Ethno-pharmacology of *Quercus infectoria* Olivier – Galls: A Review

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Abstract

The galls of *Quercus infectoria* are globular in shape and from 10 to 25 mm in diameter. They have a short, basal stalk and numerous rounded projections on the surface. Hard and heavy, usually sinking in water, they are collected for medicinal use before the escape of the insect. The green galls are preferred to the white variety, in which the tannin is said to have been partly decomposed. White galls also differ from the other grades in having a circular tunnel through which the insect has emerged. They have a very astringent taste. Turkish galls are vegetable growths formed on the young twigs of the dyer's oak, *Quercus infectoria*, as a result of the deposition of the eggs of the gall-wasp *Adleriagallae-tinctoriae*. They are powerful astringent and styptic mainly because of the tannin content. Due to its astringent, tonic, antipyretic and styptic nature, it is useful in the infection of teeth and oral cavity, piles, acute diarrhea and dysentery and sprue, leucorrhoea and in colitis etc. The dry extract exhibits analgesic, hypoglycemic and sedative-hypnotic effect. The galls have been used in Unani Medicine (*Tibb-e-Unani*) and other Traditional Systems of Medicine from time immemorial. Keeping in view the medicinal importance of the drug, an attempt has been made in the present study to review the available literature on traditional uses, phytochemistry and pharmacological properties of *Quercus infectoria* Galls.

Keywords: *Quercus infectoria* Olivier – Gall, Tannin, Astringent

Introduction

The plant *Quercus infectoria* Olivier (Family-Fagaceae) grows as a shrub or small tree, diclinous and monoecious. It is about 2.5 m in height with many spreading branches. Bark is slightly grayish in colour. Leaves are rigid, glabrescent with spinous teeth measuring 4-6 cm in length; acorns cylindrical. They are alternate, short petiolate, elongate, sinuate, roughly thorny-tipped serrate. Flowers are unisexual. The male flowers are tangled into hanging, axillary catkins, with 6-8 tepaledperigone and 6 to 10 stamens. The female flowers are single or in small groups in the leaf axils of dropping stipules. The perigone is 6-tipped with an inferior 3 chambered ovary surrounded by an initially inconspicuous and then later cup shaped cupula. Fruits are globose, 0.63 cm, lemon in colour and tingled yellow. They are up to 4 cm long, cylindrical, shiny brown and are three times longer than the cupula and are covered with the narrow scale (Anonymous, 2000; Chatterjee & Pakrashi, 2005; Anonymous, 1969).

Turkish galls (Turkey galls; Galla) are vegetable growths formed on the young twigs of the dyer's oak, *Quercus infectoria* (Family - Fagaceae), as a result of the

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deposition of the eggs of the gall-wasp *Adleriagallae-tinctoriae* (Evans, 2002). The female fly lays the egg on or in the cambium of a young shoot. The egg develops into a larva and gets surrounded by tissues of the developing gall (Anonymous, 1969; Chatterjee & Pakrashi, 2005). The development of the larva probably stimulates the bud as an infection would and produces the gall as a reaction (Anonymous, 2000). Abnormal development of vegetable tissue round the larva is due to an enzyme-containing secretion, produced by the young insect after it has emerged from the egg, which by the rapid conversion of starch into sugar stimulates cell division. As starch disappears from the neighborhood of the insect, shrinkage occurs and a central cavity is formed in which the insect passed through the larval and pupal stages (Evans, 2002). The young larva that hatches from the eggs feeds upon the tissues of the oaks and secretes in its mouth a peculiar fluid, which stimulates the cells of the tissues to a rapid division and abnormal development, resulting in the formation of galls. The larva thus becomes completely enclosed in a nearly spherical mass, which projects from the twig, furnishing it with a supply of starch and other nutritive material. The growth of the gall continues only as long as the egg or larva reaches maturity and passes into a chrysalis, from which the fully developed gall-wasp escapes out of the hole in air with its mandibles in the side of the gall. The galls are collected before the insects escape for the medicinal purposes (Khare, 2004; Ghani, 2011). Finally, if the galls are not previously collected and dried, the mature insect or imago bores its way out of the gall and escapes. During these changes the colour of the gall passes from a bluish-grey through olive-green to almost white. After drying they are graded according to colour into three grades: blue, green and white (Evans, 2002). Mature dry galls may be smooth and lustrous as if varnished and chest-nut brown, but more usually rough and of grayish-brown colour. The galls collected at right stage have a soft inner tissue, deep greenish-yellow colour, very astringent taste and slightly sweet after-taste. They are pyriform or spherical in shape with 6-50 mm in diameter (Chatterjee & Pakrashi, 2005; Anonymous, 1969). The gall is graded into two types. The heavier, bluish outer surface and non-perforated is considered as best variety, as it is more effective. While the second one is white, lighter and perforated which is considered as low variety (Ghani, 2011).

Morphologically, galls are globular in shape and from 10 to 25 mm in diameter. They have a short, basal stalk and numerous rounded projections on the surface. The galls are hard and heavy, usually sinking in water. The so called 'blue' variety is actually of a grey or brownish-grey in colour. These and to a lesser extent the olive-green or 'green' galls, are preferred to the 'white' variety, in which the tannin is said to have been partly decomposed. White galls also differ from the other grades in having a circular tunnel through which the insect has emerged. The galls without the opening have insect remains in the small central cavity. Galls have a very astringent taste. Sections through a gall show a very large outer zone

of thin walled parenchyma, a ring of sclerenchymatous cells, and a small, inner zone of rather thick-walled parenchyma surrounding the central cavity. The parenchymatous tissues contain abundant starch, masses of tannin, rosettes and prisms of calcium oxalate, and the rounded so-called 'Lignin bodies', which give a red colour with phloroglucinol and hydrochloric acid (Evans, 2002).

Habitat

This tree grows in Greece, Asia Minor, Syria and Persia. Usually it does not grow in India and are imported (Nadkarni, 1954), but they may be found in Garhwal Himalayas and Nepal (Agarwal, 1986). The various Quercus species are originated in Iran, Iraq and Turkey, but are now widespread and particularly common in Asia Minor, Europe and North Africa (Anonymous, 2000). They are found throughout the Northern Hemisphere, in woods, forest and long hedgerows (Prajapati*et al*., 2003). There are various trade names of galls which are exported to India and other countries like Aleppo Gall, Mecca Gall, Turkey Gall, Levant Gall, Smyrna Gall, Syrian Gall, etc. These all varieties vary in their general appearance, colour and size. Aleppo galls from Asia Minor, is considered to be of best quality and have highest tannin content. The galls obtained from Eastern Europe are commonly known as Knoppers or Acorn Galls and are mainly formed on *Quercus robur* and other species. They are quite different in appearance from those of Aleppo or Turkish galls. The Bassorah Galls are collected from Tigris or Euphrates rivers in Iraq and shipped frequently to Mumbai are sometimes re-exported as Bombay or Indian Galls. Some galls which are employed in India may be collected from indigenous oaks are found in Kumaun, Garhwal and Bijnor forests (Anonymous, 1969).

Vernaculars

The plant is known by different vernacular names in different language, areas and traditions:*Uffes* (Arabic); *Shewadaru, Siyahdaru* (Afganistan); *Maajuphalaka (Bhaavaprakaasha), Maayaaphala* (Ayurvedic); *Majuphal*, *Majuphala* (Bengali); *Maiphala, Maiphal* (Bombay); *Pinza-Kani-si, Pyintagar-ne-thi* (Burma); *Machikai* (Can); Gall Oak, Aleppo Galls, Mecca Galls, Magic Nuts (English); *Maiphala* (Gujrat); *Majuphal, Majuphul, Mazu, Muphal* (Hindi); *Majuphala* (Maharashtra); *Manja-kani* (Malayalam); *Maazu* (Persian); *Keetavasa*, *Majuphul* (Sanskrit); *Mochakai, Mashikkai* (Siddha); *Machakai, Mashikai* (Tamil); *Mashikaya* (Telgu); *Maajuphal* (Unani) (Chatterjee & Parkashi, 2005; Khare, 2004; Nadkarni, 1954).

Mizaj (Temperament)

The Unani physicians have unanimously described the *Mizaj* of Mazu as Cold and Dry in second or third degree (Ghani, 2011; Kabiruddin, YNM).

Afa'al (Actions)

In classical Unani literature, various actions of the *Mazu* (*Quercus infectoria*) have been described in details such as *qabis, mujaffif* (Ibn Baitar, 1999), *habis-ul-dam, dafae taaffun* (Lubhaya, 1975; Kabiruddin, YNM; Naseeruddin, 2010), *manae sailan, muqawwi dandan* (Ghani, 2011). It also has *habis-e-haiz wa ratubat-e-rahem wa ishaal, mane ruaaf* (Hakim, 1999), and *musawwid-e-shaar* property (Usmani, 2008; Ghani, 2011).

Istemalat (Uses)

Mazu has been described to be useful in various ailments. Because of its qabiz and mujaffif property, it is used in excessive perspiration (*kasrate irq*) and also helps to cure foul sweating (*irque muntin*) on local application (Ghani, 2011; Naseeruddin, 2010; Kabiruddin, YNM). It helps to strengthen teeth and gums (Lubhaya, 1975; Hakim, 1999). It is added in tooth powders or used as a single drug in excessive watering of mouth (Khan, YNM; Qutbuddin, 1917; Naseeruddin, 2010; Kabiruddin, YNM). It is used as a sprinkling powder (*zaroor*) or as a gargle in *istarkhae-lohat*, tonsillitis, mouth ulcer (*qulae dahan*) and gingivitis (*warme lissa*). It helps to cure bad odour or foul smelling of mouth because of having *dafe ta'affun* property.

Its powder is sprinkled on *quruhe saiyah, namla* (herpes), *aakela* etc. It is used along with vinegar as *tila* in *daad* (ring worm), *daussalab*, *jhain*, etc (Naseeruddin, 2010; Kabiruddin, YNM). It is useful in eye diseases (Qutbuddin, 1917; Hakim, 1999), speciall epiphora, *salaque, jarabeaain* (blephritis) (Khan, YNM; Naseeruddin, 2010; Kabiruddin, YNM). It also possesses *habisud dam* property, so it is sprinkled on fresh wounds (Naseeruddin, 2010). It is used as a *niswar* in epistaxis (Ghani, 2011; Naseeruddin, 2010; Kabiruddin, YNM; Khan, YNM; Qutbuddin, 1917; Ibn baitar, 1999; Hakim, 1999; Usmani, 2008). Its powder is used as *zaroor* in *khurooje miqad* (anal prolapse), *warme miqad* (proctitis), *quruhe miqad* (anal ulcers) (Naseeruddin, 2010; Kabiruddin, YNM). Internally it is used in *qarhe ama'a* (intestinal ulcer), *sailanur rahem* (leucorrhoea), *kasrat-e-haiz* (menorrhagia) (Khan, YNM) and *ishaal-e-kuhna* (chronic diarrhoea), *baulud dam* (haematuria) and *isha'alud dam* (malena) (Naseeruddin, 2010). It is also used for hair dyeing (Ghani, 2011; Naseeruddin, 2010; Kabiruddin, YNM; Khan, YNM; Qutbuddin, 1917; Ibn Baitar, 1999; Hakim, 1999; Usmani, 2008). *Mazu* is locally applied along with *roghan-e-zaitun*, in *falij, laqwa, raasha, wajaul mafasil, niqras, irqunnisa* etc. Internally, it is used by various ways or along with honey in nerve and phlegm diseases like asthama, cough and pleurisy. Its powder is given orally in intestinal worms and ascites. It is used in the form of *joshanda* (decoction) for *idrare haiz*, and its *abzan* (sitz bath) is given to patients of dysmennorhoea (Lubhaya, 1975). Sitz bath also helps to relieve *khurooj-e-rahem*, and chronic

leucorrhoea (Ibn Baitar, 1999). It is also used as *muqawwi-e-bah* (Lubhaya, 1975). It helps in *tahleel-e-mawad* (Qutbuddin, 1917; Ghani, 2011).

Greenish oaks (galls) have a greater *qabiz* and *mujaffif* effect as they are graded colder in *mizaj* as compared to the other varieties. It prevents the absorption of morbid matter. It helps to strenghen the weak and lax organs. In case of bleeding, burnt *Mazu* is used because its astringent effect increases when it is burnt. *Mazu* is first roasted on coal and then dipped in alcohol and used in case of bleeding (Ibn Baitar, 1999; Ghani, 2011).

Mazu helps in treating all types of diarrhea whether acute or chronic. Oral use of its powder is useful in intestinal inflammation, menorrhagia (Ghani, 2011; Usmani, 2008). In case of excessive uterine mass, burnt *Mazu* is used to resolve the mass. Its ointment is used in chest and renal pain and in fractures. In children, it is used in umbilical hernia (Ghani, 2011).

According to Vaids, *Mazu* is used as antidote in many plant poisoning. It is also added in ingredients of medicine for health tonic. It is used to cure fevers which are frequent and irregular. Its powder mixed with water is applied on breast wound and in haemorrhoid. It is helpful in treating leucorrhoea and gonorrhoea. Powder of *Mazu* and *Post Anar* (*Punica granatum* fruit rind) is used in anal fissure (Ghani, 2011).

Muzir (Adverse Effect)

It produces adverse effect on chest and throat (Usmani, 2008).

Musleh (Corrective)

Samag-e-Arbi (*Acacia arabica* gum) is used as corrective when *Mazu* produces adverse effect (Usmani, 2008).

Pharmacological Actions (as described in ethnobotanical and traditional literature)

The drug *Quercus infectoria* gall is described in detail in ethnobotanical and scientific literature and various actions have been reported to be possessed by it. Some pharmacological actions and therapeutic uses are as follows:

Galls are powerful astringent and styptic (Nadkarni, 1954). This astringent effect of drug is due to its tannin content (Anonymous, 2000). Due to its astringent, tonic, antipyretic and styptic nature, it is useful in infections of teeth and oral cavity, piles, acute diarrhea and dysentery and sprue, leucorrhoea and is also beneficial in colitis (Chatterjee & Pakrashi, 2005; Razi, 1980). The dry extract exhibits analgesic, hypoglycemic and sedative-hypnotic effect (Anonymous, 2000).

Methanol extract of galls showed analgesic activity in rats and also demonstrated significant role in reducing the blood pressure in rabbits. Another fraction of the extract had a CNS- depressant activity and moderate anti tremorine activity in which it delayed the onset and decreased the severity of tremorine-induced tremors. It also has anaesthetic action by complete blockage of isolated sciatic nerve (Rastogi & Mehrotra, 1993). Ethyl acetate extract of the galls is found to be very effective in killing the mosquito larvae and is considered as a promising agent for the development of environmentally friendly larvicide (Satirapathkul & Leela, 2011). Gallnuts are potent germicide (Agarwal, 1986). They have also been known to produce many bioactive compounds with antibacterial, antifungal, antidiabetic, antiviral, local anesthetic, and anti-inflammatory properties. They also contain the mixture of tannin with anti-tumor activity, polyphenol with anti-venom activity, gallalic acid, methyl gallate and ellagic acid with anti-oxidant activity (Satirapathkul & Leela, 2011). It also has anti-ulcerogenic and gastro protective activities (Khouzami*et al*., 2009). Barks and acorns of the plant are astringent and hence used in intertigo, impetigo and eczema (Chopra *et al*, 1956; Nadkarni, 1954).

Therapeutic Uses

Mazu (oak galls) is used as one of the most powerful vegetable astringent in Indian medicine. It is used in the form of powder, decoction, infusion, ointment etc. As many compound preparations are heavy and difficult to digest, likely to upset stomach and may precipitate diarrhoea, Mazu is added in such recipe as an astringent. Its powder is added in a number of tooth powders for strengthening gums and teeth. A decoction or infusion is used as a gargle for throat relaxation, tonsillitis, stomatitis (Khare, 2004); sore throat (Chatterjee & Pakrashi, 2005). Its decoction is also employed as astringent wash, enema or injection (Nadkarni, 1954).Ointment made by the mixture of 1 part of finely powdered galls and 4-6 parts of Vaseline is used in cases of haemorrhoids (Chatterjee & Pakrashi, 2005), anal fissure and chapped nipples (Khare, 2004). In Unani System of Medicine, powder of galls mixed with vinegar is used in ringworm and alopecia. Its ointment is used in vaginal laxity, prolapse of rectum and diseases of anus. Its pessary is used in case of excessive vaginal discharges (Khare, 2004). Powdered galls may also be given internally in leucorrhoea and other vaginal discharges (Chatterjee & Pakrashi, 2005). Ash of *Mazu* or powder of *Mazu* and *Punica granatum* rind (*postanar*) is used locally in wound and ulcers as a dusting powder (Khare, 2004). The extract of galls is reported to beneficial in dysentery, diarrhoea and nasal catarrh. Powder of galls is given in case of diarrhoea, gleet (Lindley, 1984) and long-standing gonorrhoea (Nadkarni, 1954). Externally, it is used in the inflammation of skin, frostbite and as an adjuvant in the treatment of infectious

skin condition. It is also externally used for chilblains and gingivitis (Anonymous, 2000). In the advanced and very severe cases of diarrhoea and dysentery, the decoction proves to be very effective in dose of 1 ½ to 2 ozs, thrice daily along with the opium (Nadkarni, 1954).

In case of prolapse of rectum, daily use of an enema of galls decoction proves useful and in case of children, a pad saturated with its decoction may be kept over the parts after the protruded bowel is returned to its place. The same treatment is used in case of uterine prolapse with the decoction being used as a vaginal injection (Nadkarni, 1954).

Tannic acid in its pure form, as well as the gallic acid which is derived from the gall nuts are valuable styptics and astringents, useful in all internal haemorrhages, in excessive secretions from different parts of the body and for cutting short local inflammations as in various form of sore throats, nasal catarrh and gonorrhoeas. Tannic acid is used as antidote in case of poisoning with nuxvomica, datura, opium, and aconite root, after the stomach has been emptied by emetics. The decoction of galls is given in dose of 3 to 4 ounces, every quarter hour for 5 to 6 times in succession (Nadkarni, 1954).

In Indian system of medicine, it is used in intestinal haemorrhaging, haemoptysis, ulcerative stomatitis, coughs, bronchitis, dyspepsia, fever, impetigo, pharyngodynia, diabetes, hyperhidrosis etc. In Chinese medicine, it is indicated in dysentery, hyperhidrosis, hemorrhoids, wounds and rectal prolapse, but its efficacy have not been proven (Anonymous, 2000).

In western herbal medicine, the bark is used in the form of lotion or ointment for treating haemorrhoids, anal fissure and weeping eczema. Occasionally it is present in tea mixtures and gastro-intestinal remedies. Hot tea is recommended for swollen varicose veins. Internally and externally it is used for fomentation (Khare, 2004). Its woods are used for sport goods, and as a fuel etc (Agarwal, 1986). It is also used in the preparation of ink (Agarwal, 1986; Lindley, 1984)

Phyto-chemistry

The galls contain 50-70% of the tannin known as gallotannic acid. This is a complex mixture of phenolic acid glycosides varying greatly in composition. It is prepared by fermenting the galls and extracting with water-saturated ether (Evans, 2002). Tannin which is about 60-70% contains gallotannin, particularly hexa- and heptagalloyl- glucoses (Anonymous, 2000). The galls also contain gallic acid (about 2-4%), ellagic acid, sitosterol, methyl betulate, methyloleanolate, starch and calcium oxalate. Nyctanthic, roburic and syringic acids have more recently been identified. Tannic acid is hydrolysable tannin yielding gallic acid and glucose and

having the minimum complexity of pentadigalloyl glucose. Solutions of tannic acid tend to decompose on keeping with formation of gallic acid, a substance which is also found in many commercial samples of tannic acid. It may be detected by the pink colour produced on the addition of a 5% solution of potassium cyanide (Evans, 2002). The galls also contain gum, sugar and essential oil (Anonymous, 2005). An Aleppo gall contains 50-60% of tannin (tannic acid). A Chinese gall contains 70% of tannic acid. Oak bark contains upto 16% tannic acid to which it owes its effects. Pure gallic acid is in the form of white or colourless feathery crystals of a beautiful silky luster; it is a commercial acid. However, it is pale yellow in color, soluble in alcohol and also sparingly in ether. Its solution in water undergoes decomposition when exposed to air. Gallic acid is converted into meta-gallic acid when strongly heated (Nadkarni, 1954).Amentoflavonehexamethyl ether, iso-cryptomerine and beta-sito-sterol have also been isolated (Khare, 2004).

Pharmacological Studies

A number of studies have been carried out on *Quercus infectoria* galls in recent years showing that it possesses diverse pharmacological effects. Some of the important pharmacological effects are as follows:

Anaesthetic

The local anaesthetic action of a sub fraction prepared by chloroform-methanol extraction of *Quercus infectori* galls was found due to the complete blockade of the isolated frog sciatic nerve conduction. The data obtained indicates that it is a potent local anaesthetic. The action potential was completely abolished within 7 minute when an isolated nerve was placed in a 4% solution of subfraction (Dar *et al*., 1976; Khare, 2004, Rastogi & Mehrotra, 1993).

Analgesic

A dried acetone-treated methanol extract of *Quercus infectori* dissolved in water was studied for its analgesic effect in an experimental model using the rat tail-flick test. The result showed analgesic effect in rats (Dar *et al*., 1976; Rastogi & Mehrotra, 1993; Khare, 2004).

Anticancer

The study was carried out to determine the potential of galls of *Quercus infectoria* as an antiproliferative agent towards the cervical cancer cells and ovarian cancer cells. The toxicity *in vitro* was evaluated on non-malignant cell line. The results suggested that *Quercus infectoria* galls extracts have significant anticancer effect (Hasmah *et al*., 2010).

Antidiabetic

A dried acetone-treated methanol extract of *Quercus infectoria* 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).

Antihypertensive

Quercus infectoria galls have been reported to cause a significant reduction in the blood pressure in rabbits (Rastogi & Mehrotra, 1993).

Antiinflammatory

A study was designed to evaluate anti-inflammatory effect of alcoholic extract of *Quercus 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*., 2008).

Antimicrobial

In vitro antibacterial activity of methanol & aqueous extract of *Quercus infectoria* galls against several bacterial pathogens of the urinary tract infection was evaluated using disc diffusion method at the concentration of 5 mg/disc. Both the extracts showed similar inhibitory effects against 4 Gram-positive bacteria (*Staphylococcus saprophyticus, Streptococcus agalactiae, Streptococcus pneumonia* and *Enterococcus faecalis*) and a Gram-negative bacteria *Proteus mirabilis* (Saeida *et al*., 2014). It has also been reported to be effective against *Escherichia coli, Staphylococcus aureus, Salmonella typhimurium, Pseudomonas aeruginosa* and *Bacillus subtilis* in another similar study (Hashim *et al*., 2013).

Quercusinfectoria 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. In particular, *Staphylococcus aureus* and *Bacillus cereus* were the most inhibited (Ayub *et al*., 2015).

A study was carried out to evaluate the antimicrobial activity of the aqueous, ethanol and petroleum ether extracts of galls of *Quercus infectoria.* The result reveals that the ethanol extract showed maximum inhibition against *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans* (Sreekanth*et al*., 2013).

The antimicrobial activity of extracts of *Quercusinfectoria* galls prepared from different solvents was evaluated against a wide variety of pathogenic bacteria such as *Escherichia coli, Staphylococcus aureus* and *Bacillus subtilis*by the disc diffusion method. All the extracts of galls exhibited a good antimicrobial activitycompared to the commercial antibiotics. All the Gram-positive and all the Gram-negative bacteria tested were susceptible to all the aqueous and solvent extracts of galls (Satirapathkul&Leela, 2011).

Theactivity of differentextracts (petroleum ether, chloroform, methanol and water) of *Quercusinfectoria*gallsagainst the dental pathogens like *Streptococcus mutans, Streptococcus salivarius, Staphylococcus aureus, Lactobacillus acidophilus* (designated) and *Streptococcus sanguis* (isolated) were evaluated. All the four extracts inhibited the growth of all pathogens and methanolic extract was the most effective. The study concludes that *Streptococcus sanguis* showed greater sensitivity towards the methanolic extract (Vermani*et al*., 2009).

Antioxidant

Ethanolic extract of *Quercusinfectoria* galls was investigated for its antioxidant activity *in vitro* model systems. Its protective efficacy on oxidative modulation of murine macrophages was also explored. Galls extract was found to contain large amount of polyphenols and possess a potent reducing power. The result concluded that the galls possess potent antioxidant activity, when tested both in chemical as well as biological models (Kaur *et al*., 2008).

A study was conducted to determine the antioxidant activity of *Quercusinfectoria* galls, by using different *in vitro* methodologies. The antioxidant activity was determined by the 2,2-diphenylpicrylhydrazyl (DPPH) assay and a *â*-carotene bleaching assay and compared with that of the butylatedhydroxyl toluene (BHT). The result showed that among aquatic, ethanolic and methanolic, extract of *Quercusinfectoria*galls, water extract have high antioxidant activities (Ayub *et al*., 2015).

Antitremorine

A study was designed to evaluate a subfraction prepared by chloroform-methanol extraction of *Quercusinfectori* galls for its ability to antagonize tremorine-induced peripheral parasympathetic stimulation and parkinsonian like tremors of central origin. It exhibited moderate antitremorine activity at a dose of 500 mg/kg. It can be concluded that the fraction showed very little protection against tremorine-induced peripheral parasympathetic stimulation (Dar *et al*., 1976).

Bone Metabolism

A study was carried out to evaluate the potential role of *Quercus infectoria* galls extract on osteoblast function and Bone Metabolism. The phenolic compound or the polyphenols can act on the bone metabolism by modulating osteoblast proliferation, differentiation and mineralization, as well as osteoclastogenesis. In addition, elemental and physic-chemical analysis suggested the presence of important minerals in *Quercusinfectoria*, like calcium, magnesium, phosphorus, oxygen, potassium, aluminium, carbon, zinc, iron, manganese, nickel and silica. This study focused on the potential bone health benefits of the well-known traditional herbal medicine *Quercusinfectoria* (Hapidin *et al*., 2012).

CNS depressant

In a study central nervous system depressant activity of a subfraction prepared by chloroform-methanol extraction of *Quercusinfectori* galls was determined by observation of its effect on spontaneous motor activity and the righting reflex in mice (Dar *et al*., 1976)

Effect on inflammatory bowel disease

In an experimental study *Quercus infectoria* Olivier significantly prevented the changes induced by N-ethylmaleimide(NEM) in physical and oxidative stress parameters. There was also improvement in histological scoring like colon mucosal damage index (CMDI), disease activity index (DAI), microscopic scoring, macroscopic scoring, and histopathology of the treatment groups. The result of this study suggested that *Quercusinfectoria* therapy has beneficial effects on the course of experimental colitis (Roshni *et al*., 2011).

Conclusion

Galls of *Quercus infectoria* (*Mazu*) have been in use since times immemorial to treat wide range of indications. They have been subjected to quite extensive phytochemical, experimental and clinical investigations. Experimental studies have demonstrated their anaesthetic, analgesic, anticancer, antidiabetic, antihypertensive, antiinflammatory, antimicrobial, antioxidant, antitremorine, bone metabolism, CNS depressant and effect on inflammatory bowel disease. The scientific studies have proved most of the claims of traditional medicines. However, further, detailed clinical research appears worthwhile to explore the full therapeutic potential of this plant in order to establish it as a standard drug.

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