



REVIEW ARTICLE

A brief review on medicinal plants used by the traditional healers in Assam for treating peptic ulcer

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Abstract

Peptic ulcer is a common gastrointestinal illness that affects large number of people throughout the globe. Various synthetic anti-ulcer drugs presently available in the market include antacids, proton pump inhibitors, anticholinergics, H₂-receptor antagonists and cytoprotective agents, are some of the drugs used to prevent and treat various types of ulcers. However, most of the available drugs confer simpler to several side effects like arrhythmias, impotence, hematopoietic changes etc. Traditional medicines have remained as the most affordable and easily accessible source of treatment among the economically poor people in rural areas. Numerous lesser-known medicinal plants are utilized in Assam for the treatment of gastrointestinal problems. It is well acknowledged facts that many ethnic groups of Assam possess a vast repository of ethnomedicinal knowledge and traditional healthcare practices. The traditional knowledge system widely practiced among the local tribes of Assam might be crucial in the identification of new phytotherapeutic substances that are useful in treating peptic ulcer. Therefore, this review presents common medicinal herbs, used by local people of Assam to treat or prevent stomach ulcer. The plants commonly used by the rural population in Assam for treating stomach ulcer are *Kalanchoe pinnata* (Lam.) Pers., *Aloe vera* (L.) Burm. f., *Houttuynia cordata* Thunb., *Centella asiatica* (L.) Urb., *Nyctanthes arbor-tristis* L., *Allium hookeri* Thwaites, *Azadirachta indica* A. Juss., *Solanum xanthocarpum* Schrad., *Oroxylum indicum* (L.) Kurz, *Psidium guajava* L., *Carica papaya* L., *Leucas aspera* (willd.) Link, *Piper betle* L., *Mentha x piperita* L., *Eclipta alba* (L.) Hassk., *Anethum graveolens* L., *Oxalis corniculata* L., *Paederia foetida* L., *Adhatoda vasica* Nees, *Perilla frutescens* (L.) Britton, *Caesalpinia bonducella* (L.) Fleming, *Hellenia speciosa* (J.Koenig) S.R.Dutta, *Cynodon dactylon* (L.) Pers., *Rubus ellipticus* Sm., *Sida cordifolia* L. and *Gymnanthemum amygdalinum* (Delile) Sch.Bip.

Keywords: Assam; Traditional Healers; Peptic Ulcer; Anti-ulcer drugs; Side effects; Traditional medicine

1. Introduction

The human digestive system is a complex one, consisting of the gastrointestinal tract and accessory digestive organs. The stomach is an important digestive organ where the swallowed food gets mixed with the gastric juices which contain enzymes and hydrochloric acid. The acid produced by the stomach helps in the digestion of the ingested food material and provides protection from the microbes. Due to strong acidic media, the stomach also secretes a thick mucus layer to give protection from the acid. When the mucus layer stops functioning properly, the acid tends to cause damage to the stomach wall which may lead to the formation of ulcer. A balance exists in the stomach between the aggressive digestive capabilities of acid and the mucus layer. If any disturbance occurs in the normal equilibrium, caused either due to enhanced aggression of the acid or decline in mucus resistance, then ulceration takes place (Kuna et al., 2019). Mucosal ulceration can also be caused due to oxidative damage initiated by reactive oxygen species (ROS), apoptotic cell death etc. (Abdeen et al., 2020). Peptic ulcer disease (PUD) refers to a condition characterised by a disruption in the mucosal lining of the stomach, the duodenum, or occasionally the distal oesophagus (Najm, 2011). There are two distinct forms of peptic ulcers, which can be classified according to their anatomical location. The term "Gastric ulcer" refers to an ulcer that forms in the stomach, whereas "Duodenal ulcer" refers to an ulcer that forms in the first part of the small intestine.

As already mentioned, gastric ulcer is one of the major gastrointestinal disorders caused due to imbalance between the aggressive (gastric acid secretion) and defensive (gastric mucosal integrity) factors which is now referred as the "New plague of 21st century" (Zakaria et al., 2016). It is also the most prevalent gastrointestinal problem which accounts for an approximate mortality of 15 people out of every 15,000 yearly complications around the world (Jaiswal, 2021). The progression of gastric ulcer is a very sophisticated and multifactorial process and according to few reports sometimes the gastrointestinal ulcer can be life threatening (Yang et al., 2021).

It was believed that spicy foods and stress are mainly responsible for causing ulcer. However, extensive research carried out in this field revealed that those are only aggravating factors. The real causes are either bacterial infections (*Helicobacter pylori*) or pharmacological reactions caused by various medications like non-steroidal anti-inflammatory drugs (NSAIDs). The prevalence of PUD among individuals infected with *H. pylori* is estimated to be around 1% annually, which is 6 to 10 times greater than the incidence observed in uninfected individuals (Brown, 2000). The treatment of gastric ulcers generally includes bed rest and the use of antacids. But the modern treatments involve the killing of the bacteria (*H. pylori*) or terminating the medications (NSAIDs). Various factors known to play an important role in the ulcer pathogenesis are stress, smoking, alcohol consumption, nutritional deficiencies, regular use of NSAIDs and infections caused by *H. pylori* (Tijani et al., 2021; Mahmoud et al., 2023). It has also been reported that ROS, mainly superoxide anions, hydroxyl radicals

and lipid peroxides are capable of causing gastric ulcer (Jomova and Valko, 2011).

1.1. Herbal medicine

Ayurveda, the world's oldest system of medicine offers clues for discovering plant chemicals, where the extracts of various plants are being used as therapeutic agents (Kumar et al., 2012). In India, many medicinal plants are used for human health management since ages and till serving the same purpose with stability through scientific validation i.e., with the help of modern technology where the quantitative estimation of active principles of the phytoproducts are performed as per the requirement for effective management of different ailments (El Sheikh, 2017).

According to the World Health Organization (WHO), approximately 80% of the population living in developing countries rely exclusively on traditional medicine for their primary healthcare requirements. In most of the traditional medical systems, the traditional medicinal plants play a major role. Also, in modern medicine, there are about 2000 drugs which are reported to be of natural origin, where almost all of them are derived from the different traditional systems and folklore practices (Dey et al., 2012). In India, there are about 4600 licensed pharmacies that collect medicinal plants for the preparation of herbal drugs (Chapagain et al., 2021). The use of phytoproducts as drug therapy to major ailments has also been proved to be clinically effective and also relatively less toxic than the existing synthetic/commercial drugs (Sundar and Singh, 2018).

The Northeast region of India is home to a diverse collection of ecosystems and is blessed with a wealth of natural resources (Mao et al., 2009). The region is geographically isolated from the coast and surrounded by land. It consists of eight distinct states namely; Arunachal Pradesh, Assam, Mizoram, Manipur, Meghalaya, Nagaland, Tripura and Sikkim and harbour more than 180 major tribal communities out of the total 527 tribal communities present in India (Sajem et al., 2008). It has the most abundant collection of plant diversity within India and is recognised as one of the prominent "Biodiversity Hotspots" worldwide. It sustains approximately 50% of the country's biodiversity. As a result, the northeastern region has attracted significant attention due to its abundant biodiversity and rich traditional knowledge. The various tribes residing in the region have a profound indigenous knowledge system pertaining to the utilisation of biodiversity components for their essential needs, such as sustenance, nourishment, shelter and healthcare (Chakraborty et al., 2012). People of Assam also use various plant species such as *Alternanthera sessilis* (L.) DC, *Mikania micrantha* Kunth, *Musa x paradisiaca* L., *Ocimum tenuiflorum* L., *Psidium guajava* L. and *Azadirachta indica* A. Juss. for ulcer treatment (Purkayastha and Nath, 2006). Numerous chemical compounds have also been isolated from medicinal plants that are known to possess anti-ulcer potential. A number of excellent drugs have been proven effective in controlling hyperacidity and ulceration, but the long-term use of these drugs is usually associated with side effects on the patients. The treatment of peptic ulcers is one of the main challenging problems in the modern healthcare because of the fact that the available drugs have limited efficacy against the disease and also cause severe side effects. So, the search is still going on to find a compound having anti-secretory, anti-ulcer and anti-oxidant properties which would serve as a therapeutic agent to reduce hyperacidity and ulcers (Zaghloul et al., 2019).

As, we have already stated that the northeastern region of India is a biodiversity hot spot for the medicinal plants. So, the present study focuses on the widely used medicinal plants in the rural areas of Assam. The state of Assam is inhabited by ethnic communities such as Bodo, Rabha, Kachari, Karbi, Dimasa, Mising, Santhal etc. These indigenous communities dwelling in the rural areas of Assam use various known as well as lesser-known medicinal plants for treating various stomach related problems (Chetia et al., 2023). Thus, in the present study we have extensively reviewed the most commonly used plants for treating peptic ulcer.

2. Insights on medicinal plants used in traditional treatment of peptic ulcers

The detailed descriptions of plants commonly used for the treatment of peptic ulcer by the local healers in Assam are as follows:

2.1. *Kalanchoe pinnata* (Lam.) Pers.

Parts of plant used: Whole plant

Mode of consumption: Raw

Kalanchoe pinnata (Lam.) Pers. (Family: Crassulaceae) is popularly known as 'Pategaja' in Assam. It is widely used as a medicinal plant mainly in India, Africa, China, and tropical America. Rural people of Assam consume the whole plant for treating gastric ulcer. This family has xeromorphic characteristics, which enable its species to adapt to the high incidence of sunlight and water scarcity (Herrera, 2009). It has been reported that the whole plant extract of *K. pinnata* contains different groups of phytoconstituents, among which flavonoids, phenolics, alkaloids and terpenoids are reported to be predominant (de Araújo et al., 2018). Aqueous extract of *K. pinnata* showed potent gastroprotective effect against ethanol and indomethacin induced gastric ulcer in Wistar rats (de Araújo et al., 2021). In another study, methanolic leaf extract of *K. pinnata* was found to possess significant anti-ulcer activity in gastric lesions induced by aspirin, indomethacin, serotonin, reserpine, stress and ethanol (Pal and Nag, 1991). Previous studies have also reported antileishmanial, hepatoprotective, choleric, anti-inflammatory, chemopreventive, antidiabetic and antinociceptive effects of the plant's leaf extracts (El Abdellaoui et al., 2010; Andrade et al., 2020).

2.2. *Aloe vera* (L.) Burm.f.

Parts of plant used: Whole plant

Mode of consumption: Raw

Aloe vera (L.) Burm. f. is considered as oldest medicinal plant in the world. It is an evergreen perennial plant belonging to the family of Asphodelaceae. In Assam, it is locally known as 'Salkuwari'. Recently, it has been reported that low molecular weight gel fraction of *A. vera* exhibits gastroprotection by inducing matrix metalloproteinase-9 inhibitory activity in alcohol-induced acute gastric lesion (Park et al., 2017). The extract also has potential in promoting anti-inflammatory, anti-diabetic, cell protective, healing and mucus stimulatory activities (Izzo et al., 2016). It has been reported that combination of *A. vera* juice with Amla juice possess anti-ulcer activity against ethanol induced ulcer (Gopinathan and Rameela, 2014). However, processed *A. vera* gel treatment attenuates not only the severity of intestinal ulcers but also bacterial translocation by enhancing the mucus layer in the indomethacin-induced mouse model (Kim et al., 2019).

2.3. *Houttuynia cordata* Thunb.

Parts of plant used: Leaf and root

Mode of consumption: Raw/cooked

Houttuynia cordata Thunb. belonging to the family Saururaceae is an herbaceous perennial plant that grows in moist and shady places. *H. cordata* is locally known as 'Maisundari'. Traditionally, the plant is used for its various beneficial properties against inflammation, pneumonia, severe acute respiratory syndrome, muscular sprain, stomach ulcer etc. (Shingnaisui et al., 2018). People of Northeast India use the leaf juices to treat cholera, dysentery, anaemia, and purify blood (Laloo and Hemalatha, 2011). Sodium houttuynifonate (SH), a derivative of the medicinal herb *H. cordata* showed efficacy for the treatment of ulcerative colitis (Cheng et al., 2023).

2.4. *Centella asiatica* (L.) Urb.

Parts of plant used: Leaves

Mode of consumption: Raw

Centella asiatica (L.) Urb. is locally known as 'Bormanimuni' and belonging to the family Apiaceae. It is also known as Indian pennywort. It is a perennial herbaceous creeper commonly found in abundance on moist, sandy or clay soils. *C. asiatica* has been reported to possess pro-healing efficacy for gastric ulcers induced by ethanol, indomethacin, aspirin, cold-restraint stress, pylorus ligation and acetic acid (Zheng et al., 2016). It has also been reported that the pentacyclic triterpenoid compounds in *C. asiatica* extract mainly consisting of asiaticoside (AS), asiatic acid (AA), madecassoside (MS), and madecassic acid (MA) possess wound healing and anti-ulcer properties (Wannasarit et al., 2019).

2.5. *Nyctanthes arbor-tristis* L.

Parts of plant used: Leaves and flower

Mode of consumption: Raw/cooked

Nyctanthes arbor-tristis L. is locally known as ‘Sewali phul’ and it belongs to the family Oleaceae. It is a native medicinal plant of India and is widely distributed in sub-Himalayan region. The indigenous people of Assam use leaf and flower of *N. arbor-tristis* to cure various ailments. Arbortristoside-A (AT) and 7-O-trans-cinnamoyl-6 β -hydroxyloganin (6-HL) isolated from the seeds of *N. arbor-tristis* prevents formation of irritant-gastric ulcer and also enhances gastric ulcer healing (Mishra et al., 2013).

2.6. *Allium hookeri* Thwaites

Parts of plant used: Whole plant

Mode of consumption: Raw/cooked

Allium hookeri Thwaites is a wild perennial herb belonging to the family Amaryllidaceae and the plant is locally known as ‘Piyanj’ in Assam. The plant’s leaf juice is mixed with salt and the mixture is used by the local resident for the treatment of stomach ulcer and other ailments. *Allium hookeri* has the immense beneficial medicinal properties including anti-diabetic, anti-fungal, anti-ulcer, anti-obesity, hepatoprotective, neuroprotective, hypolipidemic, anti-inflammatory activity reported in various *in vitro* and *in vivo* experimental models including clinical trial (Deka et al., 2022). In a previous study the methanolic extract of *A. hookeri* has showed significant anti-ulcer activity against ethanol induced gastric ulcer (Singh et al., 2018).

2.7. *Azadirachta indica* A. Juss.

Parts of plant used: Leaves

Mode of consumption: Raw/boiled in water

Azadirachta indica A. Juss. is an evergreen tree locally known as ‘Neem’ and belonging to the family Meliaceae. The Ayurvedic practitioners in India have been using this plant for curing various illnesses such as peptic ulcers, leprosy, fever, asthma, epistaxis, intestinal worms, piles, diabetes, urinary tract infections, scabies, ringworm and spermatorrhoea (Biswas et al., 2002). The leaves specifically have proven their medicinal value by their immunomodulatory, anti-inflammatory, anti-hyperglycemic, anti-ulcer, anti-malarial, anti-fungal, anti-bacterial, anti-viral, anti-oxidant, anti-mutagenic and anti-carcinogenic properties (Bhajoni et al., 2016). A recent study has reported that tamarixetin 3-O- β -D-glucopyranoside isolated from the methanol extract of neem leaves showed significant protection against indomethacin-induced gastric ulceration in mice in a dose-dependent manner (Yadav et al., 2017).

2.8. *Solanum xanthocarpum* Schrad.

Parts of plant used: Whole plant

Mode of consumption: Raw

Solanum xanthocarpum Schrad. is a perennial herb belonging to the family Solanaceae and locally known as ‘Kantakari’. In Ayurveda, the plant is characterized as bitter, digestive, pungent, alternative astringent. Leaves of *S. xanthocarpum* have various pharmacological properties like anti-fungal, wound healing, larvicidal, anti-bacterial, anti-hyperglycemic, anti-oxidant, hepatoprotective activities (Fathima et al., 2019). It has also been reported that methanolic extract of *S. xanthocarpum* showed anti-ulcerogenic activity and ulcer healing property on different ulcer models (Jainu and Devi, 2006).

2.9. *Oroxylum indicum* (L.) Kurz

Parts of plant used: Root bark, stem bark, fruits, seeds and leaves.

Mode of consumption: Boiled in water

Oroxylum indicum (L.) Kurz is locally known as ‘Ding dinga’ and belonging to the family Bignoniaceae. People of Assam have been using the fruits of *O. indicum* to cure various diseases. Ethanolic extract and various fractions of *O. indicum* have exhibited potent and remarkable anti-inflammatory and antiulcer activities (Begum et al., 2019). It has been reported to possess anti-inflammatory, anti-oxidant, anthelmintic and anti-cancer potential (Padgilwar et al., 2014).

2.10. *Psidium guajava* L.

Parts of plant used: Leaves

Mode of consumption: Boiled in water

Psidium guajava L. is a tropical edible fruiting plant commonly known as ‘Madhuriaam’ which is widely distributed in India. It

belonging to the family Myrtaceae. Many pharmacological activities have been reported on different extracts of the plant that include anti-diarrheal, anti-hypertensive, hepatoprotective, anti-oxidant, anti-cancer, anti-microbial, anti-bacterial, anti-inflammatory and antitumor activity (Kumadoh et al., 2021). Phytochemical constituents observed in the plant include tannins, phenols, triterpenes, flavonoids, saponins, alkaloids and glycosides (Ngbolua, 2018). It has been reported that the leaves of *P. guajava* have anti-ulcer activity as evidenced by its significant inhibition in the formation of ulcer induced by chemical agents (Edwin et al., 2007). Recent studies have shown the anti-ulcer activity of *P. guajava* seed extract against NSAID-induced gastric ulcers, as well as its antioxidant activity (Shady et al., 2022).

2.11. *Carica papaya* L.

Parts of plant used: Fruits and seeds

Mode of consumption: Raw/cooked

Carica papaya L. locally known as ‘Amita’ and belonging to the family Caricaceae. Pre-treatment with aqueous extract of *C. papaya* seed exhibited anti-ulcerogenic and anti-oxidant effects (Oloyede et al., 2015). Another study has showed that hydroalcoholic extract of *C. papaya* fruits showed anti-ulcer activity in a dose dependent manner (Kaur and Sen, 2017). Ethanolic extract of the leaves of *C. papaya* has also showed protection against the aspirin-induced gastric ulcer in rats (Odo and Odo, 2017).

2.12. *Leucas aspera* (willd.) Link

Parts of plant used: Leaves

Mode of consumption: Cooked/soaked in water

Leucas aspera (willd.) Link of Lamiaceae family is locally known as ‘Dandakalash’. It has been attributed with many medical properties in Indian system of Medicine. Hydroalcoholic extract of *L. aspera* leaves possess both dose-dependent and time-dependent anti-ulcer effects against indomethacin and ethanol induced ulcer models (Kumar et al., 2021). Medicinally, the plant contains various bioactive components such as alkaloids, steroids, terpenoids, phenols, tannins, proteins, flavonoids and saponins (Nithyatharani and Kavitha, 2018).

2.13. *Piper betle* L.

Parts of plant used: Leaves

Mode of consumption: Raw

Piper betle L. is widely known as perennial creeping and belonging to the family Piperaceae. Most of the people take *betle* leaves as a mouth freshener. It is commonly known as ‘Pan’ in Assam and traditionally the plant is used to cure many ailments such as cold, bronchial asthma, cough, stomach ache, rheumatism, boils, bad breath, constipation, conjunctivitis, gum swelling, abscesses, injuries and cuts (Gundala et al., 2014). *P. betle* extracts have been reported to exhibit high anti-bacterial, anti-oxidant, anti-inflammatory, anti-apoptotic, anti-cancer and anti-microbial properties (Biswas et al., 2022). Treatment with ethanolic extract of leaves of *P. betle* at a dose of 150 mg/kg body showed anti-ulcer effect against NSAID in albino rats (Majumdar et al., 2003). Another study has demonstrated that aqueous extract and cold ethanol extract of *P. betle* have the ability to give protection against gastric damage caused by absolute ethanol (Arawawala et al., 2014).

2.14. *Mentha x piperita* L.

Parts of plant used: Leaves

Mode of consumption: Raw

Mentha x piperita L. of the family Lamiaceae is locally known as ‘Pudina’. *M. piperita* has been utilized in folk medicine as an anti-inflammatory, anti-oxidant, anti-pyretic, anti-spasmodic, anti-bacterial, anti-fungal and anti-viral agent, and also used for curing diarrhoea and throat infection (Balakrishnan, 2015). A recent study has revealed the preventive role of aqueous extract of *M. piperita* on ethanol-induced gastroduodenal ulcers in rats without any side effects (Zangeneh et al., 2019). Besides that, the plant is known to possess anti-oxidant, anti-microbial, insecticidal, and anti-cancer potential (Abbas et al., 2022).

2.15. *Eclipta alba* (L.) Hassk.

Parts of plant used: Leaves

Mode of consumption: Raw/boiled in water

Eclipta alba (L.) Hassk. of the family Asteraceae is a small branched perennial herb, found in sandy and clay soil and waterlogged areas. *E. alba* local name is 'Kehraj'. Alcohol and aqueous extracts of the plant were found to be significantly effective in protecting the gastric mucosa in experimental animals against paracetamol induced ulcers at different doses. A clinical study has revealed that oral administration of *E. alba* prior to ulcer induction showed significant reduction in the occurrence of gastric ulcers as well as gastric inflammation (Banerjee et al., 2005). The plant is rich in various phytoconstituents such as alkaloids, flavonoids, saponins, phenolic acids etc. It is also known to possess various pharmacological properties such as hepatoprotective, antidiabetic, anti-inflammatory, antioxidant, anticancer and anthelmintic potential (Molligoda et al., 2023).

2.16. *Anethum graveolens* L.

Parts of plant used: Leaves

Mode of consumption: Cooked

Anethum graveolens L. is an aromatic and annual herb belonging to the family Apiaceae. It is locally called as 'Dhaniya'. It is a well-known herb that is frequently used as a spice and also produces essential oil. It has been utilised in Ayurvedic medicine for thousands of years (Jana and Shekhawat, 2010). It has been reported that in mice with stomach ulcers caused by HCl and ethanol, *A. graveolens* seed extracts showed considerable mucosal protection, anti-secretory and anti-ulcer properties (Hosseinzadeh et al., 2002). Previously, it has been clinically proven that two flavonoids namely, quercetin and isoharmentin, with anti-oxidant activity and the potential to neutralise free radicals were extracted from the seeds of *A. graveolens*. The prevention of peptic ulcers may depend upon the above-mentioned properties (Mohele et al., 1985).

2.17. *Oxalis corniculata* L.

Parts of plant used: Leaves

Mode of consumption: Boiled in water

Oxalis corniculata L. is a little, prostrate plant and is a member of the Oxalidaceae family, commonly known as 'Tengesi tenga'. In addition, a variety of other cultural groups have made use of the *O. corniculata* plant for medicinal purposes (Mukherjee et al., 2013). It has been showed that the methanolic extract of *O. corniculata* possesses significant anti-ulcer activity against pylorus ligated and indomethacin induced ulcer model (Sekat et al., 2012). Previous study has showed that *O. corniculata* possesses potent anti-bacterial, anti-fungal, and insecticidal characteristics, and it can be utilised for the treatment of diseases as well as in the management of pest insects (Rehman et al., 2015).

2.18. *Paederia foetida* L.

Parts of plant used: Leaves

Mode of consumption: Grinded leaves extract with water/cooked

Paederia foetida L. is locally known as 'Bhedai lota' belonging to the family Rubiaceae with foul-smelling scent. Historically, *P. foetida* has been used in traditional medicine to treat a wide range of conditions including rheumatism, diarrhoea, inflammation, and piles (Wang et al., 2014). A study has revealed the presence of β -sitosterol in the methanolic leaf extract of *P. foetida* and also showed the anti-ulcer activity against indomethacin-pylorus ligation, alcohol induced and water immersion stress induced model in rats (Chanda et al., 2015).

2.19. *Justicia adhatoda* L.

Parts of plant used: Flower and leaves

Mode of consumption: Boiled in water/raw

The plant *Justicia adhatoda* L. (Family Acanthaceae) has been reported to be utilised in India's traditional 'Ayurvedic' and 'Unani' medical systems for over two thousand years (Atal, 1980). It is locally known as 'Tita bahak'. It has a long history of traditional medical application for a variety of conditions and possesses a variety of biological activities which include anti-bacterial, anti-inflammatory bronchodilatory, anti-allergic, anti-asthmatic, anti-mutagenic, anti-tubercular activities and radioprotective effects (Singh et al., 2011). In rats, the *J. adhatoda* leaf powder exhibited a significant level of anti-ulcer activity with the maximum level of action (80%) being seen in the ethanol-induced ulceration model in contrast to pylorus and aspirin models (Shrivastava et al., 2006).

2.20. *Perilla frutescens* (L.) Britton

Parts of plant used: Stem and leaves

Mode of consumption: Soaked in water/raw

The annual plant known as *Perilla frutescens* (L.) Britton of the mint family Lamiaceae is used for a variety of purposes including as a medicinal herb, an aromatic, and functional food. It is locally known as 'Sukloti'. Various studies have revealed that different extracts and isolated/purified compounds from *P. frutescens* demonstrated anti-oxidant, anti-bacterial, anti-fungal, anti-allergic, anti-depressant, anti-inflammatory and anti-tumour activity (Ahmed, 2018). *P. frutescens* fruit oil (PFO) is rich in α -linolenic acid and it exhibits anti-ulcer effects in water immersion stress, HCl/ethanol and indomethacin-induced gastric ulcerated rats. A recent study has also revealed the analgesic effect of PFO (Paradee et al., 2021).

2.21. *Caesalpinia bonducella* (L.) Fleming

Parts of plant used: Seeds and leaves

Mode of consumption: Boiled in water

Caesalpinia bonducella (L.) Fleming is an indigenous herb of India belonging to the family of Fabaceae. It is documented in 'Ayurveda' and other traditional medicinal systems of India and has a long history of usage in the treatment of human illness across a variety of conventional medical frameworks (Pandey et al., 2018). It is locally known as 'Letaguti' in Assam. The oil derived from the seeds of *C. bonducella* has exhibited various activities in a dose-dependent manner against both acute and chronic phases, specifically demonstrating anti-inflammatory, anti-pyretic and analgesic properties (Shukla et al., 2010). Previous study has showed that methanolic extract of *C. bonducella* leaves possesses potent anti-ulcer properties (Ansari et al., 2012). Sawian et al (2016) showed that *C. bonducella* dry nut extract significantly prevented ulcer induced by pylorus ligation method at different doses of 100, 200 and 400 mg/kg body weight.

2.22. *Hellenia speciosa* (J.Koenig) S.R.Dutta

Parts of plant used: Rhizome and leaves

Mode of consumption: Raw/cooked

Hellenia speciosa (J.Koenig) S.R.Dutta is a significant botanical species with medicinal and aesthetic value. It is cultivated in India and belongs to the Costaceae family. It is known as 'Bon aadaa'. The plant has been reported to exhibit numerous pharmacological properties including anti-bacterial, anti-fungal, anti-cholinesterase, anti-oxidant, anti-hyperglycemic, anti-inflammatory, analgesic, anti-pyretic, anti-diuretic, larvicidal, anti-stress and estrogenic activities (Pawar and Pawar, 2014). It has been clinically proved that *C. speciosus* extract possesses anti-ulcer activity due to one or more number of the secondary metabolites present in it (Kujur et al., 2019). Another recent finding showed that *H. speciosa* root granules inhibited inflammation and the apoptosis of colonic epithelial cells and improved the symptoms of ulcerative colitis in rats (Wang et al., 2018).

2.23. *Cynodon dactylon* (L.) Pers.

Parts of plant used: Leaves

Mode of consumption: Raw

Cynodon dactylon (L.) Pers. is commonly known as 'Duboribon' and belonging to the family Poaceae. This plant is a perennial grass species that serves multiple purposes including its utilisation as forage, medicinal applications and for the purpose of desert greening (Savadi et al., 2020). The utilisation of this plant has been documented in the management of various medical conditions including cancer, cystitis, headache, hysteria, asthma, tumours, stones, eye disorders, weak vision, pain, inflammation and grippe in children. The combination of *C. dactylon* and sugar is utilised as a therapeutic intervention for the condition of urinary retention (Kumar et al., 2013). *C. dactylon* leaf extract has been found to be non-toxic even at relatively high concentrations and showed significant anti-ulcer activity in animal models (Sen et al., 2020).

2.24. *Rubus ellipticus* Sm.

Parts of plant used: Fruits and leaves

Mode of consumption: Raw

Rubus ellipticus Sm. is commonly known as 'Jelekipoka'. It is a member of the Rosaceae family with significant ethnomedicinal values. Leaves and fruits of the plant *R. ellipticus* have been found to possess several pharmacological properties like anti-

inflammatory, analgesic, anti-pyretic, anti-proliferative, cytotoxicity, anti-cancer, wound healing, anti-fertility, anti-plasmodial, anti-microbial and antioxidant potential (Kewlani et al., 2023). Vadivelan et al (2008) clinically proved that ethanolic root extract of *R. ellipticus* possess significant anti-ulcer activity against aspirin plus pylorus ligation induced ulcer model.

2.25. *Sida cordifolia* L.

Parts of plant used: Flower and leaves

Mode of consumption: Raw/soaked in water

Sida cordifolia L. is a perennial herb belonging to the family Malvaceae and it is locally known as 'Bon sonbarali'. According to reports, *S. cordifolia* has demonstrated significant medicinal properties in the treatment of various ailments such as fever, urinary system disorders and abdominal disorders (Sharma, 2013). Previous study has revealed that methanolic extract of *S. cordifolia* exhibited significant anti-ulcerogenic effect against aspirin and ethanol induced damage (Philip et al., 2008).

2.26. *Gymnanthemum amygdalinum* (Delile) Sch.Bip.

Parts of plant used: Leaves

Mode of consumption: Boiled in water

Gymnanthemum amygdalinum (Delile) Sch.Bip. is a shrub belonging to the family Asteraceae and is locally known as 'Kukshim'. da Silva et al (2013) reported that the leaves of *G. amygdalinum* have been used medicinally for centuries due to its wide range of medicinal properties including those of an analgesic, anti-inflammatory, anti-pyretic, anti-anaemic, and anti-bacterial agent. Ethanolic extract from leaves of *G. amygdalinum* showed gastroprotective activity and prevented gastric lesions induced by ethanol and indomethacin in rats (Boeing et al., 2016).

3. Discussion

In the present review we have reported 26 species of medicinal plants belonging to 23 different families reported to be traditionally used against peptic ulcers. Of the 26 plant species reported, 19 species are consumed raw only while rest of the species are processed in raw form. The plant species recorded in the present study are closely related with traditional believe system of the indigenous people of Assam. However, traditional healing practices have been reported to be gradually declining among the rural population due to migration of the people to the urban areas and also due to less availability of the medicinal plants in rural localities triggered by deforestation, mining, land development, and pollution (Mwchahary and Nath, 2015).

The present review also provides an in-depth examination of various plant species, revealing their potential as medicinal herbs with significant anti-ulcer properties. However, further detailed studies are required to understand the mode of action of the active principal of each of these plant species and the potential toxic effects on the consumer, if any, before prescribing the plant products for human consumption. Future research focusing on dosage and formulation are needed to be carried out for wider therapeutic use of these phytoproducts. Also, there is a considerable scope for undertaking studies dealing with phytopharmaceutical interactions and synergistic effects of the polyherbal combinations. Finally, a collaborative study where the local healers are engaged with the researchers and industrialists for the integration of traditional knowledge of the healers into the modern healthcare system for the greater benefits of the patients.

4. Conclusion

In the present review have reported 26 plant species belonging to 23 different families primarily reported to be used for the treatment of peptic ulcer disease among traditional healers of Assam. This review opens up new opportunities for further value-added research focused on phytochemicals and toxicological dimension of the species traditionally used against peptic ulcers.

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Declaration of conflict of interest

The authors declare that they have no conflict of interest.

Contribution of the authors

BR conceptualized the study, corrected and finalized the manuscript. SR carried out the survey, reviewed the literature, wrote the manuscript and prepared the final draft. AD and DD helped in final draft preparation, proofread and revised the manuscript. All authors have read and approved the final draft.

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