Phytochemical Aspects of Medicinal Plants of Northeast India to Improve the Gynaecological Disorders: An Update

15

Suparna Lodh and Mallappa Kumara Swamy

Contents

15.1 Introduction 354
15.2 Pharmacological Properties of Few Medicinal Plants Found in NE to Cure Gynaecological Disorder 357
15.2.1 Asparagus racemosus (Wild.) 358
15.2.2 Cyperus rotundus L. 361
15.2.3 Viscum articulatum Burm. f. 362
15.2.4 *Stereospermum suaveolens* 363
15.2.5 *Rubus moluccanus* L. 363
15.2.6 *Nothapodytes nimmoniana* 364
15.3 Conclusion and Future Aspects 365
References 366

Abstract

Northeast (NE) India is the richest source of medicinal plants with high therapeutic values. Herbal medicines have been used to cure women's health from ancient time by different tribal communities in NE. The medicinal herbs are the excellent sources of various bio-active compounds like steroids, flavonoids, polyphenol, tannin, saponins, glycosides, terpenoids and anthraquinones, which exerts their beneficial effect against various gynaecological disorders like poly-

Suparna Lodh and Mallappa Kumara Swamy have equally contributed for this chapter.

S. Lodh (✉)
Asian Institute of Nursing Education, Guwahati, Assam, India
e-mail: suparnatumpa@gmail.com

M. K. Swamy
Department of Biotechnology, East West First Grade College of Science, Bengaluru, Karnataka, India
e-mail: swamy.bio@gmail.com

M. K. Swamy, M. S. Akhtar (eds.), *Natural Bio-active Compounds*,
https://doi.org/10.1007/978-981-13-7205-6_15

cystic ovarian syndrome, infertility, pubertal changes, postmenopausal syndrome, menopause and low breast milk production. Some medicinal plants of NE region (NER) used to cure gynaecological disorders include Shalparni (*Desmodium gangeticum*), Patala (*Stereospermum suaveolens*), Shatavari (*Asparagus racemosus*), sweet flag (*Acorus calamus*), tamarind (*Tamarindus indica*), wild raspberry (*Rubus moluccanus*), etc. Among various reproductive problems, infertility is one of the major issues in female. Sweet flag, Indian gooseberry and Shatavari are the most commonly used herbs for infertility as they are extremely useful in maintaining the hormonal balance of follicle-stimulating hormone (FSH) and the luteinizing hormone (LH) in females. The Assam forest was recently rediscovered with *Nothapodytes nimmoniana*, an important anticancer plant species, popularly known as Gandheli in Assam. The plant contains a potent alkaloid, camptothecin known for treating ovarian cancer. Herbal medicines are attracting the attention, because they are effective, affordable and possess little or no side effects and nontoxic. The present chapter highlights on the major medicinal plants, their phytocompounds and their role in the medication of various gynaecological disorders.

Keywords
Anthraquinones · Camptothecin · Flavonoids · Gynaecology · Shatavari

15.1 Introduction

Medicinal herbs have been used as a traditional medicine for treating various human diseases in India, since ancient times. The potentiality of medicinal values of plants is due to the presence of numerous phytochemicals. Several such bio-active compounds have been identified and revealed by various investigations. The tribal communities from various parts of India have a great knowledge about medicinal herbs, and their use. They have used them to prepare traditional medicines to cure many gynaecological disorders (Deka and Kalita 2013). The traditional medicine, as an alternative treatment often involves the use of plants, includes herbal medicine, bone setting, spiritual therapies, circumcision, maternity care, psychiatric care, massage therapy, aromatherapy, etc. (Borokini and Lawal 2014). According to the World Health Organization (WHO), almost 80% of the world population depends on the traditional medicines (Bhishma and Pawan 2018). Among various parts of India, Northeast region (NER) is one of the richest sources of medicinal plants, where people largely use the traditional medicine practices. Northeast (NE) India has a great biodiversity of medicinal plants, and it comprises the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. NE India comprises about 8% of the total part of India. The total area of NE is about 262,180 km^2 with the population of about 40 million. NE India is one of the most biodiversity-rich regions of the world because of the vast diversity in soil, climate and ecological conditions. NER has a climatic condition between the tropical to alpine zone. The annual rainfall in NE India is about 2000 mm. NE India comprises

of both hilly as well as plain area of Assam. The state, Meghalaya is occupied by Garo, Jaintia and Khasi hills, and the states of Sikkim and Arunachal Pradesh fall under the Himalayan hills. The states of Manipur and Nagaland cover the Naga hill, while the state of Mizoram comes under the Lushai hill. This region comprises many economically valued plants with a great potential to cure many diseases. The biodiversity of NE India makes it a biological hotspot with many rare and endemic plant species (Rama and Rawat 2013; Aniruddha et al. 2015).

Previous studies have indicated that medicinal plant extracts are good sources of various bio-active compounds like steroids, flavonoids, polyphenol, tannin, saponins, glycosides, terpenoids and anthraquinones. Structures of some bio-active compounds are depicted in Fig. 15.1. These compounds are active against various gynaecological disorders like polycystic ovarian syndrome (PCOS), infertility, pubertal changes, postmenopausal syndrome, menopause, low breast milk

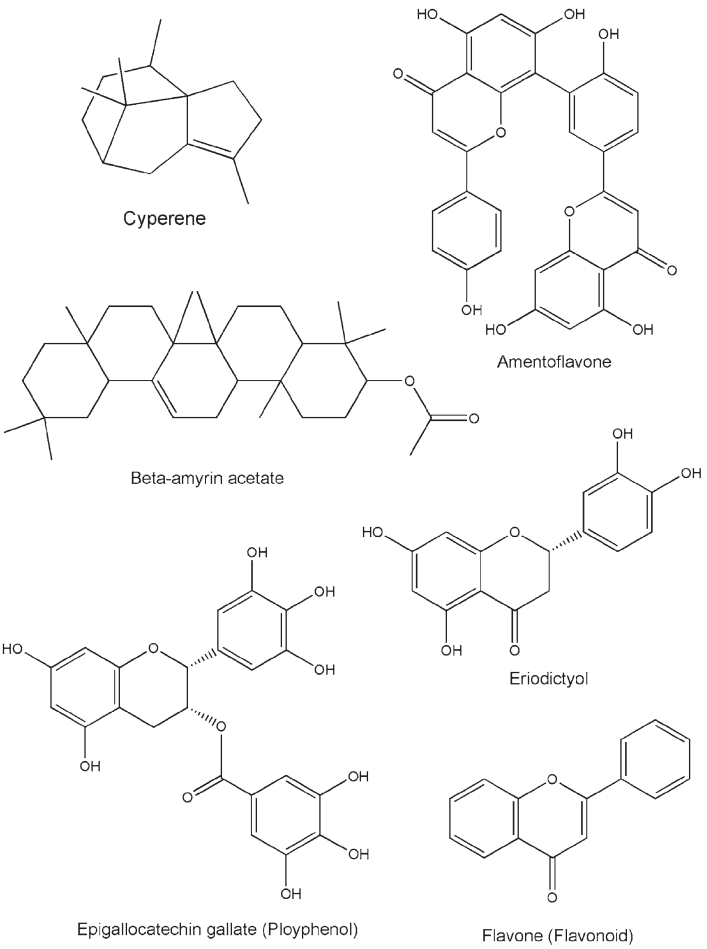

Fig. 15.1 Chemical structure of some bio-active compounds used for treating gynaecological problems

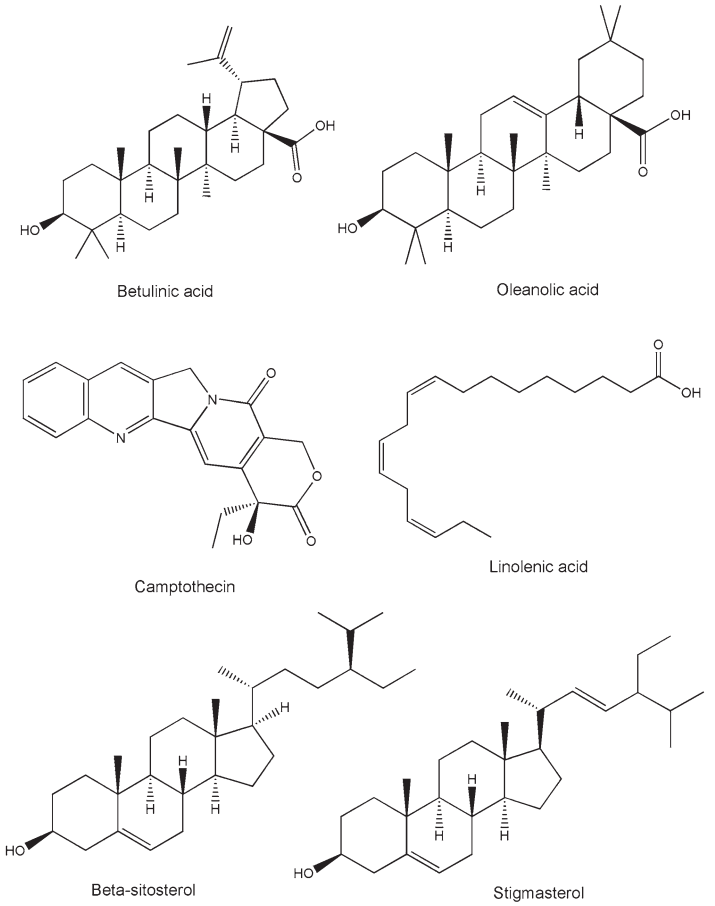

Fig. 15.1 (continued)

production, leucorrhoea, uterine fibroid, etc. (Komal and Maheep 2011; Deka and Kalita 2013; Thorwe and Choudhari 2014; Raja 2015; Ying and Bing 2016). Some important medicinal plants that are used to treat gynaecological disorders, found in NER, include Shalparni (*Desmodium gangeticum*), Patala (*Stereospermum suaveolens*), Shatavari (*Asparagus racemosus*), sweet flag (*Acorus calamus)*, tamarind (*Tamarindus indica*), wild raspberry (*Rubus moluccanus*), etc. (Deka and Kalita 2013; Tarun et al. 2014; Devanjal et al. 2016).

Women play a significant role in our society, and our modern society has started recognising the individual identity of women (Kiran 2015). Nowadays, women at all ages have been suffering from a variety of gynaecological disorders due to stress, poor healthcare, malnutrition, etc. It is very important for our society to prevent these health-related problems of female. Medicinal plants play an important role in taking care of such problems. Among various gynaecological problems, female infertility is

one of them, which is increasing gradually, and became a very common issue (Raja 2015). The infertility affects approximately 1 out of every 6 couples. The infertility can be related to both the sexes. However, the female infertility contributes to approximately 50% of all infertility cases, and about 40% cases are male related. The infertility may be caused by different factors, but when there is no cause found for infertility, it is termed as unexplained infertility. It has been reported that about 25% couple is diagnosed with an unexplained infertility. Various causes of female infertility are correlated to the hormonal imbalance, damage of the fallopian tubes, interference with the ovulation, endometriosis, premature ovarian failure, uterine fibroids, smoking alcohol or drug uses, excess weight, etc. The herbal medicines can be used to address this female infertility (Kashani and Akhondzadeh 2017).

Herbal medicines for the infertility treatment are having a great demand as they are very effective with little or no side effects and affordable. Medicinal plants are used in most cases of female health issues as infusion, decoction, or tincture from various parts of plants, such as stem, roots, leafs, flowers, fruits or trunks. For example, Shalparni, Patala, Shatavari, sweet flag, etc. are the most commonly used herbs found in NE for the infertility treatment (Deka and Kalita 2013). Apart from the infertility, herbal remedies are also used for various other female health-related issues like urinary tract infection, pubertal changes, postmenopausal syndrome, hot flushes, menopause, polycystic ovarian syndrome, bacterial vaginosis, yeast infections, low breast milk production, abortion, etc. (Raja 2015).

Another life-threatening disease in female is the ovarian cancer. Recently, the Assam forest was rediscovered with a rare plant species, namely, *Nothapodytes nimmoniana*, which contain a potent bio-active anticancer compound, called camptothecin, and it is the world's third most important bio-active compound to treat ovarian cancer. Likewise, there are many such endangered and rare plant species found in this region of India, which are yet to be identified and explored for human uses. Thus, conservation of such important medicinal plants is very necessary and highly important for future days (Kukil 2018).

Women play various roles in their life cycle and are very important for our society. Nowadays women at all ages facing a lot of problems related to gynaecology and medicinal plants play a significant role taking care of such problems. There are many factors such as stress, emotional, physical, etc. which can affect women's health. Women should be given more value in our society for their ability to bear children. Considering the above fact that NE of India has a huge biodiversity of medicinal plants, the present chapter highlights on the major medicinal plants, their phytocompounds and their role in the medication of various gynaecological disorders.

15.2 Pharmacological Properties of Few Medicinal Plants Found in NE to Cure Gynaecological Disorder

There are many medicinal plants grown in all eight states of NE India, which have an outstanding potentiality to cure gynaecological disorders. The state, Assam, offers a great scope for ethnobotanical studies, since this region is inhabited by

many aboriginal tribes. The knowledge on the traditional medicine has been transmitted orally from generation to generation. Medicinal plants are used by various tribal communities of NER, namely, Nagas (Nagaland), Meitei (Manipur), Nishi (Arunachal Pradesh), Monpas and Apatani tribe (Arunachal Pradesh), Miris (Assam) and Mizo (Mizoram). It is reported that in India, the traditional healers use more than 2500 different plant species, and nearly 100 species of plants are being used as regular sources of medicine (Tarunet al. 2014).

There are 50 medicinal plant species belonging to 33 families as reported in Kamrup, the distinct of Assam. It has been found that these plant species are used by a local people of Kamrup distinct for infertility treatment (Deka and Kalita 2013). Many studies have been performed to understand the medicinal properties of the crude plant extract or secondary metabolites isolated from them on the regulation of reproductive functions. Studies have suggested that some secondary metabolites or plant extracts possess antioxidant properties and have the ability to scavenge reactive oxygen species (ROS), and they can regulate ovarian hormonal production in female. Due to these properties, plant secondary metabolites or plant extracts are used in the drug preparation to treat many women infertility disorders. In general, various parts of plants, such as root, bark, stem, leaf and flower, can be used in the medicinal preparations, and plant extract can act directly on the ovarian cell to stimulate folliculogenesis and steroidogenesis (Gildas et al. 2017). Some of the important medicinal plants found in NER of India that are used in treating gynaecological disorders are summarised in Table 15.1, and in the following sections, phytochemical and pharmacological aspects of few important plants of NE India are discussed.

15.2.1 *Asparagus racemosus* (Wild.)

Asparagus racemosus is traditionally known as Shatavari, means "who possesses a hundred husbands or acceptable to many". This plant belongs to the family, Asparagaceae. In the Ayurveda system of medicine, it is considered as a rejuvenating herb, which is beneficial for the female infertility. It is a woody climber and grows up to a height of 1–2 m. The leaves are of pine needle shape (Komal and Maheep 2011). This plant is found throughout Asia, Australia and Africa. Around 22 species of *Asparagus* were reported in India. However, *A. racemosus* is very common in India and widely used for medicinal purposes (Noorul et al. 2016). Also, Deka and Kalita (2013) reported that *A. racemosus* is one of the important medicinal plants of Kamrup district, and the roots of this plant are used by various tribal people in this region for the infertility treatment in females.

15.2.1.1 Phytochemical Aspects

Phytochemical analysis of methanolic extract of Shatavari roots contains phytosterols, triterpenoids, saponins, alkaloids, glycosides, phenolic compounds, flavonoids, lactones, tannins, carbohydrates, proteins, etc. (Nagamani et al. 2012; Jayashree

Table 15.1 Some important medicinal plants of Northeast India region used for treating gynaecological problems

Botanical name	Common name	Local name	Family	Parts used	Medicinal uses	References
Bombax ceiba	Cotton	Semalo	Bombacaceae	Bark or root	Gynecological disorder	Deka and Kalita (2013)
Stereospermum suaveolens	Patala	Patla	Bignoniaceae	Leaves	Increase fertility	
Cyperus rotundus	Nut grass	Keya bon	Cyperaceae	Whole plant	Estrogenic	
Asparagus racemosus	Shatavari	Satamul	Asparagaceae	Root	Facilitate delivery	
Amaranthus spinosus	Spiny amaranth	Kuturahak	Amaranthaceae	Tender aerial parts, root	Increase fertility	
Clitoria ternatea	Asian pigeon wings	Aparajia	Fabaceae	Leaf, root, seed	Enhancing fertility	
Amaranthus tricolor	*Tampala*	Morishahak	Amaranthaceae	Whole plant	Induce fertility	
Colocasia esculenta	Taro	Kola Kochu	Araceae	Whole plant	Induce fertility	
Rubus moluccanus	Wild raspberry	Jutulipoka	Rosaceae	Fruit and young shoot	Increase fertility in female	Tarun et al. (2014)
Scoparia dulcis	Sweet broom	Seni bon	Scrophulariaceae	Whole plant	Irregular menstruation	Devanjal et al. (2016)
Oxalis corniculata	Sleeping beauty	Tengesi	Oxalidaceae	Leaf	Burning menstruation	
Piper nigrum	Black pepper	Jaluk	Piperaceae	Fruit	Menorrhagia	
Euphorbia hirta	Asthma plant	Era	Euphorbiaceae	Young branch	Lactation	
Hibiscus rosa-sinensis	China rose	Joba	Malvaceae	Flower	Irregular menstruation	
Adenanthera pavonina	Sandal wood	Chandan	Mimosaceae	Stem bark	Leucorrhoea	
Colocasia antiquorum	Wild taro	Dudh kosu	Araceae	Tuber	Induce lactation	
Ocimum sanctum	Tulasi	Toloshi	Lamiaceae	Leaf	Menstruation pain	
Ricinus communis	Castor oil plant	Era	Euphorbiaceae	Young leaf	Painful menstruation	
Nothapodytes nimmoniana	Ghanera	Gandheli	Icacinaceae	Whole plant	Ovarian cancer treatments	Kukil (2018)

et al. 2013). The root of this plant is very useful in the treatment of female infertility problems, and it contains four steroidal saponins, known as Shatavarins I to IV. Among them, Shatvarin I is the major glycoside with 3-glucose and rhamnose moieties attached to sarsasapogenin. In Shatavarin IV, two glucose and one rhamnose moieties are attached. Recently, Shatavarin V was also reported in *A. racemosus* (Mishra et al. 2010; Noorul et al. 2016). It is also reported that *A. racemosus* contain some other chemical compounds, such as asparginins, curillins, asparosides, curillosides, oligospirostanoside (a immunoside), asparagine A (a polycyclic alkaloid), 8-methoxy- 5, 6, 4-trihydroxy isoflavone-7-0-beta-D-glucopyranoside (isoflavones), racemosol (a cyclic hydrocarbon), racemofuran (a furan compound), polysaccharides and mucilage (carbohydrates) (Shashi et al. 2013; Noorul et al. 2016). The root also contains sterols like sitosterol, benzaldehyde and undecanylcetanoate. In addition, some trace minerals like zinc, manganese, copper, cobalt, calcium, magnesium, potassium zinc and selenium are detected in roots. (Noorul et al. 2016).

The flower and fruits of *A. racemosus* contain flavonoid compounds like glycosides of quercetin, rutin and hyperoside. It also contains essential fatty acids like gamma linolenic acids, vitamin A, diosgenin and quercetin 3-glucuronides. Also, it is mentioned that alcoholic extract of *A. racemosus* is very effective in increasing the milk production in lactating mother, and also it increases the growth of mammary glands (Shashi et al. 2013; Noorul et al. 2016). However, the phytochemicals present in the extract is yet to be disclosed, and more studies are warranted in future.

15.2.1.2 Pharmacological Aspect

Literature survey revealed that the roots of the plant are considered to be effective for dysentery, in diabetic retinopathy, inflammations, tumour, bronchitis, nervous disorder, hyperacidity, neuropathy, conjunctivitis, spasm, chronic fevers and rheumatism. It is highly beneficial for the treatment of the female infertility. It increases libido and cures inflammation of the sexual organs. It enhances the folliculogenesis and ovulation by changing the hormonal balance. It also prepares the womb for the conception, prevents miscarriages and acts as postpartum tonic by increasing the lactation. It was reported that this plant is also effective in controlling the symptoms of acquired immune deficiency syndrome (AIDS). It is also effective for night blindness, kidney problems and throat complaints (Shashi et al. 2013; Noorulet al. 2016). They also mentioned that alcoholic extract of *A. racemosus* is very effective in increasing the milk production in lactating mother and also increased the growth of mammary glands.

As root extract of Shatavari is very reputed in the Ayurveda, literature survey suggested that in young females, the root extract of Shatavari increases the weight of ovaries and enhances the folliculogenesis by increasing FSH. It is also reported that due to the enhancement of folliculogenesis and ovulation in females, it prepares the womb for the conception and prevents miscarriages. The literature review further revealed that the chemical constituents of Shatavari mimic with the female hormone oestrogens, called phytoestrogens, and it can be very potent in reducing the adverse menopausal symptoms in females. Though, these phytoestrogens are

weaker than the natural oestrogen, they compete with the oestrogen for oestrogen receptors. Researchers have found that a preparation based on the roots of Shatavari acts as an antiabortifacient due to the presence of Shatavarin I, which blocks the oxytocin-induced contractions as observed in rat model (Komal and Maheep 2011).

15.2.2 *Cyperus rotundus* L.

Cyperus rotundus is considered as one of the world's weed and has been used in medicine for thousands of years. It is widespread in the NE region and grows naturally in tropical, subtropical and temperate regions. It is a monocotyledonous, perennial plant, belonging to the family, Cyperaceae (Bhaskar et al. 2015). Deka and Kalita (2013) reported *C. rotundus* as one of the important medicinal plants found in Kamrup district and used in the treatment of female infertility.

15.2.2.1 Phytochemical Aspects

Phytochemical studies have revealed that the extract of *C. rotundus* rhizomes mainly contains essential oil and terpenoids, flavonoids, sesquiterpenes, monoterpenes, β-sitosterol, stigmasterol, sitosterol glucoside, stigmasterol glucosides, alpha-rotunol, β-cyperone, cyperolon selinene, cyperotundone, camphene, cyperene, cyperol, β-selinene, cyperenon, D-copadiene, linolenic acid, linoleic acid, oleic acid, rotundene, rotundenol, rotundone, polyphenols, pectin, stearic acid, camphene, sugeonol and sugetrio (Fig. 15.1). It also contains proteins and traces of Mg, As, Cr, Mn and Co (Bhaskar et al. 2015; Muneesh et al. 2017). Ying and Bing (2016) reported that the dried rhizome of *C. rotundus*, known as Xiang Fu, is pungent, slightly bitter and sweet and bland. It is highly beneficial as therapeutic agent. They isolated four types of biflavone from *C. rotundus*, namely, amentoflavone, ginkgetin, isoginkgetin and sciadopitysin. It has been proved that the compound, amentoflavone possess anti-uterine fibroid activity, and hence, this plant has an enormous potential to be used for therapeutic purposes.

15.2.2.2 Pharmacological Aspects

Bhaskar et al. (2015) reported that *C. rotundus* has anti-inflammatory, anticonvulsant, antioxidant, antidiarrheal, antiulcer, anti-hyperlipidemic, cardioprotective, antidiabetic, anti-allergic and hepatoprotective properties. Ying and Bing (2016) studied the antitumor mechanism action of amentoflavone of *C. rotundus* by preparing a rat model of uterine fibroids tumour. Uterine fibroids cause changes in partial or total body oestrogen and progesterone and their receptors. They observed that after administration of amentoflavone in a rat model of uterine fibroid, serum oestrogen and progesterone levels decreased, and other pathomorphological changes were also observed such as uterine smooth muscle hyperplasia is improved. This proved the anti-uterine fibroids effect of amentoflavone. Chemical structure of amentoflavone is depicted in Fig. 15.1.

15.2.3 *Viscum articulatum* Burm. f.

It is a leafless hanging perennial shrub belongs to family Santalaceae. *V. Articulatum* was reported for the first time in Arunachal Pradesh for its ethnopharmacological uses and in the procedure of ethnomedicine preparation (Chakraborty et al. 2017). The common name of this plant is leafless mistletoe. Only in the internode the leaves are visible as small bracts below the flowers. Flowers are very minute and stalkless and 3-flowered spikes. *Viscum articulatum* is a semiparasitic shrub which grows up to 20–90 cm tall. The leaves are rudimentary, 0.5–0.7 mm long, scale-like (Bhishma and Pawan 2018).

15.2.3.1 Phytochemical Aspects

The modern researchers have extensively explored *V. Articulatum* for its phytochemical constituents. The literature has revealed that this plant contains various bio-active compounds and thus encourages its uses in pharmacological preparations. It is reported that the methanolic extract of *V. articulatum* aerial parts contains proteins, carbohydrates, flavonoids, glycosides, phenolic compounds, steroids, tannins and triterpenes. It is also reported that the methanolic extract of the whole plant contains sodium, potassium, phenolic compound, oleanolic acid, flavanones, betulinic acid and proanthocyanidin. Among the various compounds, the major bioactive compounds include oleanolic acid, betulinic acid, eriodictyol, naringenin, β-amyrin acetate, visartisides, etc. (Bhishma and Pawan2018). According to Babongile et al. (2014), oleanolic acid is a nontoxic plant secondary metabolites, which has anti-infertility properties. Structures of some bio-active compounds are depicted in Fig. 15.1.

15.2.3.2 Pharmacological Aspects

The various parts of *V. articulatum* such as leaves, root, stem and bark have medicinal values and have been traditionally used in different parts of the world for treatment of various health-related issues. Modern research demonstrated that this plant is very effective against hypertension, ulcer, epilepsy, inflammation, wound, nephrotoxicity, the human immunodeficiency virus (HIV), cancer, etc. It has been reported that this plant has a potent antioxidant activity due to the presence of polyphenols, such as flavonoids and phenols. Researchers have stated that this plant has a good antiulcer activity, and the key compound responsible for this activity is reported to be naringenin. The other properties found in this plant include antihypertensive, antiepileptic, nephroprotective, immunomodulatory, anti-inflammatory and anticancer activities. This plant also showed an anti-HIV activity. Previously, various compounds were identified in this plant. Among them, the compound, homoeriodictyol-7- O-b-D-glucopyranoside-40 -O-b-D-apiofuranoside has shown to possess anti-HIV activity (Bhishma and Pawan 2018).

V. articulatum is also used in the traditional medicine for the treatment infertility by the Monpa tribes of Arunachal Pradesh. Based on the traditional knowledge, Monpa people prepare a paste by crushing the fresh roots, leaves and stems of *V. Articulatum*, and small round pills are prepared from this paste followed by

drying them under the natural sunlight. These pills are being used by women for the treatment of infertility problems (Chakraborty et al. 2017).

15.2.4 *Stereospermum suaveolens*

Stereospermum suaveolens is a large deciduous dicotyledonous tree with greyish or dark brown bark. It belongs to the family, Bignoniaceae and commonly called by the name, Patala. It is a medicinal tree species native to India, Bangladesh and Myanmar (Meena et al. 2010). It is also found growing in Kamrup district of Assam. It is reported that the leaves of this plant possess very useful properties, including the increase of fertility in women (Deka and Kalita 2013).

15.2.4.1 Phytochemical Aspect

In a research study, the roots and bark of *S. suaveolens* was shown to contain β-sitosterol, *n*-triacontanol, while the root heart wood contains lapachol, dehydro-α-lapachone and dehydrotectol. The leaves were observed to contain flavones, glycoside 6-*O*-glucosylscutellarein, dinatin, dinatin-7-glucuroniside, dinatin 7-glucuronide, quinones, stereochenols A and B, naphthoquinones, sterekunthal B and sterequinone C, stereolensin, *p*-coumaric acid, palmitic, stearic and oleic acids (Wahab et al. 2015). Cycloolivil, a lignan derivative, was isolated for the first time from the root extract of *S. suaveolens* by Wahab et al. (2015).

15.2.4.2 Pharmacological Aspects

S. suaveolens is one of the ingredients in the ayurvedic formulation, called as Dashamularishta (ten roots). Previous studies have evidenced that this plant possess antimicrobial, antiprotozoal, anti-inflammatory, antipyretic, anticancer, hepatoprotective, anti-hyperglycaemic and antioxidant properties. Moreover, various parts of *S. suaveolens* like barks, flowers, roots and leaves are used for several diseases gonorrhoea, liver disorders, malaria inflammations, heating, dyspnoea, body ache, vomiting, eructation, piles, acidity and diarrhoea by traditional healers, rural communities and pharmaceutical companies. It is reported that PCOS is one of the most common causes of infertility in 80% of cases. The main symptom of PCOS is irregular menstruation, which sometimes leads to mental depression. It was found that Dashamularishta is highly effective against PCOS in women (Thorwe and Choudhari 2014). Dashamularishta is very effective against dysmenorrhoea, which is the most common gynaecological problem faced by women during their adolescence. It reduces pain or discomfort during menstruation period (Kaumadi et al. 2010).

15.2.5 *Rubus moluccanus* L.

Rubus moluccanus is a scrambling shrub or climber. It belongs to a family, Rosaceae. It is native to eastern Australia from Queensland to Victoria and Northeast Indian states of Assam, Meghalaya, Nagaland and Arunachal Pradesh (https://en.wikipedia.

org/wiki/Rubus_moluccanus). This plant is also called as the wild raspberry. Berries are small, soft-fleshed fruits and have a potential benefit to human health. It has been reported that berries have many pharmacological properties, including anti-inflammatory, antioxidant, anticancer, antimicrobial, anthelminthic and anti-Alzheimer activities (Mohd et al. 2016).

15.2.5.1 Phytochemical Aspects

Mohd et al. (2016) have reported that *R. moluccanus* contains phenolics, flavonoids, anthocyanin and carotenoid compounds. Also studies have suggested the occurrence of phenolic compounds, such as ellagic acid, gallic acid, chlorogenic acid and caffeic acid in *R. moluccanus*. Mohd et al. (2016) identified 21 different compounds from the fruits of *R. moluccanus* by using gas chromatography-mass spectrometry (GC-MS) analysis. The major compounds identified were hydroxymethylfurfural, 1,1,2-triacetoxyethane, 2,4- dihydroxy-2,5-dimethyl-3(2H)-furan-3-one, 2-propenoic acid and 2-propenyl ester.

15.2.5.2 Pharmacological Aspects

Due to the presence of various bio-active compounds, *R. moluccanus* possess anti-oxidant, anti-inflammatory, anticancer, antihypertension, antimutagenic and anti-neurodegenerative properties. Santhosh et al. (2017) reported that *R. moluccanus* exhibit antibacterial, antifungal and anthelmintic activities against various pathogenic organisms, like *Escherichia coli* and *Candida albicans*. Therefore, they suggested that this plant extract can be used for curing various human diseases. According to the report of Tarun et al. (2014), fruits and young shoots of this plant can help to increase the fertility rate in females.

15.2.6 *Nothapodytes nimmoniana*

Nothapodytes nimmoniana is found in India particularly in Maharashtra, Goa, Kerala, Assam, Jammu and Kashmir as well as Tamilnadu areas. This plant is a small tree with a height of about 3–8 m and belongs to family, Icacinaceae. It is one of the important medicinal plants with several medicinal benefits (Nazeerullah et al. 2013; Prakash et al. 2016). In 1914, this plant was first documented by a botanist, U.N. Kanjilal, and later scientific studies have evidenced its potential medicinal value, mainly the anticarcinogenic properties. However, this plant was believed to have gone with extinction; however, recently, it has been rediscovered by a forest officer in Assam, in the Borjan area of the Tinsukia district (Kukil 2018).

15.2.6.1 Phytochemical Aspects

It was reported that this plant contains several potential alkaloids, such as camptothecin, 9-methoxy camptothecin and mappicine. This plant also contains 3-ketooctadec-cis-15-enoic acid, palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid. Studies have also revealed the occurrence of other chemical constituents, including acetyl camptothecin, (+)-1-hydroxypinoresinol,

Ω-hydroxypropioguaiacone, p-hydroxybenzaldehyde, scopoletin, uracil, thymine, sitosterol, sitosterol-β-D-glucoside, linoleic acid, trigonelline and pumiloside (Nazeerullah et al. 2013). The structure of camptothecin compound is depicted in Fig. 15.1.

15.2.6.2 Pharmacological Aspects

The presence of a variety of bio-active molecules in this plant is responsible for its wide-ranging pharmacological values. In particular, the occurrence of camptothecin, a highly renowned anticancer, occurs in this plant. This plant exhibits several therapeutical properties, such as anticancer, anti-AIDS, antimalarial, anti-inflammatory, antioxidant, antibacterial, antifungal and anti-anaemic activities. Studies suggest that camptothecin, a monoterpene indole alkaloid, is regarded as one of the most promising anticancer agent. Camptothecin mainly targets DNA topoisomerase I, a key enzyme of DNA replication. It is believed that camptothecin is an inhibitor of DNA topoisomerase I, and it acts by destabilising a strand break in the phosphodiester backbone of DNA. Camptothecin binds reversibly to a topoisomerase -1-DNA cleavable complex and form a stable ternary complex. It is also found that various numerous analogs of camptothecin have been synthesised and proved as potential therapeutic agents. Camptothecin is very effective against lung, breast, uterine and cervical cancer, and it is also effective against human immunodeficiency virus (HIV), parasitic trypanosomes and *Leishmania* (Surabhi et al. 2012; Nazeerullah et al. 2013).

15.3 Conclusion and Future Aspects

Herbal medicines are very much useful for treating various health-related issues, especially women-oriented diseases, as they are nontoxic, less expensive and easily available. Natural plant products have been used all over the world to cure various diseases in female. Assam and all other NE states are very rich in the plant biodiversity, so it could be a great opportunity for researchers to explore many other plants in this region for human benefits. Examples of some more important plants of NE having bio-active compounds used to cure gynaecological disorder are *Amaranthus tricolor*, *Colocasia esculenta*, *Clitoria ternatea*, *Rubus moluccanus*, *Piper nigrum*, *Scoparia dulcis*, etc. Among above-mentioned plants *A. tricolor*, *C. esculenta* and *C. ternatea* are highly active for enhancing fertility. As infertility is a one of the major problem in women in our society, therefore these plants should be explored more to prepare drugs against infertility. Another important plant of NE is *N. nimmoniana* as it contain bio-active compound like camptothecin. It is found that camptothecin is a highly potential anticancer agent. Thus, this plant could be a good source for anticancer drug for females.

Another important medicinal plant of NE is *O. indicum* or broken bones tree. This plant is highly beneficial for different purpose. Previously it was suggested that this plant contain large number of phytochemicals like phenols, tannins, alkaloids, flavonoids, saponins, etc. Previously it was reported that this plant has several

biological activities like antioxidant, antimicrobial, anti-inflammatory, anticancer, anti-hepatotoxic, etc. It was reported that different solvent extract of stem bark of *O. indicum* showed cytotoxicity on HeLa cells due to induction of apoptosis. Therefore, this plant needs to be explored more on its anticancer activity, and this could be a good source for anticancer drug like cervical and breast cancer of women in our society. Therefore, the herbal extracts of various plants of NE could be useful for various industries to manufacture medicine to cure gynaecological disorders.

References

Aniruddha R, Shaon KD, Tripathi AK, Singh NU, Barman HK (2015) Biodiversity in north East India and their conservation. Prog Agric 15:182–189

Babongile CN, Willie MUD, Musa VM (2014) Oleanolic acid enhances the beneficial effects of pre-conditioning on PC12 cells. Parkinsons Dis 2014:929854. https://doi.org/10.1155/2014/929854

Bhaskar D, Dilipkumar P, Arindam H (2015) A review on *Cyperus rotundus* as a tremendous source of pharmacologically active herbal medicine. Int J Green Pharm 9:198–203

Bhishma PP, Pawan KS (2018) Viscum articulatum Burm. f.: a review on its phytochemistry, pharmacology and traditional uses. J Pharm Pharmacol 70:159–177

Chakraborty T, Saha S, Bisht NS (2017) First report on the ethnopharmacological uses of medicinal plants by Monpa tribe from the Zemithang region of Arunachal Pradesh, Eastern Himalayas, India. Plan Theory 6:13. https://doi.org/10.3390/plants6010013

Deka J, Kalita JC (2013) Ethonobotanicaly important medicinal plants of kamrup district, Assam, India used in fertility treatment. Int Res J Pharm 4:229–232

Devanjal B, Selim M, Kangkan KD, Himangshu M (2016) Report on folklore medicinal plants used for female health care in Assam (India). Int J Herb Med 4:4–13

Gildas TM, Luis AV, Francisca GC, Otilia DLP, Deusdênia LP, Ana PRR (2017) Reports on *in vivo* and *in vitro* contribution of medicinal plants to improve the female reproductive function. Reprodclim 32:109–119

Jayashree GV, Rachitha P, Krupashree K, Hemanth KK, Farhath K (2013) Phytochemical analysis of methanolic extract of roots of *Asparagus racemosus* (Shatavari). Int J Pharm Bio Sci 4:250–254

Kashani L, Akhondzadeh S (2017) Female infertility and herbal medicine. J Med Plants 16:3–7

Kaumadi K, Kamayani SU, Shilpa D, Chandrika T, Dei LP (2010) A comparative study of Dashamoola Taila Matra Basti and Tila Taila Matra Basti in Kashtartava (dysmenorrhea). Ayu 31:305–310

Kiran (2015) Women in India: Role and status of Women in India. https://www.importantindia.com/20816/women-in-india-role-and-status-of-women-in-india. Accessed on 27th October 2015

Komal S, Maheep B (2011) *Asparagus racemosus* (Shatavari): a versatile female tonic. Int J Pharm Biol Sci Arch 2:855–863

Kukil B (2018) Extinct medicinal plant, which can help treat ovarian and colon cancers, rediscovered in Northeast India. International Business Times. https://www.ibtimes.co.in›Science › Health. Accessed on 19th August 2018)

Meena AK, Yadav AK, Panda P, Komal P, Rao MM (2010) Review on Stereospermumsuaveolens DC: a potential herb. Drug Invent Today 2:238–239

Mishra VK, Sheikh S, Agnihotri V, Chourey N (2010) Effects of *Asparagus racemosus*, (shatavari) on mounting behaviour of male rats. Int J Pharm Life Sci 1:30–34

Mohd FAB, Nur AI, Azizul I, Angelina LML (2016) Phytochemical composition and biological activities of selected wild berries (*Rubus moluccanus* L., R. Fraxinifolius Poir., and *R. alpestris* Blume). J Evidence-Based Compl Altern Med 2016:2482930. https://doi.org/10.1155/2016/2482930

Muneesh K, Manisha R, Bibekananda M (2017) Review on pharmacology and phytochemistry of Cyperusrotundus L. Curr Res Pharma Sci 7:11–15

Nagamani SJ, Ahuja J, Reddy V (2012) Comparative phytochemical screening of Vatashunga, Shatavari and Shatapushpa claimed for Prajasthapana activity. Ann Biol Res 3:1294–1304

Nazeerullah K, Ennus TT, Sharma VK, Sunil K (2013) Phytochemical and pharmacological aspects of *Nothapodytes nimmoniana*. Herba Pol 59:53–66

Noorul H, Nesar A, Shaikh Z, Mohd K, Juber A (2016) Asparagus racemosus: for medicinal uses & pharmacological actions. Int J Adv Res 4:259–267

Prakash L, Middha SK, Mohanty SK, Swamy MK (2016) Micropropagation and validation of genetic and biochemical fidelity among regenerants of *Nothapodytes nimmoniana* (Graham) Mabb. employing ISSR markers and HPLC. 3Biotech 6:171

Raja RR (2015) Vital role of herbal medicines in women's health: a perspective review. African J Plant Sci 9:320–326

Rama S, Rawat MS (2013) Conservation and cultivation of threatened and high valued medicinal plants in North East India. Int J Biodivers Conserv 5:584–591

Santhosh A, Uma SD, Shankaraiah P, Madhuri T (2017) Phytochemical investigation and antimicrobial anthelmintic activities of the leaves of *Rubus moluccanus* Linn. J Pharmacogn Phytochem 6:1392–1396

Shashi A, Sanjay KJ, Amita V, Mayank K, Alok Mand Monika S (2013) Plant profile, phytochemistryand pharmacology of *Asparagus racemosus* (Shatavari): a review. Asian Pac J Trop Dis 3:242–251

Surabhi S, Ajay K, Ajay GN (2012) Pharmacognostical and phytochemical analysis of nothapodytesnimmoniana stem. Int J Pharm Pharm Sci 4:455–459

Tarun CT, Ratul CR, Jogen CK (2014) A study on the medicinal plants used by the local traditional healers of Dhemaji district, Assam, India for curing reproductive health related disorders. Adv Appl Sci Res 5:296–301

Borokini TI, Lawal IO (2014) Traditional medicine practices among the Yoruba people of Nigeria: a historical perspective. J Med Plants Stud 2:20–33

Thorwe P, Choudhari SS (2014) Effect of Yogabasti upakrama in case of infertility due to pcos: single case study report. Int J Ayurveda Altern Med 2:45–48

Wahab Sab BA, Jacob J, Manjunath GG, Singh VK, Mundkinajeedu D, Shankarappa S (2015) Cycloolivil, a lignan from the roots of *Stereospermum suaveolens*. Pharm Res 7:45–48

Ying J, Bing X (2016) Chemical constituents of Cyperusrotundus L. and their inhibitory effects on uterine fibroids. Afr Health Sci 16:1000–1006