

## ***Elsholtzia communis*: A Review of its Traditional Uses, Pharmacological Activity and Phytochemical Compounds**

**Chandana Choudhury Barua\*, Nilofar Yasmin and Lipika Buragohain**

*Department of Pharmacology and Toxicology, College of Veterinary Science, Assam Agricultural University, Guwahati, Assam, India*

**\*Corresponding Author:** Chandana Choudhury Barua, Professor and Principal Investigator, Department of Pharmacology and Toxicology, College of Veterinary Science, Assam Agricultural University, Guwahati, Assam, India.

**Received:** July 06, 2018; **Published:** August 09, 2018

### **Abstract**

The genus *Elsholtzia* contains at-least thirty three species and in folk medicine, the species of this genus have immense medicinal values. *Elsholtzia* has an widespread distribution, assorted biological and pharmacological activities of pure compounds, extracts and volatile components already reported. Various phytochemical researches on the genus revealed the wide-ranging presence of flavone, coumarin, terpenoid, and other compounds, together with prolific essential oils. The pharmacological activities of volatile constituents mainly were considered on antioxidant, antiviral and antibacterial activities.

This review deals with one of the rare species of the genus *Elsholtzia*, i.e. *Elsholtzia communis*, of the family *Labiatae*. It is available mainly in China, Thailand, Indo China border and in North-eastern parts of India. It is popularly used by the tribes of Nagaland and Arunachal Pradesh as a part of their diet and for medicinal property. A survey of the available literature shows that the research work carried out on this particular plant is meager, compared to other species like *Elsholtzia blanda*, *E. kachinensis* and *E. stachyodes*. In spite, *E. communis* has various medicinal properties and food value. It is used as a traditional remedy for cough, throat infection, bronchitis, gastric problems. We have reported its adaptogenic activity in counteracting stress. Due to its high nutritive value it can be utilized as a nutritional supplement. Pharmacological investigations on the extracts and pure compounds from *Elsholtzia* cover the antiviral, antibacterial, anti-inflammatory, anti-oxidant, and myocardial ischemia protection, as well as other activities. Researchers are increasingly concentrating on the pharmacological activities of the genus.

**Keywords:** *Antiviral; Adaptogen; Elsholtzia communis; Essential Oils; Stress; Pharmacological; Nutritional; Resistance*

### **Introduction**

*Elsholtzia communis* (Coll. Et Hemsl.) Diels is a rare species of the genus *Elsholtzia* in the family *Lamiaceae*, is an herb which is 60 cm tall, with strong fresh and sweet smell of lemon [1]. Stems are erect slightly purple red and densely retrorse white pubescent, which is much branched at base. It is cultivated in China, Yunnan, Myanmar, Thailand, Vietnam, Indo China and India. In North-eastern states of India, the leaves of the plant is consumed by local tribes and is popularly used as herbal tea, spice, perfumery, cosmetics and condiment presumably due to its effect on digestion. The leaves showed high protein content [2]. *Elsholtzia communis* is mainly used for the treatment of cold, headache, fever and dyspepsia as it has the properties of detoxifying and relieving exterior syndrome [3]. *Elsholtzia communis* is locally known as lombha in Manipur, used for treating itching [4]. This herb is a flavouring agent in various food items [5-7]. Phytochemical compounds and pharmacological activities of different species of the genus *Elsholtzia* were reported earlier in the form of review [8] however, literature is scanty for *Elsholtzia communis*, mainly found in China Province as well as in North-eastern parts of India. Considering its immense popularity among various tribes of Nagaland, Manipur, where it is sold in the market everyday and local

inhabitants consume this as a favourite condiment, we have collected the plant and studied its nutritional properties, anti-stress properties to name a few [9]. The results are astonishing. It has high nutritive and adaptogenic properties. That may be the reason the people consume this plant during peak winter to acclimatize themselves with extreme cold climate prevailing in those areas of north east India. Pharmacological studies on *Elsholtzia* is mainly reported on its antiviral, antibacterial, anti-inflammatory, anti-oxidant and protection of myocardial ischemia [10]. The aim of this paper is to review the work done on the phytochemical, taxonomical, pharmacological activities of *Elsholtzia communis*, exclusively along with its traditional uses and future prospects for drug development.

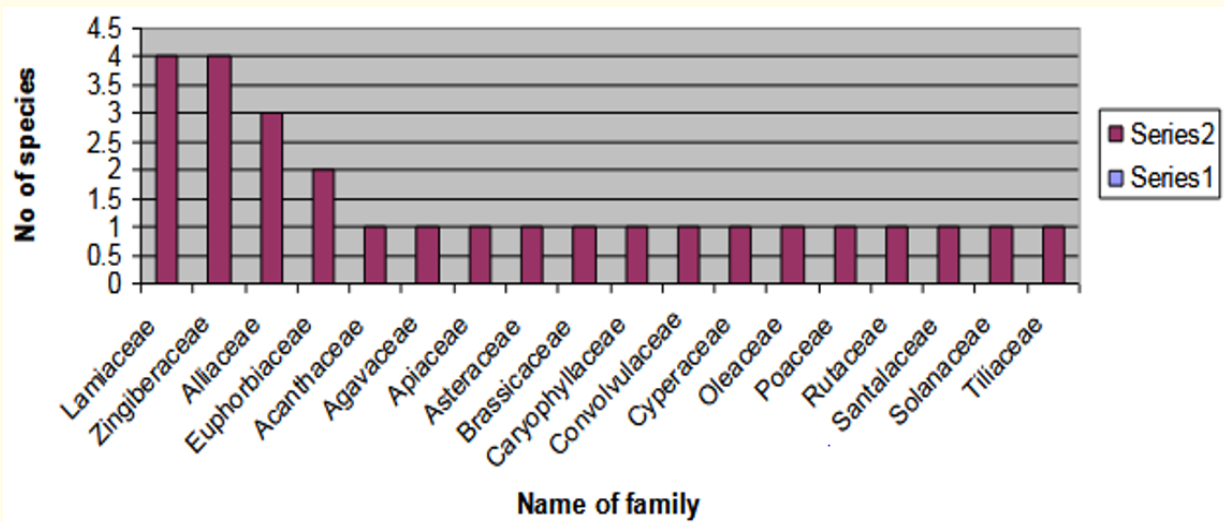
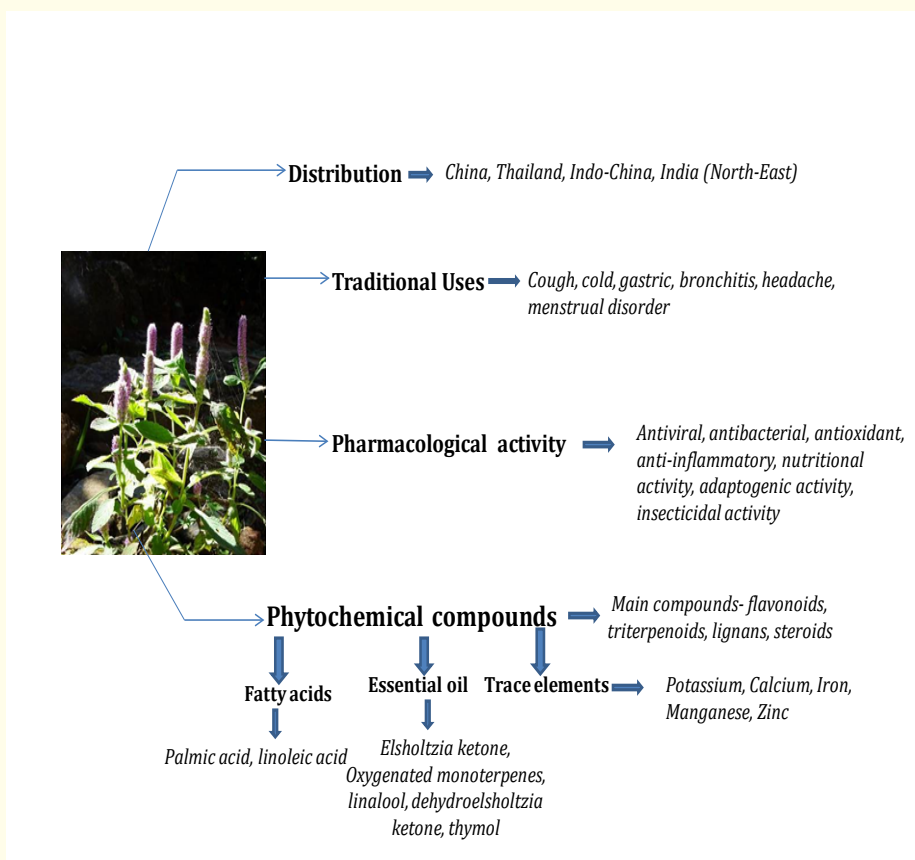


Figure 1: Distribution of species under different families showing Lamiaceae having the highest number of species.

*Elsholtzia communis* at a glance





**Figure 2:** *Elsholtzia communis*. Image of herbarium specimen held at Royal Botanic Garden Edinburgh (E). Specimen barcode number E00275776. Specimen collected from: China.

**Description**

The genus was named in honour of the Prussian naturalist Johann Sigismund Elsholtz. *Elsholtzia communis* (Collett & Hemsl.) belongs to the family Lamiaceae is widely distributed and used in East Asia (Myanmar, Thailand, Vietnam), Africa, North America. Young shoot, leaves are used for tonsillitis, fever, cough, nose bleeding and menstrual disorders. *Elsholtzia communis* is nutritionally important because of high content of minerals, essential fatty acids, essential oils, fibers and proteins. Genus *Elsholtzia* is a rich store house of phytochemical compounds like flavonoids, phenolic acid, terpenoids which are exploited for its antimicrobial, antiviral, insecticidal and other therapeutic uses. Trace elements which are essential of enzymatic processes in our body and taken as external supplement comes from this plant sources. In *Elsholtzia communis*, elemental constituents such as Potassium, Nitrogen, and Iron are present in rich quantity. *Elsholtzia communis* also possesses plentiful of essential oil, also known as volatile oils, are natural products formed by a mixture of volatile compounds with strong analgesic, antibacterial and anti-inflammatory effect.



**Figure 3:** (a) *Elsholtzia communis* whole plant (b) *E. communis* (Coll. And Hemsl.) Diels Var. (purple flower) (c) *E. communis* (Coll. And Hemsl.) Diels Var. (white flower) [11].

### Synonyms

*Aphanochilus communis* (Collett & Hemsl.) Kudô, *Dysophylla communis* Collett & Hemsl.

### Common name

In China it is commonly known as Ji long Cao [10].

### Vernacular name

It is most commonly known as Phak loom poom [10], Lomba, Youngpa in Manipur and Mizoram in India. In Nagaland it is known as Mauhri by the Tangkhul ethnic group. It is also known as Lengmasel by the Zomi and Mizo community in Northeast part of India (<https://www.flowersofindia.net/catalog/slides/Lomba.html>).

### Morphology

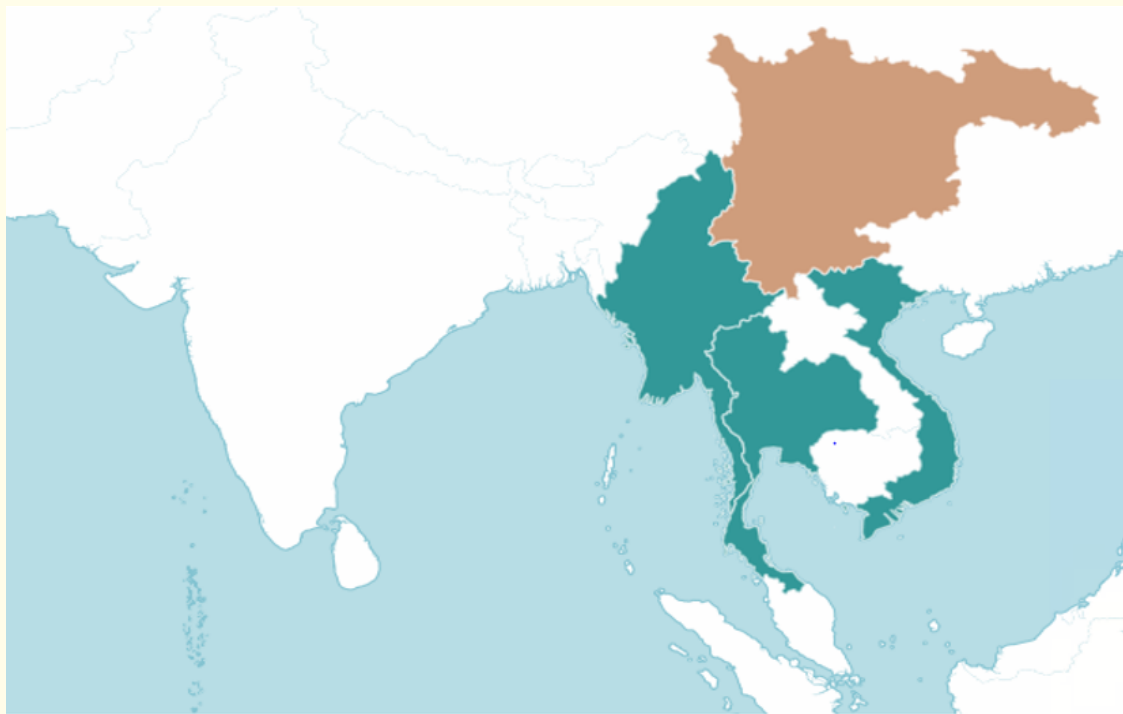
*Elsholtzia communis*, is an annual herb that grows upto 60 cm. Stems are generally erect, shiny, white pubescent, glabrescent at base. Leaves are ovate elliptic, 3 - 6 by 1 - 2 cm, base attenuate, and margin serrate or deeply serrate. Petioles 8 - 10 mm long. Inflorescence terminal and axillary, bracts narrowly lanceolate, 2 - 3 by 0.2 - 0.3 mm, pubescent on both sides. Stamens 4, slightly exerted, glabrous. Nutlets 4, oblong, 0.6 mm long [10]. Spikes terminal, cylindric, 1 - 4.5 × 0.8 - 1 cm, com-pact. Calyx is tubular, apex recurved and densely gray lanate-villous outside; teeth subequal slightly closed inside the fruit. Corolla is funnel form and glandular outside, obscurely hairy annulate inside.

**Habitat**

The plant generally grows at hilly grasslands, waste areas or valleys or in warm areas. It is found in disturbed forest or mountain valleys at 400 - 600m altitudes (<https://www.flowersofindia.net/catalog/slides/Lomba.html>).

**Geographical Distribution**

*Elsholtzia communis* (Collett & Hemsl.) Diels, (Lamiaceae) is widely distributed and used in East Asia, Africa, North America, and European countries for centuries. In Asian continent it is widely found in Myanmar, Thailand, Nepal, Bhutan [12]. In India, it is found in Sikkim, Mizoram Tawipui, Lushai Hills. Most of the *Elsholtzia* species are widely found in Northern Thailand in open dry woodland or forest margins, mostly above 600m altitude. Most of the species including *Elsholtzia communis* are distributed from the Himalaya, South East Asian mainland and Sumatra [12]. It is wide spread across much of temperate and tropical Asia from Siberia South to China, India and Indonesia.



**Figure 4:** Distribution of *Elsholtzia* species worldwide. Found in Myanmar, Thailand, Vietnam. Introduced in China South-Central (<https://www.revolvy.com/page/Elsholtzia>).

**Ecology**

Cultivated in home gardens, in disturbed forest or mountain valleys, 400 - 600m altitude. Flowering and fruiting: November to February [12].

**Taxonomic Classification**

**Class:** Equisetopsida C. Agardh

**Subclass:** Magnoliidae Novák ex Takht

**Superorder:** Asteranae Takht

**Order:** Lamiales Bromhead

**Family:** Lamiaceae Martinov

**Genus:** *Elsholtzia* Willd

**Species:** *Elsholtzia communis*

### Utility and edibility

Generally the young shoot, leaves, inflorescence are used. Leaves are primarily used in most of the *Elsholtzia* species followed by whole plant, bark, root and seeds. The plant parts are commonly used in the form of decoction paste, juice etc [13].

### *Elsholtzia communis* as folk medicine

*Elsholtzia communis* is popularly used as a medicinal plant for their diverse medicinal properties. It is used as domestic folk medicine, herbal tea, beverages, chutney etc in various forms by local tribes. *Elsholtzia* possesses antiviral, antibacterial, anti-inflammatory, antioxidant, and protects myocardial ischemia [14]. *E. communis* is taken as a remedy for headache, pharyngitis [15]. *E. communis* is consumed by local people as a vegetable or as chutney in their diet. It has cooling, detoxifying properties and relieves exterior syndrome and hence used for the treatment of cold, head ache and fever [16]. Decoction of the leaves and inflorescence is orally prescribed in fever [17] and dyspepsia.

### Pharmacological activities

#### Adaptogenic activity

Barua and her co-workers [17], evaluated the adaptogenic activity of hydroethanolic extract of *Elsholtzia communis* (Collett & Hemsl.) Diels. by investigating neurobiological and biochemical changes associated with acute and chronic stress in adult male Wistar rats. Adult male Wistar rats were given forced swimming- induced acute and chronic stress for 3 and 7 days. Hydroethanolic extract of *Elsholtzia communis* (EC) was orally administered at 100 (EC-100) and 200 (EC-200) mg/kg doses and for comparison, *Panax ginseng* (PG) extract (100 mg/kg, p.o.) was used as standard adaptogen. BDNF level, plasma corticosterone, brain levels of lipid peroxides (LPO), superoxide dismutase (SOD), catalase (CAT) and reduced glutathione (GSH), cortical and hippocampal levels of monoamines viz. norepinephrine (NE), epinephrine (Ep) and dopamine (DA) were quantified for ascertaining biochemical and neurohormonal changes accompanying stress. The results were also confirmed by the estimation of various pro-inflammatory cytokines (IL-6, IL-1 $\beta$  and TNF- $\alpha$ ) in serum. Compared to vehicle treated stressed rats, the EC and PG treated significantly normalised chronic acute and chronic stress induced elevation of corticosterone and reduction of plasma BDNF; both doses (EC-100 and EC-200) stabilized the irregular oxidative status of the brain in stressed rats. EC treatment further suppressed the elevated levels of IL-6, IL-1 $\beta$  and TNF- $\alpha$  in stressed animals.

*E. communis* has the ability to counteract stress and has the potential to develop as adaptogen and also as a replacement/substitute of the popularly used drug, Ginseng or Ashwagandha. The stress-related genes *hspa14*, *CHOP*, antioxidant gene *Nrf2*, apoptotic gene Caspase-3 over expressed in the stress control group were significantly suppressed, following administration of the extract at 100 and 200 mg/kg oral doses and the standard drug Ginseng. Brain-derived neurotrophic factor which is closely related with stress, was down-regulated in the stress control group, was found to be up-regulated following treatment with the *E. communis* extract and the standard drug Ginseng [18].

#### Antibacterial activity

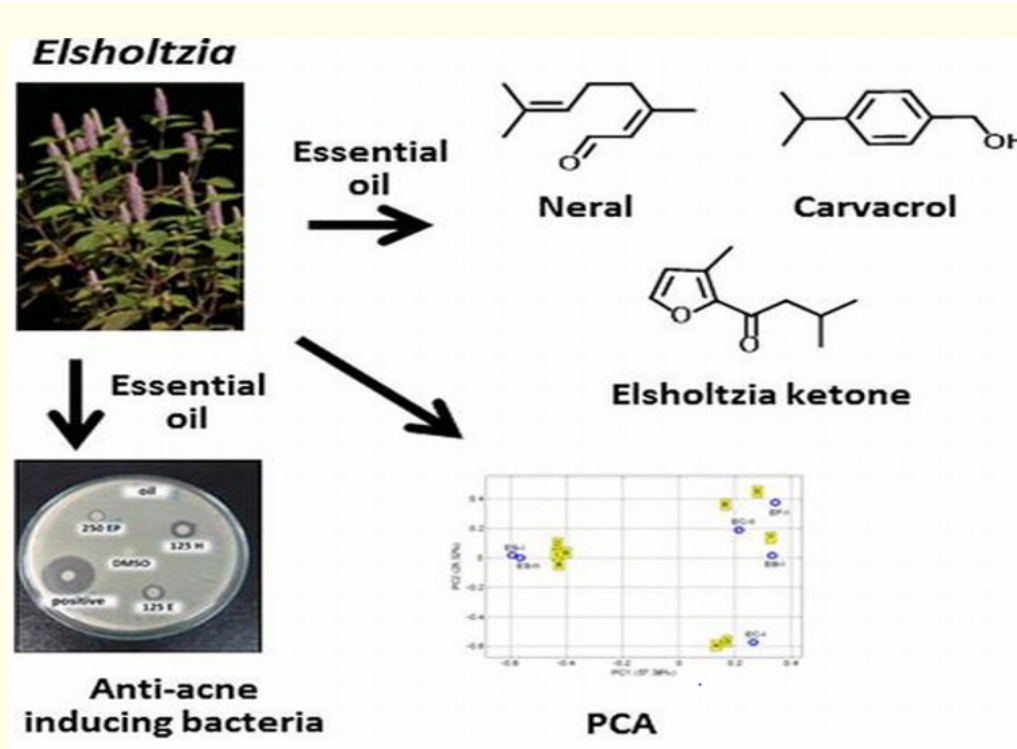
Methanolic leaf extracts of *Elsholtzia blanda* Benth., *Elsholtzia communis* (Collett & Hemsl) Diels., *Polygonum posumbu* Buchanam-Hamilton ex D. Don and *Zanthoxylum acanthopodium* DC. using methanol as a solvent were tested against 10 human pathogenic bacteria

for potential antibacterial activity. The study revealed that all extracts show varied degree of antibacterial activity against the tested bacterial pathogens. The antibacterial activity was determined using agar well diffusion method. Methanolic extract of the leaf *Zanthoxylum acanthopodium* DC. showed antibacterial activity against five bacterial strains from among the ten bacteria tested followed by *Polygonum posumbu*, *Elsholtzia communis* and *Elsholtzia blanda*. Minimum inhibitory concentration of the plants against the tested organism ranged between 3.125 - 12.5 mg/ml.

Plant	Bacteria	MIC (mg/ml)
<i>E. blanda</i> Benth.	<i>B. cereus</i>	3.125
<i>E. blanda</i> Benth.	<i>C. perfringens</i>	6.25
<i>Elsholtzia communis</i> (Collett & Hemsl) Diels	<i>C. sporogenes</i>	3.125
<i>Elsholtzia communis</i> (Collett & Hemsl) Diels	<i>S. sonnie</i>	3.125
<i>Polygonum posumbu</i> Buchanam-Hamilton ex D Don.	<i>B. cereus</i>	3.125
<i>Polygonum posumbu</i> Buchanam-Hamilton ex D Don.	<i>C. sporogenes</i>	12.5
<i>Polygonum posumbu</i> Buchanam-Hamilton ex D Don.	<i>N. gonorrhoea</i>	3.125
<i>Z. acanthopodium</i> DC.	<i>B. cereus</i>	6.25
<i>Z. acanthopodium</i> DC.	<i>C. sporogenes</i>	6.25
<i>Z. acanthopodium</i> DC.	<i>C. perfringens</i>	6.25
<i>Z. acanthopodium</i> DC.	<i>P. aeruginosa</i>	3.125
<i>Z. acanthopodium</i> DC.	<i>S. aureus</i>	3.125

**Table 1:** Minimum inhibitory concentration [2].

The antibacterial activity of essential oils obtained from the aerial parts of 4 numbers of *Elsholtzia* species *E. stachyodes*, *E. communis*, *E. griffithii*, *E. beddomei*, by steam distillation and analysed by GC-MS. Yield of four oils ranged from 0.26 - 1.21% on weight basis. Antibacterial activity of the oils was investigated against two strains of acne inducing bacteria; *Staphylococcus aureus* (ATCC 25923) and *Staphylococcus epidermidis* (TISTR518) compared with standard antibiotic Erythromycin. Essential oil of *Elsholtzia stachyodes* showed highest activity to inhibit the growth of *S. aureus*, *S. epidermidis* with MIC values of 0.78 and 1.56 µL/mL respectively. Essential oil of *Elsholtzia communis* and *Elsholtzia beddomei* displayed high efficacy against *S. aureus* and moderate for *S. epidermidis* with MIC at 3.91 and 15.62 µL/mL respectively. This result shows that the above plants including *Elsholtzia communis* is a potential source against acne induced bacteria [19].



**Figure 5:** Essential oils and Anti-acne property of *Elsholtzia communis* [19].

**Nutritional Activity**

*Elsholtzia communis* along with six other medicinal plants viz. *Homalomena aromatica*, *Clerodendrum indicum*, *Elsholtzia communis*, *Zanthoxylum alatum*, *Drymaria cordata* and *Gnetum gnemon* of the North Eastern region of India were estimated for their proximate composition and minerals content on dry matter basis. The crude protein content of *Drymaria cordata* was found to be 20.57%, followed by *Homalomena aromatica* (20.5%), *Elsholtzia communis* (16.19%), *Zanthoxylum alatum* (10.94%), *Clerodendrum indicum* (7.88%) and *Gnetum gnemon* (6.7%). Fat content ranged from 0.31% - 1.27% and crude fibre 7.31% - 20.0% in the plant species. They are rich in mineral content, iron, zinc and copper. These wild plants can be used as nutritional supplement [16,19].

Specimens	Moisture (%)	Crude protein (%)	Ether extract (%)	Crude fiber (%)	Total ash (%)	Carbohydrate (%)	Gross energy (Kcal/100g)
<i>Clerodendrum indicum</i>	15.400	7.880	0.314	11.000	5.500	59.900	273.940
<i>Homalomena aromatica</i>	10.700	20.500	20.500	20.000	5.000	42.870	261.850
<i>Elsholtzia communis</i>	8.86	16.19	16.19	7.31	14.50	51.89	283.57
<i>Zanthoxylum alatum</i>	12.80	10.94	10.94	12.5	8.5	53.99	271.15
<i>Drymaria cordata</i>	10.67	20.57	20.57	15.00	9.00	44.44	262.92
<i>Gnetum gnemon</i>	9.99	6.70	6.70	7.50	9.0	65.61	111.00

**Table 2:** Proximate composition of six selected plants species on Dry Matter Basis [20].

Specimens	Calcium (%)	Phosphorus (%)	Zinc (ppm)	Iron (ppm)	Copper (ppm)
<i>Clerodendrum indicum</i>	1.000	0.641	5.600	42.000	0.620
<i>Homalomena aromatica</i>	1.200	0.654	6.720	136.000	0.470
<i>Elsholtzia communis</i>	0.800	0.560	2.040	10.000	0.310
<i>Zanthoxylum alatum</i>	1.700	0.708	1.470	186.000	0.170
<i>Drymaria cordata</i>	0.978	0.600	10.760	792.000	1.000
<i>Gnetum gnemon</i>	0.95	0.20	0.65	10.00	0.01

**Table 3:** Mineral content of plant species [20].

*Elsholtzia communis* is taken as culinary herb in Manipur and is found to contain significant amount of aminoacids, carbohydrates, proteins and minerals, which offer significant and specific roles for proper metabolism of our body. For nutritional and toxicological analyses in food stuffs, the macro and micro elements are usually determined [21]. To investigate macronutrients and mineral elements, Khomdrum and his team investigated eight edible Lamiaceae plants, *Elsholtzia communis* is among one of them. Different amount of minerals and biochemical compounds are recorded for the selected plants. Higher concentrations of Fe (2.56 mg g<sup>-1</sup>) and Mn (0.15 mg g<sup>-1</sup>) were recorded in *Elsholtzia communis* (white flower). Cobalt (Co) which is known for a number of vital metabolic activity, its distribution in plants reported to be in the range of 0.0001 - 0.0010 mg g<sup>-1</sup> [22]. Cobalt content ranged from 0.05 mg g<sup>-1</sup> in *Elsholtzia communis* var. purple flower, *E. communis* var. white flower. Copper (Cu) content ranged from 0.03 mg g<sup>-1</sup> in *E. communis*. Manganese (Mn) ranged from 0.03 to 0.15 mg g<sup>-1</sup>. As Mn have multi-functional activities like anti-oxidant capacity, present finding of 0.15 mg g<sup>-1</sup> Mn content in *E. communis* var. white flower seems to be promising for commercial exploitation. Mineral contents of these plants are comparable with several data provided by many workers in various vegetables [23-26].

**Insecticidal activity**

A number of diseases are transmitted by mosquitoes such as malaria, filariasis, dengue etc. Oviposition deterrence is one of the most important events in the life cycle of mosquitoes. By disrupting its oviposition, mosquito population can be reduced [27]. For mosquito



control strategies, the use of botanical extracts for oviposition repellent test is the least and mostly unexplored strategy. Insecticidal characters was studied on the larvae of certain mosquitoes such as *Culex* sp. [28] and *Anopheles* species [29]. *Elsholtzia communis* has insecticidal properties. The leaf part is generally used and phytochemical compounds like phenols, flavonoids, tannins have insecticidal property [30].

#### Antioxidant activity

Study was carried out to estimate antioxidant activity of some indigenous foods. In the study, twenty eight indigenous plant foods were studied for their antioxidant activity. Antioxidant activities were determined by the following assays- (i) DPPH (2,2-diphenyl-1-picrylhydrazyl) assay, (ii) FRAP (Ferric Reducing Antioxidant Power) assay and (iii) SOSA (Super Oxide Scavenging Assay). Among the twenty eight plant foods, there were thirteen leafy vegetables, four fruits, five roots and tubers, four species and two mushrooms. Methanol and water extract of the samples were used for the analysis. The leafy vegetable samples exhibited antioxidant capacity with  $IC_{50}$  ranging from 8 - 1414 mg/ml for lipid extract and 34 - 37878 mg/ml for aqueous extract in DPPH assay. *Elsholtzia communis* showed high antioxidant activity in all the three parameters among the species. Thus *Elsholtzia communis* can be used as an antioxidant [31].

#### Phytochemical constituents of *E. communis*

Phytochemical investigations showed that flavonoids are major ingredients in *Elsholtzia*. Phenylpropanoids, phytosterols and cyanogenic glycosides are the main constituents in this genus. Till today, almost sixty eight C6-C3-C6 compounds are isolated and reported in *Elsholtzia*. They are characterized by the presence of the substitutional groups and modes, as well as their glycosides. More than fifty compounds have been isolated from *Elsholtzia* species, and more than hundred constituents have been analysed in their essential oil. The chemical constituents can be divided into flavonoids, coumarins, lignanoids, triterpenoids, steroids, fatty acids, and essential oil. Plants have provided a good source of anti-infective agents; emetine, quinine, berberine, tannins, terpenoids, alkaloids and flavonoids are highly efficient phytochemical compound in the fight against microbial infections [32]. The above mentioned phytochemical compounds are found to be present in *Elsholtzia communis*.

Study conducted by Barua and her co-workers [18], showed powdered dried leaves of *E. communis* were macerated with aqueous ethanol (1:1), to get hydro-ethanol extract of *Elsholtzia communis*. The extract was fractionated with hexane followed by chloroform. Hexane, chloroform, and remaining fractions were evaporated to dryness. Chloroform fraction of hydro-ethanol extract (30g) was chromatographed over a column of 600g of silica gel (60 - 120 mesh) starting with the solvent system hexane, and 200 ml fractions were collected in the following order: Fr. 1-3 (hexane), Fr. 4-14 (1:10, ethyl acetate: hexane), and 200 ml fractions were collected in the following order: Fr. 1-3 (hexane), Fr. 4-14 (1:10, ethyl acetate: hexane), Fr. 15-25 (1:7, ethyl acetate: hexane), Fr. 26-35 (1:5, ethyl acetate: hexane), Fr. 36-45 (1:3, ethyl acetate: hexane), Fr. 46-53 (1:1, ethyl acetate: hexane), Fr. 54-61 (3:1, ethyl acetate: hexane), Fr. 62-73 (5:1, ethyl acetate: hexane), Fr. 74-84 (7:1, ethyl acetate: hexane), Fr. 85-92 (10:1, ethyl acetate: hexane), Fr. 93-98 (ethyl acetate), and Fr. 99-110 (ethanol). The fractions were analyzed by thin-layer chromatography (TLC) in different solvent systems. Combined fractions of 1-9 of *Elsholtzia communis*/chloroform fraction/fractions 12-40 were subjected to preparative TLC using the solvent system ethyl acetate: hexane (1:2). A pure compound was isolated, and  $^1H$  NMR [18], CNMR IR and MS spectra were recorded for this pure compound. The study of these spectroscopic data allowed to identify the compound as structure given below.

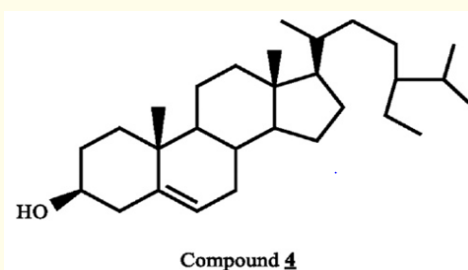


Figure 6: Isolated compound from *E. communis* [18].

A study of flavonoids in *Elsholtzia communis* was made using classic chromatography and high performance liquid chromatography for utilization of the plant. Compounds like 1. Apigenin-7-O-β-D-glucoside (C<sub>21</sub>H<sub>19</sub>O<sub>10</sub>), 2. Luteolin-7-O-β-D-glucoside (C<sub>21</sub>H<sub>19</sub>O<sub>10</sub>), 3. Quercetin-7-O-β-D-glucoside (C<sub>21</sub>H<sub>20</sub>O<sub>12</sub>), 4. Quercetin-4'-O-β-D-glucoside (C<sub>21</sub>H<sub>20</sub>O<sub>12</sub>), 5. Apigenin-5-O-β-D-glucoside (C<sub>21</sub>H<sub>19</sub>O<sub>10</sub>), 6. Kaempferol-7-O-β-D-glucoside are found in *E. communis* for the first time in the study [32]. Compounds 3 to 6 are obtained from genus *Elsholtzia* for the first time.

Results of phytochemical screening showed polyphenolic compounds like flavonoids, triterpenes and steroids are present in the leaves of *Elsholtzia communis* [33].

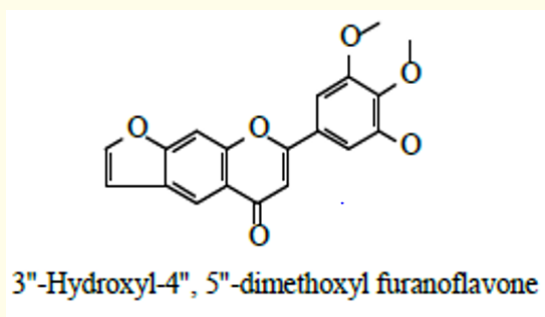


Figure 7: Structures of some flavonoids.

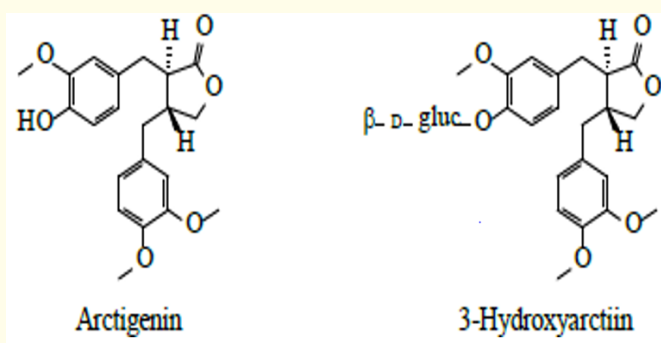


Figure 8: Structures of two lignans.

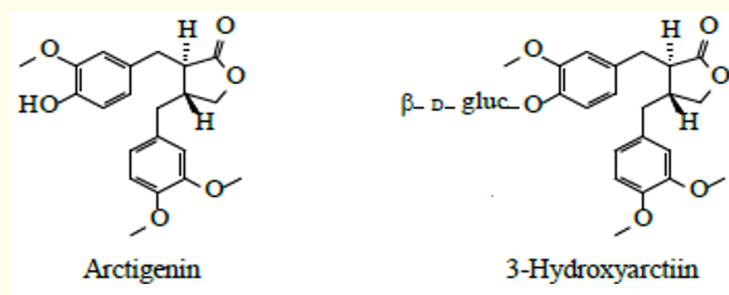


Figure 9: Structures of the triterpenoids and steroids found in *E. communis* [24].

**Essential oil**

Different species of genus *Elsholtzia*, possess many essential oils which exert strong inhibition of central nervous system, analgesic, antibiotic and anti-inflammatory effects [34]. Essential oil found from the leaves of *Elsholtzia communis* found to be 97.24% [35]. There are about hundred chemical constituents of essential oil which are analyzed by modern analytical instruments like chromatographic-mass spectrometry (GCMS) [35-39]. The main chemical constituents of essential oil of different species of *Elsholtzia* are not the same. Some of the main constituents of the essential oil from several *Elsholtzia* species were reported earlier. They are thymol, carvacrol, methyl thioether, linalool, camphor,  $\beta$ - dehydroelsholtzia ketone [41] found in *Elsholtzia rugulosa*; 5-trimethyl-benzene, aromadendrene, d-carvone, limonene found in *Elsholtzia ciliate* [40]. Aromadendrene, d-carvone is found in *Elsholtzia patrini* [42]. Tricyclo [42] undecan-1-ol, 2,3,5,6-tetramethyl phenol, 3-phenyl-2-butanone, caryophyllene is found in *Elsholtzia densa* var. *ianthina*. 2-(2', 3' - Dimethyl butyl)-3-methyl furan found in *Elsholtzia densa* var. *calycocarpa*. Geranial, neral,  $\beta$ -trans-ocimene is found in *Elsholtzia argyi*. 1,8-Cineole,  $\beta$ -pinene, camphorquinone, trans-caryophyllene is found in *Elsholtzia stauntonii* [43]. Generally the essential oils, and flavonoids from *Elsholtzia communis* extract are considered to be the active principles. The isolation of constituents from the genus *Elsholtzia* is very less and there are only about 50 compounds isolated which are extracted from different species of *Elsholtzia* [44].

Essential oils obtained from the aerial parts of four *Elsholtzia* species are (a) *Elsholtzia stachyodes*, (b) *Elsholtzia communis*, (c) *Elsholtzia griffithii* and (d) *Elsholtzia beddomei* by steam distillation and chemical variations were identified by Principal Component Analysis (PCA). Thirty-six compounds were identified in the oil of *Elsholtzia stachyodes* comprising 98.96% of the total oil. *Elsholtzia communis* revealed twenty constituents which accounts for 97.89% of the total oil. The oil was characterized as oxygenated monoterpenes (91.51%), which are neral (35.53%) and geranial (45.43%). A previous study from Vietnam shows that ketone (82.3%) was the main component of *Elsholtzia communis* [45] which was found absent in this study.

**Fatty acids**

In some *Elsholtzia* species, fatty acids such as palmic acid, linoleic acid [44,46], ascorbic acid [47] and succinic acid are present [48,49].

**Trace elements of *Elsholtzia communis***

Trace elements found in medicinal plants play an important role in the treatment of diseases. A study done by NK Sharat Singh and his team to analyze the trace elements found in six medicinal plants which were collected from Thoubal district of Manipur. The six medicinal plants are namely *Embllica officinalis*, *Catharanthus roseus*, *Azadirachta indica*, *Solanum anguivi*, *Artemisia nilagirica* and *Elsholtzia communis*. Different parts of the plant were collected as per their uses i.e. fruits of *E. officinalis*, *S. anguivi*, inflorescence of *E. communis* and leaves of *C. roseus*. For the analysis of the trace elements Proton Induced X-ray Emission (PIXE) technique is used for its quick multi-elemental trace analysis capability and high sensitivity. Elements like Potassium, Calcium, Chromium, Manganese, Iron, Nickel, Copper, Zinc, Bromine, Rubidium and Strontium were detected. Different trace elements found in the medicinal plants are having definite role for smooth functioning of the body [50].

Element	<i>Catharanthus roseus</i>	<i>Embllica officinalis</i>	<i>Azadirachta indica</i>	<i>Solanum anguivi</i>	<i>Artemisia nilagirica</i>	<i>Elsholtzia communis</i>
K	6504 ± 0.6	18184.9 ± 0.2	9678.7 ± 0.4	12229.2 ± 0.3	54793.7 ± 1	34535.8 ± 1.3
Ca	29098 ± 0.2	2494.1 ± 1.8	19984.4 ± 0.3	2433.7 ± 1.5	88930 ± 3.6	66014 ± 3.8
Ti	-	-	-	-	72.3 ± 77.9	102 ± 49.8
V	-	-	-	-	12.1 ± 142.1	17.8 ± 94.7
Cr	24.6 ± 16.9	-	-	-	1.3 ± 959.8	32.6 ± 39
Mn	183.7 ± 2.2	111.0 ± 12.6	603 ± 4.4	313 ± 7.8	123 ± 4.5	144 ± 3.8
Fe	424.9 ± 1.2	311.1 ± 1.2	569.5 ± 0.8	321.7 ± 1.2	820.4 ± 1.4	751.3 ± 1.5
Ni	6.8 ± 18.4	7.0 ± 12.8	4.1 ± 24.9	4.1 ± 20.9	5.6 ± 20	7.6 ± 16
Cu	3.7 ± 32.1	5.9 ± 13.6	9.5 ± 105	165 ± 6.8	22.1 ± 12.2	30.1 ± 9.8
Zn	54.6 ± 3.3	23.3 ± 4.5	51.6 ± 2.9	29.7 ± 45	33.7 ± 4.9	62.8 ± 3.5
As	-	-	-	-	0.3 ± 264.8	2.1 ± 36.4
Sc	-	-	-	-	0.3 ± 295.2	0.5 ± 233.6
Br	6.0 ± 23.9	6.7 ± 16.3	9.3 ± 14.7	3.4 ± 26.7	5.7 ± 24.3	8.1 ± 20.3
Rb	15.4 ± 1.6	33.3 ± 7.9	-	295 ± 8.7	1.5 ± 126.6	9.4 ± 22.1
Sr	247.2 ± 3.1	19.1 ± 11.6	124.6 ± 4.0	165 ± 13.8	34.9 ± 12.9	49.9 ± 10.6

**Table 4:** Trace elements (ppm) found in selected medicinal plants including *Elsholtzia communis*.

### Other Compounds found in the genus *Elsholtzia*

Some other kinds of compounds which are found in the genus such as saussurenoside, eicosane, hexatriacontane, 3, 4-dihydroxyl cinnamic acid (i.e. caffeic acid) [51].

### Toxicity of genus *Elsholtzia*

Generally the species of genus *Elsholtzia* is devoid of toxicity; oral administration of the plant material shows that it is practically nontoxic and may be used safely in human at moderate doses [52]. *Elsholtzia splendens* have good biological properties, but there are no significant background information on toxicological evaluation found on this plant extracts to give an assurance of safety for developing dietary supplements and functional foods. Safety evaluation on *Elsholtzia splendens* extracts was done using acute oral toxicity, bacterial reverse mutation and chromosome aberration test. The study implies that *Elsholtzia splendens* extracts do not cause any acute toxicity. Similar safety evaluation is also done with other *Elsholtzia* species [53]. The LD<sub>50</sub> of essential oil from *E. densa* ranged from 1.304 - 1.333 ml/kg by oral administration. No obvious pathological change in animal organs have been observed by microscopic observation. The LD<sub>50</sub> of essential oil from *E. ciliata* was 4.497 ± 0.368 ml/kg and the LD<sub>50</sub> of *E. splendens* was 1.145 ± 0.100 ml/kg [54]. We have found that *Elsholtzia communis* hydroalcoholic extract, at a dose of 2000 mg/kg on oral administration did not show any signs of toxicity or mortality [17].

In another study, effects of excessive Copper (Cu) on the seed germination and growth and tolerance mechanism of three plant species of the genus *Elsholtzia* namely *Elsholtzia haichowenchis*, *Elsholtzia aypriani* and *Elsholtzia ciliate* were conducted by solution culture experiments. The results showed that *E. haichowenchis*, had higher tolerance to excessive Copper than *E. aypriani* and *E. ciliate* and that the adaptive Cu tolerance mechanism in *E. haichowensis* might involve the active participation of proteins [55].

### *Elsholtzia communis* in NCBI database

In NCBI, (<https://www.ncbi.nlm.nih.gov>) database, one can search for genes, their locations, proteins, nucleotide sequence, complete sequence, coding sequences, characteristics of some submitted genes, proteins associated with *Elsholtzia communis*. The database shows genes like Ycf1, Ycf1-rps15 intergenic spacer, ribosomal protein S15 of this plant from which one can gather information and can know the mechanism of this plant with drugs, disease in human.

One can also go directly through the database with the available options in it and also using suitable query sets for *Elsholtzia communis* and can get the reliable information related to this plant.

### Conclusion

Traditional medicinal plants or healers are found in most societies. *Elsholtzia communis* is one such important medicinal plant exerting influence on local health practices. Advantage of traditional medicine is that the plants are found within a particular area, familiar with the patient's culture and cost associated with the treatment is also less. *Elsholtzia communis* which reveals up-to-date pharmacological activity on antiviral, antibacterial, adaptogenic, nutritional, antioxidant, anti-inflammation are provided in this review. Moreover, the chemical compounds, essential oils, various essential elements in this plant play a potent role in our daily life that is the reason why skipping therapeutic drugs one opts for medicinal plant supplements, without the apprehension of side-effects. In depth pharmacological studies and detailed isolation studies of *Elsholtzia communis* is needed for the chemical compounds present this plant to explore their true-potential since it is difficult to judge the high effectiveness of folk medicine. Isolation of new active principles from this plant would be of great scientific value. The population of this plant is decreasing day by day up to the extent that people are unable to recognize this plant easily [55]. So, an innovative method for popularizing the plant is needed. However recently, knowing its medicinal values, due to its essential oil, cultivation of this plant in vast scale is started. Therefore, plethora of further studies are necessary in order to illustrate the chemo-diversity and to make full use of the biological significance of the compounds and extracts of *Elsholtzia*, especially the antiviral and anti-inflammatory activities. The authors desire the review can provide a helpful data for explorations and advanced researches of *Elsholtzia communis*.

### Conflict of Interest

The authors report no conflicts of interest.

### Bibliography

1. Harley RM., *et al.* "The families and Genera of Vascular Plants". 7<sup>th</sup> edition. Springer-Verlag publication, Berlin, (2004): 167-275.
2. Wu ZY and Raven PH. "Flora of China (Verbenacea through Solanaceae)". Publisher: Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, MO (1994).
3. Wu ZY., *et al.* "Flora of China, State Chinese Medicine Administration Bureau". Publisher: Shangai Scientific and Technical Publishers (1999): 268.
4. Shi ZZ., *et al.* "Central inhibition effect comparison of *Zizyphus jujube* root and Semen". *Journal of Traditional Chinese Medicine Research* 7.4 (1996): 25-26.
5. Singh T., *et al.* "Plants used in the treatment of piles by the scheduled caste community of andro village in Imphal east district, Manipur (India)". *Journal of Plant Sciences* 2.3 (2014): 113-119.
6. Zheng W and Wang SY. "Antioxidant acidity and phenolic compound in selected herbs". *Journal of Agricultural and Food Chemistry* 49.11 (2001): 5165-5170.
7. Rajurkar NS and Damame MM. "Mineral content of medicinal plants used in treatment of diseases resulting from urinary tract disorders". *Applied Radiation and Isotopes* 49.7 (1998): 773-776.
8. Liu A., *et al.* "*Elsholtzia*: review of traditional uses, chemistry and pharmacology". *Journal of Chinese Pharmaceutical Sciences* 16 (2007): 73-78.
9. Negi PS and Ray SK. "Effect of blanching and drying methods on  $\beta$  -carotene, ascorbic acid and chlorophyll retention of leafy vegetables". *Lebensmittel-Wissenschaft and-Technologie- Food Science and Technology* 33.4 (2004): 295-298.
10. Bongcheewin B., *et al.* "*Elsholtzia* (Lamiaceae) in Thailand". *Blumea* 59 (2015): 209-214.
11. Das A., *et al.* "A comparative study in rodents of standardized extracts of *Bacopa monniera* and *Ginkgo biloba*". *Pharmacology Biochemistry Behavior* 73.4 (2002): 893-900.
12. Khomdaram SD., *et al.* "Estimation of nutritive indices in eight Lamiaceae plants of Manipur". *American Journal of Food Technology* 6.10 (2011): 924-931.
13. Salam S and Jamir NS. "Common Spices Plant Used as Medicine by the Tangkhul Tribe of Ukhrul District, Manipur, India". *International Journal of Scientific and Research Publications* 6.7 (2016): 22-25.
14. Zhao Y., *et al.* "Research progress on essential oils of *Elsholtzia* in Yunnan Province". *Chinese Traditional Patent Medicine* 11 (1990): 33.
15. Barua CC., *et al.* "Role of *Elsholtzia communis* in counteracting stress by modulating expression of *hspa14*, C/EBP homologous protein, nuclear factor (erythroid-derived 2)-like-2 factor, Caspase-3, and brain-derived neurotrophic factor in rat hippocampus". *Indian Journal of Pharmacology* 49.2 (2017): 182-188.
16. Ishwori L., *et al.* "Antibacterial activity of some selected plants traditionally used as medicine in Manipur". *African Journal of Biotechnology* 13.13 (2014): 1491-1495.

17. Barua CC., et al. "Nutritional evaluation of few selected medicinal plants of north eastern region". *International Journal of Pharma and Biosciences* 6.3 (2015): 538-546.
18. Barua CC., et al. "Attenuating Effect of *Elsholtzia communis* (Collett & Hemsl.) Diels. on Dysregulated HPA Axis in Stressful Conditions". *International Journal of Pharmacognosy and Phytochemical Research* 8.4 (2016): 651-658.
19. Cowmann MM. "Plants products as antimicrobial agents". *Clinical Microbiological Reviews* 12.4 (1999): 564-582.
20. Cabrera C., et al. "Mineral content in legumes and nuts: contribution to the Spanish dietary intake". *Science of the Total Environment* 308.1-3 (2003): 1-14.
21. Jaleel CA., et al. "Low concentration of Cobalt increases growth, biochemical constituents, mineral salts and yield in *Zea Mays*". *Journal of Scientific Research* 1.1 (2009) 128-137.
22. Al-Naqueep GN., et al. "Nutritional composition and minerals content of three different samples of *Nigella sativa* L. cultivation in Yemen". *Asian Journal of Biological Sciences* 2.2 (2009): 43-48.
23. Saupi N., et al. "Analytic chemical composition and mineral content of yellow Velvet leaf (*Limnocharis flava* L. Buchenau)'s Edible parts". *Journal of Applied Sciences* 9.16 (2009) 2969-2974.
24. Ihedioha JN and Okoye COB. "Nutritional Evaluation of *Mucuna flagellipes* Leaves: An underutilized Legume in Eastern Nigeria". *American Journal of Plant Nutrition and Fertilization Technology* 1.1 (2011): 55-63.
25. Seal T. "Determination of nutritive values, mineral contents and antioxidant activity of some wild edible plants from Meghalaya State India". *Asian Journal of Applied Sciences* 4.3 (2011): 238-246.
26. Xue L., et al. "Multiple protein functions of Paired in *Drosophila* development and their conservation in the Gooseberry and Pax3 homologs". *Development* 128.3 (2001): 395-405.
27. Thekkevlayil GT., et al. "Mosquito larvicidal properties of essential oil of indigenous plant *Ipoemoea cairica* Linn". *Japanese Journal of Infectious Disease* 57.4 (2004): 176-177.
28. Sengottayan SN., et al. "Efficacy of *Melia azedarach* L. extract on the malarial vector *Anopheles stephensi* Liston (Diptera: Culicidae)". *Bioresource Technology* 97.11 (2006) 1316-1323.
29. Khomdaram SD., et al. "Polyphenolic compounds and free radical scavenging activity in eight Lamiaceae herbs of Manipur". *Notulae Scientia Biologicae* 3.2 (2011) :108-113.
30. Bidyalakshmi L., et al. "Antioxidant activity of some important indigenous plant foods of the North-eastern Region of India". *International Journal of Nutrition and Food Engineering* 11.2 (2017): 45-78.
31. Guo Z., et al. "*Elsholtzia*: phytochemistry and biological activities". *Chemistry Central Journal* 6 (2012): 147.
32. Ding C., et al. "Study on chemical constituent of essential oil from Tibetan medicine *Elsholtzia ianthina*". *Acta Botanica Sinica* 24.10 (2004): 1929-1931.
33. He FJ., et al. "Study on chemical constituents of essential oil of *Elsholtzia patrini*". *Chinese Journal of Pharmaceutical Analysis* 15.5 (1995): 20-22.
34. Le TB. "In vitro Anti-Leishmanial activity of essential oils extracted from Vietnamese Plants". *Molecules* 22.7 (2017): 1071-1084.
35. Zhu GP., et al. "Study on chemical constituents of essential oil from *Elsholtzia splendens*". *Acta Beijing Academy of Chinese Medicine* 15 (1992): 57-59.

36. Zhu GP and Zhou WS. "Study on chemical constituent of essential oil from *Elsholtzia rugulosa* Hems". *Chinese Medicine Abstract* 11 (1989): 33-35.
37. Zhang GB and Wang MK. "Isolation and identification of the main constituents of essential oil of *Elsholtzia calycocarpa* piels". *Journal of Ningxia Medical College* 17 (1995): 24-26.
38. Huang BD., et al. "Study on oil constituents of *Elsholtzia regulosa* by means of supercritical fluid CO<sub>2</sub> extract". *Acta Lanzhou Medica Coll* 30 (2004): 34-37.
39. Shi XF, et al. "Study on chemical constituents of essential oil from *Elsholtzia ciliate* (Thunb.) Hyland [J]". *Gansu Medical* 13 (1994): 152-153.
40. Du HQ, et al. "Study on chemical constituents of essential oil from *Elsholtzia staunionii*". *Journal of Medical Analysis* 9 (1989): 18-21.
41. Phetsang S, et al. "Chemical diversity and anti-acne inducing bacterial potentials of essential oils from selected *Elsholtzia* species". *Natural Product Research* 26 (2017): 1-4.
42. Ding CX, et al. "Study on chemical constituent from Tibetan medicine *Elsholtzia ianthina*". *Acta Botanica Boreali-Occidentalia Sinica* 24 (2004): 1093-1095.
43. Zhao Y, et al. "Study on chemical constituents of *Elsholtzia rugulosa*". *Chinese Journal of Material Medicine* 29 (2004): 1144-1146.
44. Dung NX, et al. "Contribution of HRC to the study of natural plants, chemotaxonomy, and biodiversity conservation". *Journal of High Resolution Chromatography Banner* 18.9 (1995): 603-606.
45. Sun LP, et al. "Study on chemical constituents from *Elsholtzia densa*". *Acta Botanica Sinica* 38.8 (1996): 672-674.
46. Zheng SZ, et al. "Study on chemical constituents from *Elsholtzia ciliate*". *Acta Botanica Sinica* 32 (1990): 215-217.
47. Mei WQ, et al. "Constituent analysis of lipid acids from the seeds of *Elsholtzia ciliate*". *China Lipid* 29 (2004): 68-70.
48. Sun LP, et al. "Study on chemical constituents from *Elsholtzia densa*". *Acta Botanica Sinica* 38.8 (1996): 672-674.
49. Singh NKS, et al. "Trace elements of some selected medicinal plants of Manipur". *Indian Journal of Natural Products and Resources* 1.2 (2010): 227-231.
50. Zheng SZ, et al. "Study on chemical constituent from *Elsholtzia eriostachya*". *Acta Botanica Sinica* 34.9 (1992): 705-711.
51. Zhong LI, et al. "Study on the Flavonoids from *Elsholtzia communis* (Coll.et Hemsl.) Diels". *Medicinal Plant* 4.1 (2013): 67-68.
52. Kim DW, et al. "Anti-inflammatory activity of *Elsholtzia splendens*". *Archives of Pharmacal Research* 26.3 (2003): 232-236.
53. Shim SM, et al. "Safety evaluation of *Elsholtzia splendens* extracts: Assessment of acute toxicity and mutagenicity". *Food and Chemical Toxicology* 46.3 (2008): 1042-1047.
54. Gong MX, et al. "Research progress of *Elsholtzia splendens* on pharmacology". *Journal of Beijing Medicine* 6 (1997): 46-48.
55. Xia Y, et al. "Comparative studies of Copper tolerance and uptake by three plant species of the genus *Elsholtzia*". *Bulletin of Environmental Contamination and Toxicology* 79.1 (2007): 53-57.

**Volume 6 Issue 9 September 2018**

**©All rights reserved by Chandana Choudhury Barua, et al.**