



A review on medicinal plant galls used in Siddha and other Indian systems of medicine

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Received: 14 January 2025

Accepted: 22 May 2025

Abstract

In ancient times galls were considered as supernatural outgrowths, and several myths were being created related with these mysterious formations of nature. Later the knowledge about these valuable structures have been given the name as “medicinal balls” since it showed the potential efficacy in treating various diseases on those days. Various traditional and folk systems of medicine prescribed about its bioactivity and recommended and used them for curing several ailments. Siddha system of medicine included different plant galls forming on different species of plants and its therapeutic uses in various siddha drugs and poly herbal formulations. The present study is focusing on the morphology, causal organism, phytochemicals, bioactivities and medicinal uses of some of the plant galls being described in the Siddha system of medicine. Collection of data and literature review is done by referring pharmacopeias and formularies of Siddha, published articles and books. The study will provide a valid account on medicinal aspects of these plant galls and will help to remove all mysteries behind these abnormal growths.

Keywords: Ayurveda, Cecidology, Gene expression, Macikkay, Plant galls

1. Introduction

Plant galls are surely the unresolved mystery in the natural world with respect to their formation and actions on plants. Galls are abnormal growth of tissues in different parts of a plant in response to the invasion of foreign organisms. The galls are being caused by wide range of unique organisms like viruses, fungi, bacteria, insects and mites and they appear on more than half of all plant families. Mostly the galls are formed by insects, mites and nematodes which forms a protective covering around the insect or its various stages of larvae. Gall is known as cecidia in botany and the study of gall is known as cecidology. Gall-causing animals (insects, mites and nematodes) are cecidozoa and galls induced by cecidozoa are referred to as zoocecidia (Gullan and Cranston, 2014). Galls provide shelter to insects and larvae where they get food and nutrition. Since the gall morphology and its biochemistry depend upon the plant family features and the invader, most of galls are enriched with bioactive phytochemicals. Much about their chemistry remains to be discovered and many of the life cycles of the

organisms that cause them are completely unknown. However, it is clear that galls make a huge contribution to the diversity of life in the forest and some of them contribute to the therapeutic field like other plant parts which human have brought into light through the long history of evolution. This study is mainly focusing on the different types of galls which are exploited in Siddha system of medicine for treating various ailments.

Siddha system of medicine is the most established and practicing traditional system in south India. Different galls are used in Siddha and ayurvedic systems to cure diseases. The five important galls which are mentioned in traditional literatures are; *Terminalia chebula* Retz. (nut gall, leaf gall), *Garuga pinnata* Roxb. (leaf gall), *Pistacia chinensis* Bunge. (leaf gall), *Quercus infectoria* G. Olivier (leaf gall) and *Rhus succedanea* Linn. (leaf gall). This study is mainly focusing on the bioactivity and pharmacological role of galls used in Siddha system of medicine.

2. Materials and methods

Collection of data and literature review is done by referring pharmacopeias and formularies of Siddha, published articles and books.

3. Results and discussion

3.1. Types of plant Galls

Different types of plant galls are found. Their morphology and physiological functions changes according to the plant part they formed and the organism it is infected with (Table 1).

3.2. How are the galls formed?

The gall formation by insects and tumor by bacteria are similar in their basic development pattern. The galls shape and structure may vary based on the invading species and the plant organ it is formed. The morphology of galls will be different according to the part on which it forms. The most important step in gall development is the induction of gall by insect by attacking a site in the plant body which leads to the growth and differentiation accompanied by new physiological activities. Due to these external stimulus two to three cells in the attacked organ is isolated from their normal metabolic activity and growth resulting formation of metaplasia cells (Raman, 2005) leading to newly differentiated tissues. At the initial stages of gall formation, stress responses are evoked in the attacking sites by gall-inducing insects.

These stress responses entail gene expression from cells in the vicinity (Ananthakrishnan, 1998), which in turn, activate new growth and differentiation, resulting in a gall with defined nutritional and shelter functions (Raman *et al.*, 2011) It is a known fact that the continuing stimuli from the insect controls gall shape and structure (Rohfritsch and Shorthouse 1982). Galls may be useful as a source of highly valued medicinal therapeutics since it contains bioactive compounds. As the chemical ingredient changes the pharmacology of galls also will change.

Table 1. Classification of galls

| Sl. No. | Type of galls based on plant part | Types of galls based on shape |
|---------|-----------------------------------|---|
| 1 | Leaf galls | Filz galls: Formed as a tuft of hairs on leaves Blister galls or pit galls: Doming one side of leaf blade with a depression beneath Pouch galls: A pouch like hollow invagination in leaves Roll and fold galls: Caused by rolling or folding of leaf margin |
| 2 | Stem galls | Covering galls: Found on leaf or stem, as wholly enclosed by plant tissues Mark galls: Deep inside pith of stems |
| 3 | Root galls | Root knots: galls on roots |
| 4 | Bud galls | Bud and rosette galls: forms when galls causing insect lays egg in buds or flower |
| 5 | Flower galls | Corolla tube galls Ovarian galls |
| 6 | Fruit galls | Nil |

The three major groups of insects that cause galls are aphids and their related genera, gall midges and gall waspp. The aphids include aphids, phylloxerans and psyllids. Gall midges (Cecidomyiidae) are a large group of small (usually less than 1/4 inch long), delicate flies that cause mainly bud galls, blister galls and galls on leaves and other plant tissues. Gall wasps belong to the family Cynipidae are most found on oaks, but roses, maples and other plants also serve as viable host plants (Raman *et al.*, 2011).

3.3. Cytological changes inside galls

As the galls appear as abnormal structures, the cytological nature of their cell may show many variations from normal cells. Many of the cells usually appear with polynucleate conditions with tetraploid or polyploid cells. The various cytological studies in galls revealed different cell wall compositions and protoplast modifications to fasten its functional role (Oliveira *et al.*, 2010; Bozbuga *et al.*, 2018). The cellular microfibrils reorientation (Suzuki *et al.*, 2014) and the composition of pectins, hemicelluloses and glycoproteins determine the flexibility, malleability, porosity and stiffness of the walls of re-differentiated cell types in galls (Bozbuga *et al.*, 2018). Some glycoproteins in the gall cell wall give strength during development and help to defend pathogens.

3.4. Physiological effects of galls on plants

As the plant galls are formed giving stress to the plant it provokes plant to go through stress pathways to cope up with the infection. It will cause production of higher amount of secondary metabolites than normal, such as phenolic acids, anthocyanins, flavonoids, tannins, steroids, triterpenes, alkaloids, lipophilic components, etc. (Patel *et al.*, 2018). Galls cause multiple physiological changes in host plants such as changes in pH and polarity, excess sugars and free amino acids, alterations in nutrient composition, deficiencies in pigment–protein complexes, lower chlorophyll and carotenoid content and a higher content of secondary metabolites, altering the chlorophyll metabolism of galls on host plants, all of which may

impact the photosynthetic capacity of host leaves (Stone and Schönrogge, 2003; Yang *et al.*, 2003; Motta *et al.*, 2005; Yang and Raman, 2007; Huang *et al.*, 2014a,b). All these changes play or contribute to the role as therapeutic drugs and adding medicinal value to the plant galls. The studies show both positive and negative impacts on the photosynthetic rates of plants which may change according to the host plant, type of gall and the gall makers.

3.5. Galls in traditional medicines

Galls have been used in various indigenous systems of medicine as ancient source of medicinal drugs. The list of five important galls used in the Siddha system of medicine with corresponding gall forming organisms, chemical constituents of galls and uses/pharmacological actions of the galls are given in Table 2.

3.5.1. Terminalia chebula Retz.: This plant belonging to the family Combretaceae is a medium to large sized deciduous tree found distributed in south Asia. The leaf galls of *T. chebula* used for diarrhoea and available in the south Indian markets in the name of *karkatashrungi*. The galls are very hard, yellowish brown externally and yellow internally, about 2 to 3 cm long, 1.6 to 4 cm wide, fan shaped, oval-oblong, with faint granular markings on external surface (Fig. 1) (Upadhye and Rajopadhye, 2010) with characteristic odour and astringent taste (Shankara *et al.*, 2012a). *Rhipiphorothrips cruentatus* and *Liothrips* spp., were found to be the gall causing thrips in the plant (Reena *et al.*, 2016). The galls of *T. chebula* frequently appear in many Thai medicinal plant recipes for promoting longevity (Manosroi *et al.*, 2010). Medical applications include astringent, purgative, supplements for anti-aging, imparting of longevity as well as boosting of the immune system (Pharmacopoeia Commission of PRC, 1997). In Siddha system of medication, they are used in the preparation of *karisalai lehyam*, *venpocesunai nei*, *gana thailum* used for

treating diseases like cough, bronchial asthma, diarrhoea, dysentery (Santha *et al.*, 1991). Powder of gall nut can be taken for 48 days with water in the evening time to relieve jaundice, ascites and mental diseases like delusions. The folklore use of *T. chebula* leaf gall extracts as a natural antioxidant also reported (Birur *et al.*, 2015). Shankara *et al.*, (2012a) studied the phytochemicals in the galls and reported the presence of alkaloids, flavonoids, triterpenoids, steroids, tannins, carbohydrates, saponins and glycosides.

In the Siddha system of medicine, these galls are called *kadukkai poo* which are used in the preparation of *padaiga linga thuvar* for the treatment of diarrhoea and dysentery. *Kadukkai poo* is also used as *karkatasringi* in the preparations like *karisalai legium*, *venpoosunai nei*, *gana*



Fig. 1. Galls of *Terminalia chebula* Retz.

Table 2. The list of gall forming plants and the associated microbes

| Sl. No. | Scientific names | Organism responsible for the gall formation | Chemical constituents of the gall | Uses/pharmacological actions |
|---------|--------------------------------------|---|--|--|
| 1 | <i>Terminalia chebula</i> Retz. | <i>Rhipiphorothrips cruentatus</i> and <i>Liothrips</i> spp. (Thrips) | Alkaloids, flavonoids, triterpenoids, steroids, tannins, carbohydrates, saponins and glycosides. | Antioxidant, antibacterial, anticancer and anti-aging activities |
| 2 | <i>Pistacia chinensis</i> Bunge | <i>Dasia asdifactor</i> (Aphis) | Alkaloids, terpenoids, flavonoids and tannins | Antioxidant, analgesic and anti-inflammatory activity and lowering uric acid content |
| 3 | <i>Rhus succedanea</i> L. | Psyllids | Alkaloids, flavonoids, steroids, triterpenes and carbohydrates | Antibacterial activity |
| 4 | <i>Garuga pinnata</i> Roxb. | <i>Phacopteron lentiginosum</i> Buckton. (Psyllid) | Flavonoids, glycosides, tannins and reducing sugars | No significant activities reported |
| 5 | <i>Quercus infectoria</i> G. Olivier | <i>Adleria gallae-tinctoriae</i> (gall-wasp) | Alkaloids, phenols, flavonoids, steroids, triterpenes, tannins and saponins | Anti-proliferative agent, antidiabetic, anesthetic and analgesic, antioxidant, antibacterial and anti-inflammatory |

tailam and *vazhai vadagam* which are used in the treatment of diseases like *irumal* (cough), *iraippu* (bronchial asthma), *kazhichal* (diarrhoea) and *ninakazhichal* (dysentery) (The Siddha Formulary of India, 1992). The accepted source of *karkatasringi* in Siddha is the galls of *Pistaia integerrima* J.L.Stewart but *Rhus succedanea* L., and *T. chebula* are generally used as substitutes (Pillai, 1931; Mudaliar, 1951).

Other pharmacological actions: The leaf gall contains high amount of polyphenols and flavonoids which attributes the antioxidant activity of gall as reported by Birur *et al.*, 2015. The ethanolic extracts of leaf gall showed antibacterial activity against *Staphylococcus aureus* (Shankara *et al.*, 2012b). A study by Manosroi *et al.*, (2010), confirmed the traditional use of *T. chebula* galls for longevity which will be beneficial for further development of anti-aging products. Anticancer activities of galls are also reported against human cancer cell lines (Shankara *et al.*, 2016).

3.5.2. *Pistacia chinensis* subsp. *integerrima* (J. L. Stewart ex Brandis) Rech. f. (Anacardiaceae): It is a dioecious tree native to Asia widely distributed in east Afghanistan, Pakistan and northwest - west Himalaya to Kumaon growing at an altitude of 800 to 1900 m (Pant and Samant, 2010). It is well pronounced due to galls present on the leaves, petioles and branches. These galls are hard, hollow, horn shaped, rugose, thin walled, cylindrical, tapering at both ends, grayish brown externally and reddish brown internally (Siddha formulary) and formed due to insect attack of aphid - *Dasia aedifactor* (Fig. 2). The galls are considered as store houses of secondary metabolites and hence important in Indian traditional medicine systems (Patel *et al.*, 2018). Galls are strongly astringent and slightly bitter in taste, aromatic and terebinthine and used as expectorant as well as tonic (The Siddha Formulary of India, 1992); each gall contains numerous dead insects. Roasted galls are taken with honey for cough asthma and diarrhoea in northern areas of Pakistan (Abbasi *et al.*, 2010). Furthermore, galls are also used against hepatitis and other liver disorders in Pakistan (Uddin *et al.*, 2012). Galls in combination of other drugs are also used against snake bite and scorpion sting (Ahmad *et al.*, 2010).

The phytochemical screening studies reported the presence of alkaloids, terpenoids, flavonoids and tannins



Fig. 2. Galls of *Pistacia chinensis* subsp. *integerrima* (J. L. Stewart ex Brandis) Rech. f.

in the gall which strongly contributes its medicinal properties. It is used in indigenous systems of medicine (Ayurveda, Unani and Siddha) as a remedy in cough, asthma, fever and respiration and liver disorders (AVS Kottakkal, 1995; Bhattacharjee, 2004) and also represents usage in the treatment of children's ear infections, suppress haemorrhage from gums and used to suppress nose bleeding (Kritikar and Basu, 1935; Sukh, 1997) and the galls are useful in pulmonary infections, diarrhoea and vomiting (Nadkarni, 1976).

In Siddha system of medicine, it is known as *karkatakashringi* used for various therapeutic values including diarrhoea, bleeding disorders, strain and toxic fever. It is the main ingredient of various Siddha formulations such as *kanat tailam* (fever, emesis, anemia and indigestion), *katukkay ilakam*, *kapata ilakam*, *naval pattai ney* and *valaippu vatakam* (menorrhagia). The dosage of gall powder is about 3 to 6 g and galls should be thoroughly cleaned for debris from insects and fungus prior to use (The Siddha Formulary of India, 2011).

Other pharmacological actions: Significant antioxidant activity was obtained for *P. chinensis* subsp. *integerrima* leaf and gall extract which was attributed to presence of phenolics in it (Ahmad *et al.*, 2020). Galls were reported to have significant analgesic and anti-inflammatory activity (Brantner *et al.*, 2003). Galls were found more potent than leaves as far as analgesic and anti-inflammatory activities were concerned however no acute toxicity was found on oral administration of extracts (Ahmad *et al.*, 2010). Galls of *P. chinensis* subsp. *integerrima* were also known to lower uric acid content in mice in a dose dependent manner (Ahmad *et al.*, 2020).

3.5.3. *Rhus succedanea* L. (Anacardiaceae): This plant is a deciduous tree of 10 m height found in low land and hill forests distributed in Japan, Korea, Thailand and Myanmar. In India it is found distributed throughout Assam (Anonymous, 2023). Leaf galls, commonly known as *karkatsringi* in Sanskrit are one of the appendages of the plant formed due to the invasion of insect - psyllids (Shreshta *et al.*, 2013). Galls are flower like or horn like depending upon to the species of aphid attack. The shape, size and structure of galls may vary in response to the infection (Yang *et al.*, 2010). Galls have been traditionally used to maintain digestive comfort and as an overall support of the respiratory tract. Its benefits to support bronchial and pulmonary functions have been well documented. It is said to have cooling and astringent properties and is primarily used to treat dysentery, intestinal hemorrhage, menorrhagia and spermatorrhea. They are used as a hemostatic agent and for treating patients with blood in their feces or urine. It was clinically shown to be able to treat trichomoniasis (Deshpande *et al.*, 2005; Santha *et al.*, 1991).

The phytochemicals reported were steroids, triterpenes, alkaloids, flavonoids and carbohydrates (Shreshta *et al.*, 2013). In Siddha system of medicine gall is used for bleeding piles and chronic ulcer (Arumugam, 2018). It is also an important ingredient of *thalisadi choornnam*, a

Siddha polyherbal formulation prescribed in the management of respiratory disorders of adults and children.

Other Pharmacological actions: *R. succedanea* leaf gall extracts have showed antibacterial activity against *Escherichia coli*, *Salmonella typhi*, *Micrococcus luteus* and *Staphylococcus aureus* (Shrestha *et al.*, 2013). Aqueous extract of leaf gall also possesses same efficacy (Kumar *et al.*, 2003). The potential antibacterial activity of leaf gall extracts of *R. succedanea* reveals its efficacy in using as natural drugs against bacterial infection.

3.5.4. *Garuga pinnata* Roxb. (Burseraceae): A deciduous tree growing up to 25 m in height, occurring in the Indo-Malaysian region. Within India, found almost throughout the tropical forests especially in moist deciduous forests. The leaf gall is used in traditional medicines. The gall insect is a psyllid and may be the gall-making psyllid, *Phacopteron lentiginosum* Buckton. Seeing from distance the galls look like fruits. The galls are very hard, outer reddish yellow coloured and inner reddish brown coloured with faint granular markings on external surface, oval shaped, sometimes beaked, 1.5 to 2.5 cm long and 0.8 to 1.2 cm wide with no characteristic smell or taste. The galls are characterized by the presence of flavonoids, glycosides, tannins and reducing sugars and is used in the traditional systems of medicine as anti-diarrhoeal drugs (Upadhye *et al.*, 2010). The local peoples of Western Ghats of Maharashtra use the gall (Upadhye *et al.*, 2010). The gall is often found mixed with market samples of *karkatakashringi*. Only a few studies have been conducted with these galls more research should go on to explore the phytochemistry and therapeutic efficacy of the plant since it is mentioned in traditional systems.

3.5.5. *Quercus infectoria* G. Olivier (Fagaceae): A small tree native to Greece, Asia Minor, Syria, and Iran; the gall is imported into India (The Siddha Formulary of India, 2011). Oak galls are the abnormal growth on young twigs of oak trees as a result of the deposition of the eggs of the gall-wasp, *Adleria gallae-tinctoriae* having many medicinal and pharmacological uses (Shrestha *et al.*, 2014). It is an important medicinal plant used in Indian systems of medicines. The gall is globose, hard and brittle with horny appearances or rounded projections on upper part of the gall; surface is smooth, shining, bluish-green, olive green or white, brown (Fig. 3); taste astringent, followed by sweetness and with unpleasant odour (The Siddha Formulary of India, 2011). It is hard, heavy and sinks in water and collected for medicine before the escape of insects (Ahmad, 2016). This is because at this stage the galls are deep greenish-yellow coloured, pyriform or spherical shaped and possess a soft inner tissue, tastes astringent and slightly sweet (Chatterjee and Pakrashi, 1991). This bluish gall is considered as best variety and more effective. If the insect goes out of gall it stops growth and becomes white coloured with a perforation *via* which insect escapes. This lighter and perforated graded as low variety (Ghani and Advia, 2011). Preliminary phytochemical screening showed the presence of phenols,



Fig. 3. Galls of *Quercus infectoria* G. Olivier

flavonoids, steroids, triterpenes, tannins, saponins and alkaloids (Shrestha *et al.*, 2014). The galls of *Q. infectoria* possess wound healing properties and used as an ethnomedicine (Jalalpure *et al.*, 2008).

In siddha system the dried leaf gall is known as *macikkay* which is used in important formulations such as *amirtatik kulikai*, *kanat tailam*, *puliyarai ney*, *pura mattirai*, *venpucani ney*, etc. The valuable medicinal activity reported in Siddha literatures are for mouth ulcers, genital discharge diseases and general debility diseases. The dosage of powder is 250 to 500 mg, twice or thrice a day (The Siddha Formulary of India, 2011).

Other pharmacological actions: The anesthetic and analgesic studies of gall extract have been studied and reported in animals (Rastogi and Mehrotra, 1993). The potential of galls of *Q. infectoria* as an anti-proliferative agent towards the cervical cancer cells and ovarian cancer cells has been recorded (Hasmah *et al.*, 2010). Antidiabetic activity of dried acetone-treated methanol extract of gall dissolved in water was studied for its hypoglycemic effect in an experimental model. The result revealed that it significantly reduced blood sugar level in rabbits (Dar *et al.*, 1976). A study was designed to evaluate anti-inflammatory effect of alcoholic extract of *Q. infectoria* galls on various experimental models of inflammation. Oral administration of gall extract significantly inhibited carrageenan, histamine, serotonin and prostaglandin E2 (PGE2) induced paw edemas, while topical application of gall extract inhibited phorbol-12-myristate-13-acetate (PMA) induced ear inflammation. The extract also inhibited various functions of macrophages and neutrophils relevant to the inflammatory response (Kaur *et al.*, 2004). *Q. infectoria* galls, at a concentration from 300, 600 and 1200 µg/ml exhibited a significant antibacterial effect expressed as minimum inhibitory concentration (MIC) against Gram-positive bacteria (Fathabad *et al.*, 2015). The galls possess potent antioxidant activity, when tested both in chemical as well as in biological models (Kaur *et al.*, 2008).

3.7. Plant galls used in other systems of medicine

Galls are commonly and effectively used in most of the Indian system of medicines. Various plant galls used in Siddha medicine for different ailments are discussed above. The other traditional systems like Ayurveda and Unani also uses the galls for the cure of plenty of diseases. The following Table will clearly explain the different galls and their therapeutic uses and the formulations used in Ayurveda and Unani systems (Table 3).

3.8. Economic importance of galls

Plentiful ethnobotanical studies have reported the usage of galls for diverse illness alleviation. Common plant galls with therapeutic applications include *Rhus*, *Pistacia*, *Quercus*, *Terminalia*, etc. Galls are rich in resins and tannic acid and have been used widely in the manufacturing of permanent inks (such as iron gall ink) and astringent ointments, in dyeing and in leather tanning (Fagan, 1918). Some plant galls are consumed in different geographical

Table 3. Various galls used in Ayurveda and Unani systems of medicine

| Sl. No. | Plant | Uses | Formulations | References |
|--|--|--|---|---|
| Galls used in Ayurveda medicine | | | | |
| 1 | <i>Pistacia integerrima</i> Stew. Ex Brandis (<i>Karkatakashringi</i>) | To treat vomiting, fever, loss of appetite | <i>Balacaturbhadrika churna</i> | Ayurvedic Pharmacopoeia of India, 1986 |
| 2 | <i>Rhus succedanea</i> Linn. (<i>Karkatakashringi</i>) | | | |
| 3 | <i>Quercus infectoria</i> G.Olivier (<i>Mayyakku</i>) | To treat digestive disorders, diarrhea, mouth ulcers, tooth ache | <i>Madayantyaadi churna</i> | Ayurvedic Pharmacopoeia of India, 2004 |
| Galls used in Unani medicine | | | | |
| 1 | <i>Quercus infectoria</i> G.Olivier (<i>Mazoo/Mazhuphal</i>) | Used in decoction or powder form for diarrhea, dysentery, and leucorrhoea. Applied as paste/powder on wounds and ulcers for wound contraction, drying, and healing. Used as tooth powder and mouth wash gum bleeding, inflammation, strengthens gums. Gargling with decoction in sore throat and tonsillitis reduces pain and swelling in throat and oral conditions. Treats leucorrhoea and used as vaginal astringent. Applied topically or used in skin disease formulations as act as an anti-bacterial agent. Helps stop minor internal or external bleeding. | <i>Majoon Muqawwi Dimagh</i> <i>Majoon Ushba</i> , <i>Safoof Mohazzil</i> | Unani Pharmacopoeia of India, 2007; Rehman et al., 2022; Chand, 2024; Ghani, 2011 |
| 2 | <i>Tamarix gallica</i> L. (<i>Kazmāzaj/Mayeenkalan</i>) | Galls used against watery fluxes and in chronic discharges as powder or decoction. A potent gall infusion makes a powerful astringent gargle and can be used locally to filthy sloughing ulcers and phagedenic buboes, as well as for stomatitis and sore throat. Powdered galls with Vaseline or any non-irritating oil form an effective ointment and are useful for ulcerating piles and anal fissures. Infusion of the bark or galls, in a dose of 4 to 5 ounces in a pint of water, is used for diarrhoea and dysentery, preferably in conjunction with an infusion of Chirā'tā. | <i>Habb-i-Pechish</i> <i>Safūf-i-Tha'lab</i> <i>Safūf-i-Sailān-ur-Raḥim</i> <i>Safūf-i-Hābis</i> <i>Habb-i-Qābid</i> <i>Sinūn-i-Supārī</i> | Usmānī, 2008; Unani Pharmacopoeia of India, 2009; Ateeq and Firdose, 2024 |
| 3 | <i>Pistacia integerrima</i> Stew. Ex Brandis (<i>Kakdasingshi</i>) | Acts as a strong expectorant and antitussive agent. Often used in decoctions or powders. Clears nasal and respiratory passages. Helps in easing breathing and reducing inflammation. Relieves bloating and gas. Carminative and reduce internal gas. | <i>Habb-i Diq al-Nafas</i> , <i>Tiriyaq-i Sual</i> , <i>Safoof-i Kakra Singhi</i> | Usmānī, 2008; Ram Lobhaya, 2019; Singhi et al., 2025 |

regions. Perhaps, the most popular gall of culinary importance is 'huitlacoche' or corn smut (Pataky and Chandler, 2003). Burls of the plants are a form of gall as well. Burls are adaptations to stress, be that climatic, mechanical, or pathogenic. So far, burls are harvested for furniture making, and not likely to be of any medicinal relevance (Patel *et al.*, 2018).

3.9. Discussion

Right through the extensive course of evolution, humans have equipped to make use of the galls as therapeutics to a great extent similar to other plant parts. Many of the plant galls are reported having medicinal properties and described in ethnobotanical and folklore literatures. The potent pharmacological actions rendered by these galls are due to presence of particular growth regulating chemicals and phytohormones produced during the gall growth and development. Different plant galls possess specific therapeutic actions based on the secondary metabolites and defensive chemicals produced in response to the gall inducing agent. These irregular growth forms show distinct phytochemistry from the normal plant tissues as they are formed under stress in presence of various effector proteins of invaders and also forces the plant to produce a large repertoire of metabolites which is not produced by them normally. Gene expression profiles indicate high levels of auxin and cytokinin activities in growing galls and the shakeup of the jasmonic acid pathway promote the tissue proliferation and the resultant galls (Yamaguchi *et al.*, 2012). The various physiological changes in the plants in response to gall formation affect the plant both positively and negatively. More research must be carried out to address this issue.

This review has analyzed the presence of various secondary metabolites in the galls mentioned in Siddha medicine. The different studies reported have confirmed that the plant gall extracts could be exploited for the treatment of several conditions described in folkloric medicine. All these five galls are with great medicinal value and possess various bioactivities such as antioxidant, antibacterial and anti-inflammatory effects. These biological activities of gall extracts can be attributed to the phytochemical constituents of phenolic and flavonoid compounds. Most of the studies reported the strong astringent effects of these galls and used for treating chronic diarrhoea, dysentery, etc. More research is needed to focus the therapeutic and pharmacological activities. Further steps should be taken to discover and bring the pharmaceutical products or biomedicines from the bioactive plant gall extracts.

4. Conclusion

This review gives a clear picture of bioactivity and pharmacological role of plant galls used in Siddha system of medicines. The five important galls which are mentioned in traditional literatures (*T. chebula* (nut gall), leaf gall), *G. pinnata* (leaf gall), *P. chinensis* (leaf gall), *Q. infectoria* (leaf gall) and *R. succedanea* (leaf gall)

possess antioxidant, antibacterial, anti-inflammatory and astringent effects.

Acknowledgements

The authors extend their heartfelt thanks to the Director General, CCRS, Chennai, Tamil Nadu, India for the support and to the Assistant Director in Charge, SCRI, Chennai, Tamil Nadu, India for the positive encouragement.

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