diseases in the region. From the eastern zones of Assam Adhikary and Barman (2014) identified 23 species of medicinal plants used by the Rabha tribe of Chirang District for the treatment of various diseases like cough, jaundice, deworming, dysentery, malaria, toothache, antibleeding, stomach pain, eye allergy, curing boils, gastric problem and ringworm. Another survey conducted by Das, 2016 in Barpeta district which is also in the east zone of Assam successfully listed the use of more than 66 plant species in fomulations for the treatments of several diseases in the area. The authors also reported that several medicinal plants have been assessed as endangered, vulnerable and threatened due to over harvesting or unskillful harvesting in the wild. 25 medicinal plant species belonging to 23 families of angiosperms used by Garo tribe in Dimoria tribal belt of Assam was reported to be used for diseases such as stomach diseases (dysentery, diarrhoea and gastric problem), followed by skin problems, body pain and gonorrhoea/piles (Sharma and Chetri, 2017). One of the latest article by Gogoi and Sen (2023) confirm the use of 45 medicinal plants used by rural people for treatment of cuts and wounds in Kailashpur, Tinsukia district of West Assam. More specific attempts for molecular identification of medicinal plants by DNA barcoding was also carried out by Mahadani *et al.* (2012). They identified ethnomedicinal plants including Rauvolfioideae: Apocynaceae from Northeast India through DNA barcoding using matK and trnH-psbA gene.

To date, research around ethnomedicinal plants has either: 1) Documented the traditional knowledge of traditional healers on ethnomedicinal plants of a particular area by listing the plant species and there mode of use 2) has applied scientific methods to generate fresh knowledge around phytoconstituents. Nutrition is treated as a critical part for the wellbeing, health and development of an organism. Shortcomings of nutrients in nutrition always results to one more diseases so nutrients are also important contributors in treatment of diseases. To the best of author’s knowledge, most studies on ethnomedicinal plants has to a greater part focused on studying the phytoconstituents and attempts to study their nutrients seems scanty. Among the few studies the study of Borkataky *et al.* (2013) showcased the proximate composition of *Eclipta alba* (L.) Hassk. Their proximate analysis testified the presence of moisture (79.02 %), ash (15.78 %), organic matter (84.22 %), fibre (2.22%), carbohydrates (67.50%), proteins (2.60%) and lipids (4.87%) along with major phytochemicals including alkaloids, saponins, flavonoids, phenols, tannins, sterols, cardiac glycosides and anthraquinone glycosides. Providing good nutrition is a national problem and hence the requirement of natural food holding good nutritional values is increasing. To address this issue Shah (2016) evaluated essential nutrients and phytoconstituents of Smilax ovalifolia dried leaves an ethnomedicinal plant of Assam and reported the presence of essential nutrients and phytochemicals that can serve as a dietary source for human consumption. Brahma *et al*. (2014) determined nutritional analysis of some selected wild edible ethnomedicinal plant species consumed by the Bodos tribes of Kokrajhar district, BTC, Assam.

The micronutrients in studied wild edible plants were also reported high. Comparing the nutritional contents with recommended dietary allowances (RDA), they also mentioned the studied plants could act as a good supplement for various nutrients like proteins, carbohydrates and micronutrients. The nutritional values and heavy metals in four selected medicinal plants of Assam viz., *Centella asiatica* (L) (Indian pennywort), *Pogostemon benghalensis* (Patchouli), *Stellaria media* (L) (Chickweed) and *Cinnamomum tamala* (Bay leaf) revealed that the studied plants possessed a high and significant level of nutritional values while *C. tamala* had minor value as compared to other three varieties. It was also reported that the wild medicinal plants do not contain any heavy metals and hence pose no threat to humans. Recently by the year 2021, Chetia (2021), determined the nutritive value of some medicinally important species of Lamiaceae from Dibrugarh, Assam, India and were reported to found nutritional value above 300cal/kg and conveyed that ash, moisture, fat, protein and carbohydrate content of the plants varied from plant to plant

A study attempting to investigate phytoconstituents in medicinal plants and their association to treatment of various diseases of Assam was first endeavored by Yadav and Agarwala (2011). Through their study, was reported the presence of important bioactive compounds used for treatment of many diseases. Following this in the next year Nishat *et al.* (2012) analyzed the phytoconstituents of *Lasia spinosa* and *Alpinia nigra*, which are two potential medicinal plants of Assam. Their findings indicated the therapeutic potential of these plants owing to their use as anti-inflammatory, antioxidant, antitumor agent and various other disease preventive factors. Leaf extracts of wild *Sarchoclamys pulcherrima* Goud, a wild vegetable used by Mishing tribe of Assam is a rich source of phytochemicals viz. alkaloids, saponins, flavonoids, tannins etc. with good antioxidant activity and maximum cancer cell damaging activity (Borah *et al.* 2013 Mahato *et al.* (2015) conducted research on three ethnomedicinal plants including *Calamus leptospadix* Griff., *Heliotropium indicum* Linn., *Lasia spinosa* Lour of Assam with a view to evaluate their in-vitro antioxidative potentials. They reported in the study that aerial parts of *Calamus leptospadix* have potent, *Lasia spinosa* have moderate and *Heliotropium indicum* (HI) have mild antioxidant and free radical scavenging activity. Another study by Kotoky *et al.* (2016) to evaluate the antioxidant and anticancer activity of methanol extracts of the leaf, bark and fruit of *Garcinia morella* in both in-vitro and in-vivo experimental conditions reported its potent antioxidant and anticancer properties, where the fruit extract (GF) showed maximum activity on DLA through induction of caspases and DNA fragmentation that ultimately leads to apoptosis.

Thakuria *et al.* (2018) screened the presence of phytochemical constituents in three selected different medicinal plants *Artocarpus heterophyllus* (Kathal), *Carica papaya* (Papaya) and *Terminalia bellerica* (Bhumura) locally available in Assam, India and revealed that it is source of important phytochemicals. From Lakhimpur of Assam, Ayam and Gogoi, (2018) evaluated the antioxidant activity of methanol extract of selective and frequently used traditional wild medicinal plants which showed good antioxidant activity. Phytochemicals of an ethnomedicinal plant *Drymaria cordata* (L.) wild. ex schult. (whole plant) which are used by the tea tribes of Nagaon district of Assam, India was studied by Bhattacharyya *et al.* (2019). Additionally through FT-IR analysis, they confirmed the presence of various functional groups. Bioactive compounds like Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid, Beta-Dglucopyranose-1,6-anhydro, L-gala-L-ido-octose, 3, 7, 11, 15-Tetramethyl-2-hexadecen-1-ol, n-Hexadecanoic acid, 9, 12 Octadecadienoic acids (Z,Z)-, 9,12-Octadecadienoic acid, methyl ester, oleyl alcohol and 17-Octadecynoic acid were identified through GC-MS analysis in the same study.

Meanwhile Bora *et al.* (2019) demonstrated the presence of phytoconstituents in ethanolic extract of an ethnomedicinal plant *Meyna spinosa* of Assam. Paul and Devi, (2021) identified the various major bioactive components in *Ficus racemosa* which are known to exhibit medicinal value as well as pharmacological activities. The identified bioactive compounds were 9, 12, 15-octadecatrienoic acid (z,z,z)- (14.323%); (z)6,(z)9-pentadecadien-1-ol (10.190%); Resorcinol (5.613%); n-hexadecanoic acid (2.965%) and Chloroacetic acid, dodec-9-ynyl ester (0.659%), L-(+)-Ascorbic acid 2,6-dihexadecanoate (5.459%), Geranylgeraniol (0.432%), 9,12-Octadecadienoyl chloride, (Z,Z)- (0.151%) and 2HBenzo [f]oxireno [2, 3-E] benzofuran-8 (9H)-one, 9-[[[2-(dimethyl-amino) ethyl]amino]methyl]octahydro-2,5a-dimethyl- (0.132%).

In Sonitpur district of Assam fresh leaves or the extracts of orchid species *Rhynchostylis retusa* is used for treating rheumatics, skin diseases, blood dysentery and earpain. Through FTIR analysis of this orchid species it was observed that fresh leaves had antimicrobial activity which activated with the presence of some functional group (Das *et al.* 2013). In the year 2021, on studying the antiproliferative and apoptosis inducing properties of selected medicinal plants of Assam, India it was reported that most of the studied plants exhibited potential antiproliferative and apoptosis-inducing properties along with their strong antioxidant property (Roy *et al.* 2021). From docking studies it was displayed that 2-methyl-5- (1-adamantyl) pentan was the best binding affinity with anti-apoptotic proteins.

Borah and Sarma, (2022) reported the presence of alkaloids, glycosides, flavonoids, phenolic compounds, terpenoids, tannin and bioactive compounds using GCMS of *Aristolochia assamica*. The identified bioactive compounds were 2-Octylcyclopropene-1-heptanol, α-ylangene, 6,10,14,18,22-Tetracosapentaen-2-ol, 3-bromo-2,6,10,15,19,23-hexamethyl-, (all-E)-, (Z)-7-Hexadecenal, 1-Naphthalenemethanol, 1,4,4a,5,6,7,8,8a-octahydro-2,5,5,8a-tetramethyl-, 3-Hexadecyne. These compounds were also mentioned recorded for the first time in this plant.

Probable toxicity exhibited by plant extracts and isolated phytochemicals from medicinal plants by phytochemical screening or cytotoxicity test are helpful. As such Baruah *et al.* (2021) evaluated the cytotoxicity activity of the hydroethanolic plant extract of *Azadirachta indica* A. Juss., *Curcuma longa* L. and *Ocimum sanctum* L. in Baby Hamster Kidney cell line (BHK-21 cell line).

2.3. Ethnomedicinal research carried out in North East India

India has a well-established tradition of using ethnomedicinal plants, predominantly in the northeastern areas of the country. Sangma and Sahoo, (2017) documented a total of 38 medicinal plants belonging to 27 families and 36 genera used to cure 24 diseases in Meghalaya. It was reported that tree species maximally contributed to traditional uses of the medicinal plants and the bark portion mostly attributed to majority of cases in medicinal preparation. Report from Borah *et al.* (2021) documented a total of 153 plants under 126 genera and 62 families used for different disorders like kidney stone, bone fracture among the Mishing community of Northeast India. For molecular characterization of medicinal herbs Saikia *et al.* (2020) attempted and developed an efficient barcode locus in *Clerodendrum* species of North East India using four barcode candidates (*ITS*2, *mat*K, *rbc*L, *ycf*1) and its combinations. The results exemplified that *mat*K possessed maximum number of variables and parsimony-informative sites (103/100), intra- (0.021 ± 0.001) and inter- (0.086 ± 0.005) specific divergences and species resolution rate (89.1%) followed by *ITS*2, *ycf*1 and *rbc*L. Among the combinatorial locus, $ITS2 + matK$ showed the best species discrimination with distinctive barcode gaps. The study also suggested that the combination of *ITS*2 + *mat*K as core barcode for *Clerodendrum* species. Recently Pukhrambam *et al.* (2023) identified *Polygonum posumbu* successfully by DNA Barcoding, The species was collected from Awang- khunou, Manipur, India and was identified based on DNA characterization at ITS gene. This study strongly suggested that ITS is the reliable marker for identification of *Polygonum posumbu* from Manipur, India.

From anecdotal evidence it is known that ethno botanical and traditional knowledge system published by various workers convey the requirement of critical study, some as over exploited medicinal plants in the region and some mentioned as threatened important plants of North East India. Though very little information on nutritive values of medicinal plants are available at this point of time, inclusively authors like Baruah *et al.* (2015) and Arya *et al.* (2016), Seal *et al.* (2017**)** evaluated the nutritional potential of ethno botanically important medicinal plants from Eastern Himalayan region of North East India. These studies indicated the nutritional values and mineral contents of these medicinal plants and proved that they were superior to many commercially used nutritive herbs. In a study by Basumatary and Narzary (2017), the nutritional composition, phytochemical constituents and antioxidant activities of six wild edible plants consumed by the Bodo tribe of North-East India were assessed. The investigation showed that medicinal plants have varying quantities of proximate and mineral compositions. The phytochemical screening revealed the presence of a number of medicinally active secondary metabolites. Among all of the plants under study, *Melothria perpusilla* displayed a better antioxidant property, maximum FRAP value, and the highest phenolic and flavonoid contents. These studies give an account of ethnomedicinal significance of the wild plants under investigation.

Through preliminary investigation on some anticancer medicinal plants of North-Eastern states of India conducted by Prasad *et al.* (2010) in Murine tumor model it was found that nine different plants namely *Ageratum conizoides* Linn. (Asteraceae), *Blumea lanceolaria* Linn. (Asteraceae), *Dillenia pentagyna* Roxb. (Dilleniaceae), *fulgens* Wall. (Rosaceae), *Taxus baccata* Linn. (Taxaceae), *Mirabilis jalapa* Linn. (Nyctaginaceae), *Xanthium strumarium* Linn. (Asteraceae), *Dillenia indica* Linn. (Dilleniaceae) and *Gynura conyza* Cass. (Compositae) are used. A significantly higher antitumor activity of *Dillenia pentagyna* and *Potentilla fulgens* were reported which might have been due to the presence of alkaloids and flavonoids. Saikia *et al.* (2017) evaluated antioxidant activities and cytotoxic activity of methanolic leaf extract of *Blumea lanceolaria* (Asteraceae) which showed moderate cytotoxicity against HeLa cell lines. 14 important homegarden food crops were analyzed by Sahoo and Rocky, (2019**)** for proximate compositions and household food security involving 22 villages and 92 homegardens in Aizawl district of Mizoram. Out of the 351 plant species encountered in home gardens, 133 were vegetables and fruits bearing plants which indicated higher diversity of food plants within the region. The study also mentions that homegarden food crops not only help in supplementing the dietary requirements but also in ensuring household food security in Mizoram.

Singh *et al.* (2022) screened for qualitative phytochemicals test of the polyherbal formulation traditionally used for the management of diabetics from Northeast India. Various functional groups in the formulation extract were also recorded by FTIR analysis. Nearly 51 compounds including small peptides and 42 potential phytochemical compounds were identified using HR-LC/MS analysis. Active phytocompounds of *Eranthemum indicum* like 3-beta-hydroxy-5-cholen-24-oic-acid which facilitates fat absorption was detected in aqueos extracts. Other bioactive compounds beta-1-arabinopyranoside an anticancer and 2-methyl-3-(3-methyl-but-2-enyl)-2-(4-methyl-pent-3-enyl)-oxetane were detected in methanol extracts were identified (Nonglang *et al.* 2022). It was also shown that methanol extracts depicted better inhibitory concentration when compared to aqueous extract indicating the effective extraction capacity of methanol which is consistent with the fact that methanol extract had a higher polphenol and flavonoid content resulting in their antioxidative activity. Parallely Bordoloi *et al.* (2022) performed the first study of compounds, their cytotoxicity and antimicrobial activity of bark, wood and leaf of *Illicium griffithii* Hook. f. & Thoms from the North Eastern region of India. They identified major chemical constituents and determined their cytotoxicity and antimicrobial activities. Isolated compound 1 exhibited significant cytotoxicity activity against Lung cancer (A549) and pancreatic cancer (MIAPaCa2) cell lines. Further, it also exhibited good antimicrobial activities against *Escherichia coli* and *Candida albicans.* The other isolated compounds also displayed moderate anticancer and antimicrobial activities against respective strains. In the most recent research the antioxidant and anticancer potential of selected ethnomedicinal plants collected from Assam and Meghalaya were tested against breast cancer (MCF-7, MDA-MB-231, and MDA-MB-435S), hepatic cancer cell lines (HepG2) and human PBMCs (peripheral blood mononuclear cells). The study recorded that the selected dosages of none of the extracts from any of the five plants that were exposed to breast cancer cells, showed any cytotoxicity against human PBMCs (Das *et al.* 2023).

2.4. Ethnomedicinal research carried out in India

Around 65-50% of populations from developing countries essentially rely on plants for primary healthcare owing to poverty and inability to access to modern medicines (Calixto, 2005). In recent years the quantity of information on the use of ethnomedicinal plants in traditional healing systems by indigenous communities of India is rising. Data on ethnomedicinal plants from other states of India have been documented by Savithramma *et al.* (2007); Kosalge and Fursule, (2009); Upadhyay *et al.* (2010); Ayyanar and Ignacimuthub, (2011) and Manikrao and Singh, (2013). Through molecular identification the medicinal plant *Boerhavia diffusa* could be distinguished from its adulterants using DNA barcode with nuclear ribosomal DNA regions ITS, ITS1, ITS2 and the chloroplast plastid gene psbA-trnH. Study revealed that ITS and ITS1 could be used as potential candidate regions for identifying *Boerhavia diffusa* and for authenticating its herbal products Ramalingam *et al.* (2012).

Another study from Garhwal Himalaya by Chandra *et al.* (2014) determined the nutritional and anti nutritional content of *Indigofera tinctoria* flower. The flower was reported to be rich in nutrients and antinutrients. This analysis also revealed the plants contained potent medicinal properties. Fatty acid composition and antioxidant potential of five medicinal plants *Ulmus wallichiana* Planch., *Celosia argentea* L., *Sisymbrium irio* L., *Aesculus* *indica* Colebr. and *Abies pindrow* Royle from Kashmir were studied by Nengroo and Rauf (2019). The study indicated the presence of unsaturated fatty acids notably oleic and linoleic acids. Also substantial amount of saturated fatty acids mostly palmitic acid was also reported. The study also suggested that all the performed assays have the strongest antioxidant property. Amino acid composition and antioxidant activity of three medicinal plants including *Piriformospora indica*, *Euphorbia thymifolia* and *Parafreutreta hirta* from Pithoragarh) Uttarakhand Himalayas were recorded. Results of the study also highlighted the value of these species for use in pharmacy and phytotherapy (Prasad, 2017). Sar *et al.* (2013) confirmed the presence of alcohol, phenol, alkanes , alkyl halide, amino acids , carboxylic acid, aromatic , amines in the leaves and seeds of the medicinal plants including *Ocimum santum*, *Azadirathta indica*, *Pongamia pinnata*, *Celastrus paniculata* and *Embellia ribes* collected from Chhattisgarh, India. 18 components from leaves and 14 components from bark of *Feronia elephantum* Correa (Rutaceae) were identified by Mohan *et al.* (2012**)**. The study suggested the presence of bioactive compounds and justified the traditional use of the plant for various ailments.

Seven medicinal plants including (*Asparagus racemosus*, *Ocimum sanctum*, *Cassia fistula*, *Piper betel*, *Citrus aurantifolia*, *Catharanthus roseus* and *Polyalthia longifolia*) from Jalandhar, Punjab were investigated by Kaur and Mondal, (2014) for phenolics, flavonoids, antioxidant activity and antimicrobial properties wherein they found that leaf extracts of this plant significantly inhibited human pathogenic strains. Beegum *et al.* (2014) investigated the major bioactive constituents of the medicinal plant *Boerhavia diffusa* L. The study noticed the presence of various phytochemicals and also revealed that the flavonoids and phenols quantities were higher than alkaloids. It was also suggested that plants are rich sources of minerals due to its high total ash value along with high carbohydrate, high protein content and low fat. A total of 31 bioactive compounds in *Achillea filipendulina* (L.) leaves collected from Mashobra, Himachal Pradesh were detected by Khan *et al.* (2019). The study also revealed that the extract is showing the highest percent inhibition as compared to standard. The study also exhibited the presence of significant amount of phenolic content, flavonoid and antioxidant and reported that it may have pharmacological values.

Phytochemicals and FTIR analysis of *Myristica dactyloids* fruit extracts were evaluated by Rajiv *et al.* (2017)**.** Results revealed that the majority of the phytochemicals were present in the methanolic extract when compared to other solvent extracts. The study also showed the presence of different functional groups in the fruit extracts. Kalakandan *et al.* (2017) monitored the phytochemical constituents in the *Curcuma caesia* Roxb by GC-MS and FT-IR analysis. Preliminary phytochemical analysis revealed the presence of tannins, terpenoids, flavonoid, alkaloid, phenol, phytosterol Quinones and saponins. Totally 15 compounds were identified. FTIR analysis confirmed the presence of N-H, O-H, C=C, C-H, C-O and CH3 functional groups. Kavipriya and Chandran (2018) examined the methanalic leaf extract of *Cassia alata* for analysis of FTIR and GCMS**.** Phytochemical screened by FTIR spectroscopic analysis of chloroform and methanol extracts of leaves and stem of *Wedelia biflora* confirmed the presence of amide, alcohols, phenols, alkanes, carboxylic acids, aldehydes, ketones, alkenes, primary amines, aromatics, esters, ethers, alkyl halides and aliphatic amine compounds (Gowri *et al.* 2015). The anticancer activity of *Solanum nigrum* fruits extracted with methanol on HeLa cell line and Vero cell line showed greater cytotoxicity activity on HeLa cell line and little activity on Vero cell line and reported that *Solanum nigrum* could be used as anticancer activity. Pasalar *et al.* (2011) investigated cytotoxic effects of *Hibiscus sabdariffa* aqueous extract (HSE) on a human breast adenocarcinoma cell line (MCF-7) and fetal foreskin fibroblast (HFFF). Results also indicated that HSE inhibited the growth of MCF-7 cells selectively in a concentration- and time-dependent manner. HSE induced apoptosis only in MCF-7 cells. The extract was not cytotoxic against normal HFFF cells. It was also suggested that as this herbal substance is nontoxic at very high doses in experimental animals, it might be a good anticancer drug candidate for breast cancer treatment.

Cytotoxicity of ethyl acetate extract of *Zanthoxylum alatum* was studied on different cancerous cell lines such as pancreatic, lung, breast and colon cancer using MTT assay by Kalia *et al.* (2015). The extract showed significant cytotoxic potential on lung and pancreatic cancer cell lines and also shown antioxidant potential.

2.5. Ethnomedicinal research carried out in the World

Herbs make up 57% of the total medicinal plants used. As many as 107 plants species from 54 plant families, 98 genera are used for treating diseases in Babungo, Cameroon. A majority of the species belongs to Asteraceae family (Simbo, 2010). Mussarat *et al.* (2014) reported the ethnomedicinal uses of 70 plant species belonging to 39 families and 62 genera from Pakistan. Out of 39 families, the dominant family with highest number of medicinal plants was Solanaceae (5 species) followed by Moraceae, Poaceae (4 species) and 3 species each in Liliaceae and Asteraceae. Moreover, the local healers mostly used herbs (57%) followed by trees (29%). Of the 70 species, 50% were cultivated while (44%) were wild.

Two endangered medicinal plants including *Cleome droserifolia* and *Iphiona scabra* identified by El-Atroush *et al.* (2015) were authenticated using two DNA barcoding regions (ITS and rbcL). The ITS and rbcL regions showed good universality. It was also found that the viability and potentiality of ITS region in identification process used is more efficient than rbcL, where rbcL confirmed the identification of two plants upto generic level, while ITS upto the species level. Jima and Megersa (2018) documented a total of 70 medicinal plants distributed in 56 genera and 46 families in the study conducted at Berbere District, Bale Zone of Oromia Regional State, South East Ethiopia. Mohamed, (2016**)** identified five medicinal plants using DNA Barcoding from Siwa Oasis, Egypt with matk and rbcL as core barcode sites and showed that matk was more powerful than rbcL in discriminating and identifying samples at the species level and rbcL was not suitable as a solo marker. Fatty acid contents of the *Peganum harmala* plant were analyzed by Moussa and Almaghrabi, (2016) using GC-MS and recorded the presence of both saturated and unsaturated fatty acid. Tahir *et al.* (2018**)** assessed universality of DNA barcoding in geographically isolated selected desert medicinal species of Fabaceae and Poaceae using six DNA barcodes, namely ITS2, matK, rbcLa, ITS2+matK, ITS2+rbcLa, matK+rbcLa and ITS2+matK+rbcLa indigenous to the desert of Cholistan. Comparison of six barcode regions showed that ITS2 as the best barcode region in identifying medicinal species of both Fabaceae and Poaceae. The study was also concluded with advocating the DNA barcoding as an effective tool for species identification. Naim *et al.* (2018) authenticated selected medicinal plants using DNA barcoding technique. Study revealed that medicinal plant and their closely related species can be distinguished by using DNA barcoding technique with ITS2 region and it is considered as an efficient marker and potential DNA marker for authentication of selected plants.

Through the research work of Mohamed, (2016) five medicinal plants were identified using DNA Barcoding. The medicinal plants were collected from Siwa Oasis, Egypt with matk and rbcL as core barcode sites. They also proved that matk was more powerful than rbcL in discriminating and identifying samples at the species level and rbcL was not suitable as a solo marker. Naim *et al.* (2018) authenticated selected medicinal plants using DNA barcoding technique. Study revealed that medicinal plant and their closely related species can be distinguished by using DNA barcoding technique with ITS2 region and it is considered as an efficient marker and potential DNA marker for authentication of selected plants.

Seven barcode markers from the chloroplast (psbA-trnH, matK, rbcL, rpoB, and rpoC1) and nuclear region (ITS1 and ITS2) was investigated by Khan *et al.* (2018) to know the taxonomic accuracy of *Rhazya stricta*, widely used folkloric plant in Saudi Arabia. Apart from the intergenic spacer psbA-trnH, most of the chloroplast markers (matK, rbcL, rpoB, and rpoC1) showed high similarity with other taxa. In contrast, nuclear ITS2 distinguished between *Rhazya stricta*, *Rhazya orientalis* and other related species, emerging as an ideal barcode for the genus *Rhazya*. A two-locus marker of ITS1+ITS2 sequences also showed promising results. Li *et al.* (2019) used one nuclear ITS and other three chloroplast DNA markers (rbcL, matK, and trnH-psbA) to evaluate 39 accessions of Omphalogramma (Primulaceae) from the Hengduan Mountains, representing seven species using DNA Barcode technique. Results showed that the discrimination power of the markers at the species level was 14.3% (rbcL), 28.4% (trnH-psbA), 42.9% (matK) and 100% (ITS). This study indicated that DNA barcoding is a useful technique in the phylogenetic and taxonomic description of Omphalogramma species. Xi-Wen *et al.* (2019) identified poisonous medicinal plants in Chinese pharmacopoeia and their poisonous related species or adulterants using DNA barcoding. 4 commonly used regions as candidate DNA barcodes (ITS2, psbA-trnH, matK and rbcL) and compared their identification efficiency in 106 species from 27 families and 65 genera totally. It was reported to found that ITS2 sequence region had high variation, stable genetic distance and identification efficiency relatively. Findings showed that among barcode used, ITS2 can be applied as a universal barcode for identifying poisonous medicinal plants in Chinese pharmacopoeia and their poisonous related species or adulterants. Cahyaningsih *et al.* (2022) identified 61 Indonesian medicinal plant species from 30 families using a pair of ITS2, matK, rbcL and trnL primers for a DNA barcoding study.

Proximate and minerals composition of medicinal plants from Jordan was investigated by Khalil *et al.* (2010). They observed appreciable amounts of Ca, K, Na, Mg and P and trace amounts of Fe, Cu, Mn and Zn in all plants. In the year 2014, Rosas-Rodriguez *et al.* (2014) determined amino acids in medicinal plants from Southern Sonora, Mexico. High concentrations of aspartic acid, glutamic acid, serine, glycine, valine, alanine and leucine predominate in all the plants analyzed viz., *Rhizophora mangle* L (Leaf) *Rhizophora mangle* L (bark), *Lycium berlandieri* Dunal, *Zizyphus obtusifolia* A. Gray *Tournefortia hartwegiana* Steud, *Vallesia glabra* Link, *Forchammeria watsonii* Rose. Olanrewaju and Ahmed (2014), reported proximate analysis and phytochemical screening of some medicinal plants commonly used by Guaris of Fct, Nigeria. The result of the study suggested that the plant leaves if consumed in sufficient amount could contribute greatly towards meeting human nutritional requirement for normal growth and adequate protection against diseases arising from malnutrition. Apart from their medicinal values, these plant leaves are recommended for continuous use for nutritional purposes considering the amount and diversity of nutrients they contain.

A study was conducted by Ali *et al.* (2018) on proximate composition, phytochemical analysis and antioxidant capacity of *Aloe vera*, *Cannabis sativa* and *Mentha longifolia*. Proximate analysis indicated that the plants contain crude protein in the range 0.447 to 0.953%, crude fiber ranged from 12.33 to 28.47 % and crude fat in the range of 5.87 to 14.86%. Furthermore, analysis indicated the presences of important phytochemicals such as tannins, flavonoids, alkaloids, glycosides and saponins. Antioxidant activity of the selected plants indicated that *Cannabis sativa* and *Aloe vera* had the strongest antioxidant activity. Fatty acid contents of the *Peganum harmala* plant were analyzed by Moussa and Almaghrabi, (2016) using GC-MS**.** They recorded the presence of both saturated and unsaturated fatty acid.

A study performed by Shaayau and Kurya, (2019) of the *Solanum incanum* fruit. Findings stated that the fruit contains substantial amounts of macronutrients, phytochemicals and vitamins. Rabeta *et al.* (2019) investigated the nutritional and antinutritional values of leaves and stems of *Ocimum tenuiflorum* L. leaves and stems. The result of antinutritional and nutritional contents clearly indicated that the antinutritional compounds were recorded in the safe range. They also mentioned that the amount nutritional content of the leaves and stem proved that this plant a good source to improve our body health system. In his study, Adam *et al.* (2019) reported the polar solvent methanol extract of some Sudanese medicinal plant exhibited the best antioxidant results. The study also reported that the methanol was found more efficient solvent in extracting phytochemicals as compared to other solvents. In an In vitro antioxidant activity experiment of hexane, chloroform, ethyl acetate and methanol extracts of *Bridelia stipularis* stem in Malaysia. 1-dodecanol (40.917%), oxalic acid, cyclobutyl octadecyl ester (24.985%), 1-octanol,2-nitro (12.424%), benzaldehyde, 2,4-dimethyl- (9.583%), 4-tridecanol (6.359%) and nitric acid, nonyl ester (5.616%) were identified as major constituents. The study also reported that the polar solvents were good extraction solvents for the identification of free radical scavenging properties, TFC and TPC by Khan *et al.* (2019). Abdulaziz *et al.* (2019) reported the medium antioxidant activity of leaves of *Gliricidia sepium* (Jacq.) Walp. 22 bioactive compounds were identified using GCMS technique. Of these, 10 were reported to be known antimicrobials, while 8 compounds were found to be antioxidants based on published literature.

In vitro pharmacological activities of *Lantana camara* leaves collected from Tropical Region of Malaysia revealed that the methanol solvent is the most potent in recovering higher bioactive compounds due to the fact that it contained many phytochemicals and exhibited superior biological activities (Swamy *et al.*, 2015). Isah *et al.* (2015) screened the flower and seed of the plant *Senna alata* L. for phytochemicals which revealed the presence of flavonoids, phenols, saponins, tannins, alkaloid and anthraquinone. The values of anti-nutritional factors obtained from this work showed that they may not pose any effects based on their toxicity levels as recommended by World Health Organization. The pharmacologically active bioactive compounds were also identified in the study. Phytochemical, proximate and mineral analysis of *Urena lobata* stems from Imo Statte Nigeria evaluated by Njoku *et al.* (2021).

Cytotoxic effect of some Bangladeshi medicinal plant extracts against healthy mouse fibroblasts (NIH3T3) and three human cancer-cell lines (gastric: AGS; colon: HT-29; and breast: MDA-MB-435S) were experimented by Uddin *et al.* (2011) using the MTT assay. Booth *et al.* (2012) reported cytotoxicity of some selected medicinal and nonmedicinal plant extracts to microbial and cervical cancer cells. About 79% of the medicinal plants showed some cytotoxicity, while 75% of the nonmedicinal plants showed bioactivity. It was also reported that there are much toxicological work yet to be done with both medicinal and nonmedicinal plants. In Iran, Nemati *et al.* (2013) determined the cytotoxic activity of some medicinal plants from Iran using MTT assay. This study recorded that the ethanolic extract of *Consolida orientalis* L., *Ferula assa-foetida* L., *Coronilla varia* L. had potential cytotoxic activity on HeLa cell, indicating the presence of cytotoxic compounds in these extracts. The study also suggested that extracts of the *Consolida orientalis* L., *Ferula assa-foetida* L., *Coronilla varia* L. could be considered as potential sources of anticancer compounds. The efficacy of three extracting solvents (methanol, butanol and ethylacetate) was experimented on the yield and antioxidant activity of *Peperomia pellucida* L. Kunth extracts. Results showed that among the extraction solvents, the higher extract yield, total phenolic contents and antioxidant activity were obtained in ethyl acetate extract Phongtongpasuk and Poadang (2014).

Numerous pharmacognostic and proximal investigations have used traditional knowledge data, and the results have scientifically confirmed the extensive indigenous knowledge held by people all over the world. Current research suggests that ethno medicinal plants could be used to create potential herbal medications. The current study intends to assess the nutritional qualities of the three chosen plants and to identify the active components by modern scientific methods, herbal medicines with potential efficacy could be created using plants used in traditional medicine. Based on its folklore use, where the current knowledge of the plant's medicinal capabilities is passed down from earlier generations, particularly through traditional healers, the plant material was chosen for the screening of pharmacological and nutritional properties. In North East India, no molecular studies on particular plant species have been conducted, particularly on the use of DNA barcodes for species identification. With the help of DNA barcodes, the current study intends to precisely identify the plant species, which will be helpful for upcoming conservation and utilization initiatives. The study also makes an effort to demonstrate the reliability and suitability of ITS as barcodes for the classification of the chosen plants from various families found in Goalpara District, Assam. According to the literature, there is a dearth of trustworthy information that might be used to support claims that the authority of the species on phytochemistry and pharmacological aspects of the three selected ethnomedicinal plants.

2.6. PLANTS USED IN THE STUDY

In the present study, three ethno medicinally were selected plants viz., *Zanthoxylum oxyphyllum*, *Rotheca serrata* and *Blumea lanceolaria* based on their use by local and herbal practitioners of Goalpara district, Assam. These plants with medicinal properties are widely distributed and available in Assam but detailed study with focus on molecular characters, nutritional potential and pharmacological properties in Goalpara District of Assam are found to be lacking. So, this study aimed to study the taxonomy, molecular taxonomy, nutritional value and bioactive compounds in three selected plants including *Z. oxyphyllum*, *R. serrata* and *B. lanceolaria* from Goalpara district of Assam.

2.6.1. Review on *Zanthoxylum oxyphyllum* Edgew

The plant *Zanthoxylum oxyphyllum* is a scrambling shrub belonging to family Rutaceae and is distributed in the tropical and temperate regions (Pioani, 1993). In India, the genus *Zanthoxylum* is represented by around 11 species (Hooker, 1875) namely, *Z. budrunga, Z. oxyphyllum, Z. ovalifolium, Z. acanthopodium, Z. planispinum, Z. armatum, Z. nitidium, Z. rhesta, Z. simulans, Z. avicennae and Z. limonella.* Out of these, *Z. armatum DC, Z. oxyphyllum* Edgew *Z. acanthopodium DC, and Z. budrunga* have been reported from Uttarakhand *(*Kala *et al.,* 2005) and *Z. alatum, Z ovalifolium, Z. rhesta, Z. acanthopodium, Z. hamiltonianum and Z. oxyphyllum* in North East India (Hajra *et al.,* 1996). All these species are commonly used by local population for ethno-medicinal purposes. Deshpande and Shastri (1977) reported the presence of sesamin, eudesmin, epieudesmin, syringaresinol, y-fagarine, b-sitosterol and lupeol from the dried branches together with stem bark of the plant *Z. oxyphyllum*. The MeOH extracts of the barks and roots of this plant also show potent anti-proliferative activity against the growth of human keratinocytes (Kumar and Muller, 1999).

An antimicrobial compound was isolated from the tender shoots of *Z. oxyphyllum* which was assigned the structure 2-methyleptyisonicotinate. The compound was the first to be reported from *Z. oxyphyllum* (Buragohain *et al.*, 2011). Bhau *et al.* (2014) studied the genetic diversity in *Zanthoxylum* species viz. *Zanthoxylum nitidum*, *Zanthoxylum oxyphyllum* and *Zanthoxylum rhesta* collected from the Upper Brahmaputra Valley Zone of Assam (NE India). It was amplified using 13 random amplified polymorphic DNA (RAPD) markers and 9 inter-simple sequence repeat (ISSR) markers. RAPD markers were able to detect 81.82% of polymorphism whereas ISSR detected 98.02% polymorphism. The genetic similarities were analyzed from the dendrogram constructed by RAPD and ISSR fingerprinting methods which divided the 3 species of *Zanthoxylum* into 3 clear different clusters. Phytochemical studies carried out on *Zanthoxylum oxyphyllum* revealed the occurrence of glycosides, coumarins, flavonoids, phenols, tannins in crude ethanolic leaf and seeds extract as reported by Ayangla *et al.* (2016). Munda and Kakoti (2017) studied the anti-inflammatory and analgesic activities in the methanolic extract of *Z. oxyphyllum*. The results showed that at dose of 250 mg/kg and 500 mg/kg it produced significant reduction in the paw edema ($P< 0.05$ and $P< 0.01$) in a dose dependent manner when compared to the control (Diclofenac). The extract showed less analgesic effect at the dose of 500 mg/kg when compared to the control group. These inhibitions were statistically significant ($p < 0.05$). Results of their study demonstrated the anti-inflammatory and analgesic effects of methanolic extracts in animal models and justified the traditional use of this plant in the treatment of pain and inflammatory conditions.

2.6.2. Review on *Rotheca serrata* (L.) Steane & Mabb

The plant *Rotheca serrata* earlier known as *Clerodendrum serratum (L)* Moon is one of the important medicinal plants of India belonging to the family Lamiaceae. Few important common names of this plant are Moon, Bharangi, Phelang Riho, Bamun Hatee, Baman hatee, Bhuijam, Bharangee etc. Literature revealed the pharmacological activity of the plant such as anti-inflammatory activity, antinociceptive activity, anticarcinogenic activity, wound healing activity (Singh *et al.* 2012) and hepatoprotective activity (Gupta *et al.*, 2008; Sinha and Sinha, 2013; Jain *et al.,* 2016). Phytochemical studies showed the presence of secondary metabolites such as glycosides, steroids, alkaloids and phenolic class of compounds. It has been found to contain ursolic acid, spinasterol, spinasteryl-β-D glucopyranoside, β-sitosterol, sucrose (disaccharide), bauer-9-en3-one, and 5-hydroxy-7, 4-dimethoxy flavones in the stem part (Vidya *et al.,* 2007). The minerals reported in the plant were: Na, Mg, Al, K, Ca, V, Cr, Mn, Fe, Co, Ni. The leaves yielded α-spinasterol, (+)- catechin, luteolin and luteolin-7-O-β-D-glucuronide and flavones namely apigenin, luteolin, baicalein, scutellarein, 6-hydroxyluteolin; a glucoside of 6- hydroxyluteolin; caffeic and ferulic acids; and a mixture of glucose, arabinose and glucuronic acid. The bark was rich in saponins, which on hydrolysis yielded sapogenin mixture containing three major triterpenoid constituents viz., oleanolic acid, queretaroic acid and a new acid serratagenic acid identified as 3β- hydroxyl-▲-oleane-28, 29-dioic acid. The sugars identified were D-glucose, Lrhamnose and D- xylose. The bark also contained β-sitosterol and D-mannitol (Gupta *et al.,* 2008).

Aqueous and methanolic extracts of *Clerodendrum serratum* roots were used to study the anti-cancer activity in Swiss albino mice by Zalke *et al.* (2010). Mice were treated with the extracts (100 and 200 mg/kg/day per orally) respectively for 14 days. The parameters studied were mean survival time, percentage increase in life span, body weight, hematological parameters like RBC, WBC and Hb, biochemical investigations viz. ALAT, ASAT, total protein. The study confirmed that the methanolic extract of the roots of *Clerodendrum serratum* exhibits anticancer activity at the dose of 100 and 200 mg/kg body weight. Structural elucidation carried out on flavonoid glycoside from the roots of *Clerodendrum serratum (L.)* Moon belonging to family Verbanaceae (Bhujbal *et al.,* 2010). Apigenin-7-glucoside, C21H20O10 (7-(β-D-glucopyranosyloxy)-5-hydroxy2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one) was first time isolated from the roots of the plant. Kaliwal *et al.* (2011) reported that the leaf extracts of *Clerodendrum serratum* showed anti-cancer activity against skin carcinogenesis induced by 7, 12-dimethylbenz (a) anthracene (DMBA) in mice. In this study, analgesic effect of the ethanolic extract of leaves of *Clerodendrum serratum* Linn. was evaluated at the dose of 200 and 500 mg/kg by tail flick method and acetic acid induced writhing test in Wistar rats for seven days orally and standard group rats were administered diclofenac sodium (10mg/kg per orally) one hour before study on seventh day. The drug showed significant analgesic activity when compared to standard drug (Saha *et al.,* 2012). In another anti-inflammatory study, aqueous extract of *Clerdendrum serratum* root and stem in low (90 mg/kg per orally) and high dose (180 mg/kg per orally) was administered to Albino rats for ten days. The standard group received Dexamethasone as a single dose daily. Both root and stem have shown the anti- inflammatory effect, but root showed significant activity in comparison with Dexamethasone (International Journal of Pharma and Biosciences, 2012). In yet another study, the methanolic extracts of aerial and root parts of *Clerodendrum serratum* Linn. was carried out to study the anti-rheumatic properties based on the effects on carrageenan induced paw oedema in rats. The results showed that the roots possess significant while the aerial parts exhibited moderate anti-inflammatory activity. Thus, from the study it was evident that the roots of *Clerodendrum serratum* L. possess potent anti-rheumatic properties (Shareef *et al.,* 2013). Aerial part of the plant possesses bis (2-ethylhexyl) phthalate, hispulidin, serratumin A, acteoside, martynoside, serratumoside-A and myricosoid, whereas root was found to contain D-mannitol, stigmasterol, oleanolic acid, ferulic acid, lupeol and ursolic acid as reported by Kumar and Niteshwar (2013). Quality assessment and phytochemical analysis of *Clerodendrum serratum (L)* roots was also evaluated (Acharya and Patel, 2016).

The qualitative and quantitative phytochemical analysis of methanolic root extract showed the presence of phenolics, flavonoids, saponins and carbohydrates. In vitro effect of various plants growth promoters on *Clerodendrum serratum (L)* Moon were also carried out by Vijay *et al.* (2016). The phytoconstituents present in the root of n-hexane extract were evaluated by GC-MS which showed that a total of 15 constituents were identified and characterized. Out of all the compounds, 60% comprised the oxygenated compounds. Compound hexadecanoic acid, methyl ester and benzene, 1, 3-bis (1, 1-dimethylethyl) showed highest percentage about 6.5 and 74.9, respectively (Tiwari *et al.,* 2017).

2.6.3. Review on *Blumea lanceolaria* (Roxb.) Druce

Blumea lanceolaria (Roxb.) Druce (Asteraceae), often known as "Jwglaori," is a perennial herb found in many regions of India. *B. lanceolaria* (Roxb.) is a distinct folklore medicinal plant utilised by the natives of Goalpara. Around 70 constituents derived from the genus *Blumea*, including flavonoids, sesquiterpenes, triterpenoids, acetylenic thiophenes, monoterpenes, xanthenes, diterpenes and essential oils. Blumealactones A, B, and C derived from *B. balsamifera* demonstrated antitumor activities against Yoshida sarcoma cells in tissue culture (Chen *et al.,* 2009; Yasuo *et al.,* 1988). Two acetylenic thiophenes, 63 and 64, isolated from *Begonia oblique*, had antifungal activity against Epidermophyton floccosum and Pleurotus ostreatus (Chen *et al.,* 2009; Ahmed and Alam, 1995). Dung *et al.* (1991) analysed the essential oil of *B. lanceolaria* (Roxb.) Druce and discovered that methyl thymol (95%) was the major ingredient. Victoria *et al.* (2012) studied analgesic, antipyretic and anti-inflammatory activities of the methanolic extract of *B. lanceolaria* (Roxb.) Druce used by the tribal people of Mizoram. The methanolic extract doses of (200 and 400 mg/kg) showed significant ($p < 0.01$) analgesic, antipyretic and anti-inflammatory activities were observed in all the experimental models tested. The extracts may be exerting its effects through central mechanisms. These findings confirmed its ethnomedicinal use in the treatment of pain, fever and inflammation. Results proved that the plant *B. lanceolaria* (Roxb.). Druce traditionally used by the tribal people of Mizoram have good potential for analgesic, antipyretic and anti-inflammatory activities. The DPPH free radical scavenging activity of *B. lanceolaria* leaf was 302.37±59.78mg/100g DW TE. The presence of high antioxidant activity of *B. lanceolaria* was also reported by other researchers (Bhaumik *et al.,* 2008; Saikia *et al.,* 2017). Bhaumik and his associates (2008) reported that the methanolic fraction of *B. lanceolaria* exhibited significant DPPH free radical scavenging activity with an IC50 value of 45.79 µg/ml whereas the IC50 value of the standard drug L-ascorbic acid was found to be 13.76 µg/ml. Saikia *et al.* (2017) reported the antioxidant activity in the form of IC50 values, 55.56 µg/ml compared to standard BHA which exhibited 12.76 µg/ml. The FRAP activity investigation was 4.60±0.17g TE/ 100g DW. The high antioxidant activity of *B. lanceolaria* in terms of ferric reducing/ antioxidant power (FRAP) was reported by Mishra *et al.* (2015). Mishra and his colleagues reported in vitro antioxidant activity, in terms of ferric reducing antioxidant potential (FRAP) of the methanolic extract of stem, root and leaf as 29.00±0.02 mg GAE/g DW, 39.29±0.05 mg GAE/g DW and 33.72 mg GAE/ g DW respectively. The total phenolic content of *B. lanceolaria* leaf was 1298.93mg GAE/100g DW. The total phenolic content of the *B. lanceolaria* were also evaluated by Mishra *et al.* (2015) and Saikia *et al.* (2017). Mishra and his associates (2015) reported that the total phenolic content in the methanolic extract of stem, root and leaf were 23.18±0.32 mg GAE/g DW, 31.40 mg GAE/g DW and 29.20±0.8 mg GAE/g DW respectively while Saikia *et al.* (2017) reported total phenolic content of 67.20 mg GAE/g DW of the leaf.

Mishra *et al.* (2015) screened different extracts for antibacterial activity by using agar well diffusion test against three different pathogens. Ethanol extracts of stem, roots and leaf showed promising results against Staphylococcus with high (10 to 12mm) inhibition zone as compared to standard antibiotics (2 to 10mm). The cytotoxic of activity *B. lanceolaria* methanolic leaf extract from Mizoram was investigated using MTT assay on HeLa (Human cervical cancer) cell line. The MTT assay suggests that the methanol leaf extract of *B. lanceolaria* exhibited moderate cytotoxicity against HeLa cell lines with IC50 95.63µg/ml (Saikia *et al.*, 2017).