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A REVIEW ON THERAPEUTIC POTENTIAL AND PHYTOCHEMISTRY OF *TEPHROSIA PURPUREA*

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Abstract

Tephrosia purpurea is a wild herb belongs to the family fabaceae and commonly known as sharpunkha. It is distributed among India, Australia, China, Sri Lanka up to 400 m to 1300 m altitude. It occurs naturally in the waste places along the road sides and it prefers to grow in dry, gravelly or rocky and sandy soil. It is being used as folk medicine because of its several properties such as anticancer, antipyretic, antidiabetic, antiviral etc. Pharmacologically it is one of the most important herb because of its chemical constituents and various applications.

Keywords: *Tephrosia purpurea,* Phytochemistry, Wound healing, Antimicrobial, Antioxidant.

INTRODUCTION

The plants are employed in large scale as a medicine to treat several kinds of diseases for the human welfare from long time. *Tephrosia purpurea* belongs to family fabaceae and used traditionally as a folk medicine. According to Ayurveda it is called as "Sarwa wran vishapah" which means the ability to cure all kinds of wounds (Deshpandey *et al.,* 2003). It is being used as folk medicine because of its several properties such as anticancer, antipyretic, antidiabetic, antiviral, anti-inflammatory etc. It is one of the most effective folk medicine for the treatment of inflammation as well as enlargement of liver and spleen. Due to this property it is also known as plihari or plihasathru where plihari denotes spleen (Shivrajan and Balachandran 1993). This plant has also been used for the treatment of several gastrointestinal disorders and has ability to cure disorders related to bowel, kidney, liver and spleen (Zafar *et al.,* 2004; Rahman *et al.,* 1985). It is widely distributed among India, Australia, China, and Sri Lanka up to 400 m to 1300 m altitude. It occurs naturally in the waste places along the road sides and it prefers to grow in dry, gravelly or rocky and sandy soil (Orwa *et al.,* 2009). This plant has a number of chemical compounds which are medically important. These compounds include

tephrosin, isotephrosin, rotenone, tannins, purpurin, phytosterols etc. are present in different parts of plant.

Taxonomy
Kingdom - Plantae
Subkingdom - Tracheobionta
Division - Magnoliophyta
Class - Magnoliopsida
Subclass - Rosidae
Order - Fabales
Family - Fabaceae
Genus - *Tephrosia*
Species – *purpurea*

Vernacular names
Sanskrit - Sharpunkha
Hindi - Sarponkh
Rajasthani - Masa
Gujrati - Unhali
Urdu -Satawar
English - Wilde indigo, Fish poison
French - Indigo sauvage
Hawaiian - Auhuhu

Botanical description
T. purpurea is an annual or short lived, spreading or erect herb about 40 cm to 80 cm tall, rarely exceeding 1.5 m in length. Stem of this plant is slender, erect and decumbent at base. Leaves are imparipinnate having narrowly triangular stipules with size 1.5 - 09mm x 0.1 - 1.5 mm. Its rachis are up to 14.5 cm in length with petiole of 1 cm. Petiolule are 1 - 3 mm long having 5 - 25 leaflets which are obovate to narrowly elliptical. The terminal leaflet is of 7 - 28 mm x 2 -11mm in size where as lateral leaflets are having size of 5 - 30 mm x 2 -11 mm which are acute at base and has rounded to emarginated apex. Venation of leaves is distinct on both the sides. Its inflorescence is an axillary or leaf opposed pseudo- raceme with length (1.5-) 10-15(-25) cm long sometimes having basal leaf like bracts. Flowers of this plant are in fascicles of 4 - 6 with 2-6 mm long pedicle. Length of flower is 4-8.5 mm long having colour purplish to white. It has campanulate persistent calyx having cup size of 1.4-2.3 mm x 1.5-3.2 mm which is unequally 4-toothed inside pubescent teeth, standard broadly ovate, 3.5-7.3 mm x 5-10 mm, clawed; wings 2.5-6 mm x 1.5-3.8 mm, auricled on vexillary side, clawed; keel 2.2- 4.5 mm x 2-3 mm, auricled on vexillary side, clawed; stamens 10, staminal tube 4-6 mm long, filaments alternately longer and shorter, free part up to 3.5 mm long, vexillary filament free at base, connate halfway, 5-8 mm long; style up to 4.5 mm long, upper half glabrous, stigma penicillate at base. *T. purpurea* having linear, flat pod of size up to 2 - 4.5 cm x 3 -5 mm with up curved ending which is convex around the seed, flattened between, thickened margins and dehiscent with twisted valves having 2 -8 seeds. Seeds of *T. purpurea* are dark brown to black coloured, rectangular to transversely ellipsoid with size of 2.5mm x 1.8 mm (Orwa *et. al.,* 2009).

Folk uses
As in Ayurveda system it is called as “Sarwa wran vishapah” which reveals that it has the ability to heal any type of wound (Deshpandey *et al.,* 2003). It is being used as a home remedy for healing wounds. Several ethno botanical articles revealed this plant as a folk medicine and is being used for the treatment of cuts and wounds in broad spectrum. It is one of the effective folk medicine for the treatment of inflammation as well as enlargement of liver and spleen. Because of this property it is also known as plihari or plihasathru where plihari denotes spleen (Shivrajan and Balachandran, 1993). This plant has also been used for the treatment of several gastrointestinal disorders and has ability to cure disorder related to

bowel, kidney liver spleen (Zafar *et al.,* 2004; Rahman *et al.,* 1985). Its dried parts can be used effectively for the treatment of boils, bleeding piles, bronchitis etc. It also has diuretic property (Ashokkumar *et al.,* 2012). Its roots decoction is useful in enlargement and damage of liver. It can be used as mouthwash and very helpful against gingivitis (Bhavamisra, 1949). Its roots are able to cure several skin disorders, can be used in elephantiasis, flatulence, asthma, anemia, chronic fever. Moreover, roots and seeds of this herb can be used as insecticide as well as pesticide. Its roots being used as herbal fish poison by many hunters in Gunia. Its seeds oil has anthelmintic properties and also used in scabies and leucoderma. Leaves of this herb can be used in syphilis, gonorrhea, pectoral diseases etc. (Singh *et al.,* 2002)

PHYTOCHEMISTRY

T. purpurea has been studied for its chemical constituents and pharmacological activities. Phytochemicals isolated from *T. purpurea* includes flavonoids, estres, neoflavonoids, sterols, acids etc. (Table 1).

Roots:
Roots of this plant contains several important phytochemicals such as tephrosin, deguelin, isotephrosin, rotenone, tannins, purpurin sterols, glycosides which has been frequently used for the treatment of wounds, boils, pimples, liver and spleen diseases, useful for the treatment of asthma, chronic diarrhoea, helpful in enrichment of blood (Akansha *et al.,* 2014).

Seeds:
Seeds contain tephrosin, deguelin, quercetin which is helpful for the treatment of poisoning due to bite of rat (Akansha *et al.,* 2014).

Leaves:
Similar to roots and seed leaves are also have several important phytochemicals which are useful. Leaves contain osyritin, glycosides, rutin, rotenone, tephrosin, pongamol, semiglabrin. These are useful for the treatment of lungs diseases, piles, syphilis, and gonorrhea. These are also helpful for improvement of appetite (Akansha *et al.,* 2014).

Whole plant:
As listed above this plant contains the number of phytochemicals which are having several ethnopharmacological applications. This plant as a whole has lots of applications. It is anthelmintic, purifies blood, useful for the treatment of heart, liver and spleen diseases, useful for the treatment of leprosy, bronchitis, ulcers (Akansha *et al.,* 2014).

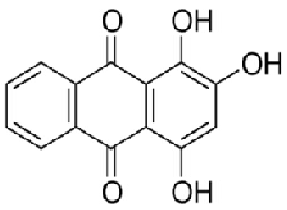
PHARMACOLOGICAL ACTIVITIES

T. purpurea has several pharmacological activities which are given below:

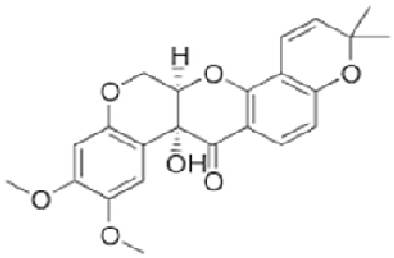
Antioxidant activity
Due to presence of several biologically active compounds *T. purpurea* has great antioxidant activity. Ethanolic extract of this plant showed potential against lipid peroxidative effect as well as enhanced antioxidant potential in DMBA (7,12-dimethyl benz(a)anthracene) painted animals (Kavitha *et al.,* 2006). Leaves of *T. purpurea* has antioxidant potential. Its ethanolic extract and ethyl acetate extract were studied for CCl_4 (Carbon tetrachloride) induced lipid and superoxide generation among which ethyl acetate has improved antioxidant activity (Palbad *et al*., 2014). Roots extract of *T. purpurea* showed free radical scavenging activity with oxidative stress and xanthine oxidase activity (Nile *et al.,* 2011). The aqueous extract of whole plant has potential of free radical scavenging activity in DPPH free radical assay (De Smet, 1998).

Table 1: Chemical constituents of *T. purpurea*

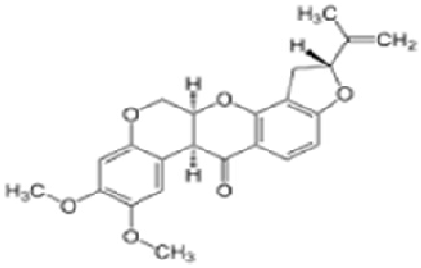
S. No.	Name of the compound and class	References
	Flavones	
1	Tephroglabrin	Pelter *et al.,* 1981
2	Tepurindiol	Pelter *et al.,* 1981
3	Apolline	Khalafalah *et al.,*2010
4	Terpurin flavones	Juma *et al*., 2011
5	Isoglabratephrin	Hegazy *et al*., 2009
6	Tephropurpurin A	Hegazy *et al*., 2009
	Flavans	
7	(+)- tephrosin A	Chang *et al*., 2000
8	(+)- tephrosin B	Chang *et al*., 2000
9	7,4'-dihydroxy-3',5'-dimethoxy isoflavone	chang *et al*., 1997
10	O-methyl pongamol	Pelter *et al*., 1981
11	(+)-tephrosone	Chang *et al*., 2000
12	(+)-tephropurpurin	chang *et al*., 1997
	Chalcones	
13	Purpuritenin	Sinha *et al*., 1982
14	6'-demethoxypraecansone B	Rao and Raju., 1984
	Other Flavonoids	
15	Purpureamethied	Sinha *et al*., 1982
16	quercetin-3-O-rhamnoglucoside	Pandey *et al*., 2015
17	Rotenone	Akansha *et al*., 2014
18	Deguelin	Akansha *et al*., 2014
	Sesquiterpenes	
19	Linkitriol	Khalafalah *et al.,* 2010
	Neoflavonoids glycoside	
20	serratin 7-O-[β-D-glucopyranosyl-(1→4)-O-β-D-galoctopyranoside	Saxena and Choubey., 1997
	Sterol	
21	β-sitosterol	Chang *et al.,* 1997; Parmar *et al.,* 1989
22	spinasterol-α	Chang *et al.,* 1997; Parmar *et al.,* 1989
	Acid	
23	Ursolic acid	Chang *et al.,* 1997; Parmar *et al.,* 1989



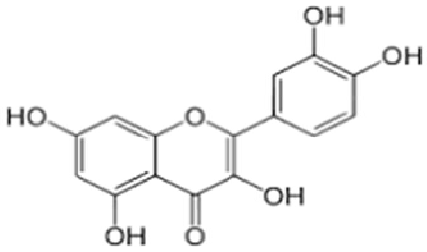
Purpurin



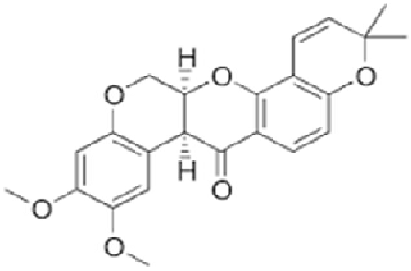
Tephrosin



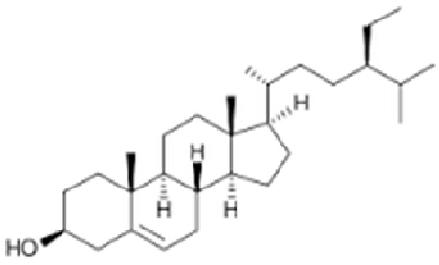
Rotenone



Quercetin



Deguelin



β- Sitosterol

Figure1: Some important phytochemicals of *Tephrosia purpurea*

Figure 2: *Tephrosia purpurea.*

Antimicrobial activity

Screening of antibacterial activity of *T. purpurea* ethanolic root extract showed considerable inhibition of three *Pseudomonas* isolates i.e. *P. aeruginosa* [NCTC 10662] *Pseudomonas* strain 1, *Pseudomonas* strain 2 and two *E. coli* strains i.e. *E. coli* strain 6 and *E. coli* strain 9 (Rangama *et al.,* 2009). In another study methanolic extract of roots of *T. purpurea* inhibit the growth of gram positive (*S. aureus, M. luteus* and *B. subtilis*) as well as gram negative bacteria (*P. aeruginosa* and *S. typhimurium*) (Soni *et al.,* 2006). Antimicrobial activity of ethanolic and methanolic extract of *T. purpurea* was tested against several gram positive, gram negative and fungal species. Both of the extracts gives moderate antimicrobial activity, antimicrobial activity increases with increase in the concentration of the extract from 25 to 100 mg/ml. Methanol extract at the concentration of 100 mg/ml showed highest activity followed by ethanol (Laishram *et al.,* 2013). Alcoholic extract of aerial parts of *T. purpurea* showed activity against *E. coli*, *Serratia marcesens* and *S. epidermidis* (Nivedithadevi *et al.,* 2012). Pelter *et al.,* (2006) reported that gram positive bacteria are more susceptible to extract in comparison with gram negative. According to Kumar *et al.,* (2007) this plant has potential antimicrobial property against the bacteria which induces acne. Singh *et al.,* (2002) reported that *T. purpurea* has antimicrobial property due to presence of flavonoids. Chinniah *et al.,* (2009) reported *T. purpurea* as anti – *Helicobacter pylori* agent. They found that methanolic extract of *T. purpurea* has more potential than aqueous extract of *T. purpurea.* Among different fractions of methanolic extract TPME- Fr-H and TPME- Fr-C were found active against metronidazole resistance as well as sensitive strains.

Wound healing potential

Akkol *et al.,* (2009) reported that *T. purpurea* has potential of prohealing and able to improve collagen maturation by cross linking. Its antioxidants help to prevent the damage caused by free radicals by quenching superoxide radicals. Lodhi *et al.,* (2006) also reported that ethanolic extract of *T. purpurea* have effective wound healing capacity because of increased fibroblast and collagen fibers promoting angiogenesis in wound. Ethanolic extract of this plant potentially stimulate wound contraction by increasing tensile strength (Akkol *et al.,* 2009).

Antidiabetic properties

Vijayakumar *et al.,* (2014) reported that hydroalcoholic extract of *T. purpurea* leaf powder significantly decrease the level of glucose in hyperglycemic animals. The aqueous extract of leaves of this plant is capable of controlling diabetes mellitus similar to that of glibenclamide in streptozotocin induced diabetic rats. Similarly oral dose of ethanolic seeds extract of this

plant significantly showed antihyperglycemic as well as antilipid peroxidative effects (Gupta *et al.,* 2008). Seed extract of *T. purpurea* resulted in increasing hexokinase and decreasing glucose – 6 – phosphatase activity in diabetic rats (Amor *et al.,* 2008).

Anticarcinogenic activity

Leaf extracts of *T. purpurea* in different solvents have good cytotoxic activity against MCF-7 human breast cancer cell line because of its flavonoids and phenolic compounds (Gulecha and Shivakumar 2011). Gnanarajan and Prakash**, (**2014) reported that methanolic extract of this plant showed great potential against n,n-diethylnitrosamine induced hepatocellular carcinoma in swiss albino. Kavita and Manoharan, (2012) found that ethanolic root extract of *T. purpurea* has potent chemopreventive efficacy and anti lipid peroxidative effect in DBMA induced oral carcinogens. According to Muralidhar *et al.,* (2014) aqueous and ethanolic extracts of roots of this plant showed potential anticancer activit against Ehrlich ascites carcinoma cells in swiss albino mice. Ethanolic extract of *T. purpurea* able to reduce TBARS (Thiobarbituric acid reactive substances) level and also enhances the antioxidants status in the circulation of 1, 2 - dimethylbenz -(a)- anthracenes painted hamsters (Duraipandiyan and Ignacimuthu, 2007).

Antiinflammatory activity

Ethanolic extract of whole plant (roots as well as aerial parts) gives dose related inhibition of both acute as well as chronic phase inflammation (Khatri *et al.,* 2009). Oral administration of ethanolic extract of *T. purpurea* shows significant anti inflammatory effect in subcutaneous inflammation (Smita *et al.,* 2010). Anbarsi and Vidya, **(**2015) reported that anti inflammatory activity of *T. purpurea* seeds extract is due to presence of several bioactive compounds such as flavonoids and triterpenoids. Ethanolic root extract of *T. purpurea* at dose of 200 and 400 mg/kg have significant effect in the management of inflammation and pain. It reduces the carrageenan induced paw edema volume in rats (Batini *et al.,* 2012). Gangwar and Ghosh (2016) reported that administration of 40 mg/ kg methanolic extract of *T. purpurea* stem showed effective inhibition in edema volume in carrageenan induced model because of high concentration of compound which inhibits prostaglandin synthesis.

Antileishmanial activity

N - butanol extract of *T. purpurea* showed antileishmanial activity against *Leishmania donovani* infection in hamster at the rate of 50 mg/kg for 5 days through oral route results were further confirmed in Indian Langoor monkeys (*Presbytis entellus*) (Sharma *et al.,* 2003). Byadgi, (2011) reported that among fractions of n-Hexane and n-butanol, n-butanol showed 80.72% inhibition at 50 mg/ kg p.o. X 5 dose as compared to sodium stibogluconate which gives 95% to 99% inhibition.

Immunomodulatory activity

The flavonoid fraction from aerial parts of *T. purpurea* (FFTP) was studied by Damre *et al*., (2003) for its effect on humoral and cellular functions and on macrophage phagocytosis in mice at the rate of 10 - 40 mg/kg. It potentially inhibited sheep red blood cells (SRBC) - induced delayed type hypersensitivity reaction when given by oral route. It also decreased erythrocytes specific haemagglutinin antibody titre in sheep. Although, it failed to show any change in macrophage phagocytic activity. Vinay *et al.,* (2010) reported that methanolic extract of aerial parts of *T. purpurea* showed significant immunomodulatory effect which was evaluated by carbon clearance and WBC count method in the group of animals.

Antiulcer activity

Deshpandey *et al.,* (2003) studied the effect of extract of *T. purpurea* on different types of ulcers. They found significant results in all the tests which were performed by them. Aqueous extract of *T. purpurea* significantly affects ethanol induced gastric ulcers at the dose of 1- 20 mg/kg. Whereas 10 and 20mg/kg give appropriate result on 0.6 M HCl induced gastric ulcers. On indomethacin induced gastric ulcer they required only 5-20 mg/kg. Similarly on cysteamine – induced duodenal ulcer 5- 20mg/kg is sufficient. For the pylorus ligands rats 5-10 mg/kg dose is beneficial for the significant reduction in gastric ulcer and total acid output as compared to control group.

Spasmolytic activity

Soni *et al.,* (2004) performed the experiment for spasmolytic activity from leaves on isolated tracheal tissue of guinea pig. The effect of alcoholic and water extract of *T. purpurea* was dose dependent and the action was prolonged with increase in dose. Similarly, Janbaz *et al.,* (2013) also tested spasmolytic effect of crude methanolic extract of whole plant of *T. purpurea* on isolated jejunum of rabbit for possible presence of spasmogenic and/or spasmolytic activity. The extract exhibited inhibitory effect on spontaneous contractions of isolated rabbit's jejunum preparations and was dose dependent.

Diuretic activity

Ashokkumar *et al.,* (2012) studied the diuretic effect of *T. purpurea* on male albino rats weighing 150 – 180 g and divided them into five different groups. Group I was served as control and was fed with normal saline. On other hand group II and III received osmotic diuretic urea (1 g/kg b.w.), high – ceiling diuretic and furosemide. Whereas group IV and V received the different concentration of METP (methanol extract of *T. purpurea*) (200 mg/kg and 400 mg / kg b.w.). All the test animals were placed at room temperature 25° ± 0.5° C without food and water for 24 hours. After 24 hours urine sample was collected and analyzed by flame photometer. They found that *T. purpurea* significantly increased the flow rate of urine, electrolyte excretion and maintains the pH as compared to control and similar drugs.

SEASONAL VARIATION

Pandey *et al.,* (2015) found that *T. purpurea* showed huge variation in the phytochemicals of the plant material collected in different seasons due to seasonal impact. They reported that total phenolic content as well as total flavonoid content of the plant were high in 95% ethanolic extract of the material collected in August contrary lowest in 50% hydroethanolic extract of plant material collected in December. They also found that most abundant flavonoid glycoside was quercetin-3-O-rhamnoglucoside in all the seasons. *T. purpurea* collected in summer (April), rainy (August) and winter (December) seasons were quite similar; however they showed marked differences in the quantitative content of the 3 major glycoside flavonoid quercetin-3-Orhamnoglucoside, biochanin A-7-Orhamnoglucoside and kaempferol-3-O-rhamnoglucoside. Total concentration of all three flavonoid glycosides were maximum in the 95% ethanolic extract of rainy (August) sample, followed by the 95% ethanolic extract of summer (April) sample and least in 50% hydro-alcoholic extract of winter (December).

Table 2: Summarized pharamacological activity of *T. purpurea.*

S. No.	Pharmacological activity	Part used	References
1	Antiulcer activity	Roots	Deshpande *et al.,* 2003
2	Anticarcinigenic activity	Roots	Kavitha *et al.,* 2006
3	Antimicrobial	Roots	Kumar *et al.,* 2007
4	Antiinflammatory	Roots	Gopalakrishnan *etal.,* 2010
5	Antioxidant	Roots, Leaves, Seeds	Shah *et al.,*2010; Patel *et al.,* 2010; Soni *et al.,* 2006
6	Ameliorates carbon tetra chloride induced hepatic injury	Roots	Sangeetha *et al.,* 2010
7	CNS depressant and analgesic activity	Roots	Valli *et al.,* 2011
8	Ameliorates benzoyl peroxide induced cutaneous Toxicity	Leaves	Saleem *et al.,* 1999
9	Alleviates phorbol ester induced tumour promotion	Leaves	Saleem *et al.,* 2001
10	Spasmolytic activity	Leaves	Soni *et al.,* 2004
11	Anti hyperglycemic and anti lipid peroxidative activity	Leaves	Pavana *et al.,* 2007
12	Anti Pyretic	Leaves	Kumar *et al.,* 2011
13	Anti hyperlipidemic activity	Leaves	Mustak *et al.,* 2012
14	Anthelminticactivity	Leaves	Manjula *et al.,* 2013
15	Ameliorates diethylnitrosamie and pot.bromate mediated renal oxidative stress	Whole plant	Khan *et al.,* 2001
16	Anti leishminal activity	Whole plant	Sharma *et al.,* 2003
17	Anti epileptic activity	Whole plant	Asuntha *et al.,* 2010
18	Anti carcinogenic and anti hypercholesterolemic	Whole plant	Kishore *et al.,* 2011
19	Anxiolytic activity	Whole plant	Kumar *et al.,* 2011
20	Diuretic activity	Whole plant	Kumar *et al.,* 2012
21	Anti diarrheal	Whole plant	Janbaz *et al.,* 2013
22	Hepato protective activity	Aerial part	Khatria *et al.,* 2009
23	Anti cholestic activity	Aerial part	Mitra *et al.,* 1999
24	Inhibition of mast cell degranulation and haemolysis	Aerial part	Gokhale *et al.,* 2000
25	Immunomodulatory activity	Aerial part	Damre *et al.,* 2003
26	Anti asthmatic activity	Aerial part	Lallubhai *et al.,* 2011
27	Wound healing activity	Aerial part	Chaudhari *et al.,* 2012
28	Antitumor activity	Seeds	Saleem *et al.,* 2001
29	Anti hyperglycemic and anti oxidant activity	Seeds	Pavana *et al.,* 2009
30	Antiviral activity	Flowers	Parmar *et al.,* 2010

BIOGENIC SYNTHESIS OF NANOPARTICLES

Metal nanoparticles are extensively exploited because of their unique physical properties, chemical reactivity and potential applications in various research areas such as antibacterial, antiviral, diagnostics, anticancer and targeted drug delivery (Bhumkar *et al.,* 2007; Jain *et al.,* 2009)**.** Biogenic synthesized nanoparticle in which biological material such as plants, fungi, bacteria are more frequently used. In this scenario green synthesis of metal nanoparticles by *T. purpurea* are also reported. Ajitha *et al.,* (2014) reported that green synthesized silver nanoparticles by extract of *T. purpurea* showed potential antimicrobial activity towards *Pseudomonas* spp. and *Penicillium* spp. compared to other test pathogens using standard Kirby–Bauer disc diffusion assay. In another study gold nanoparticles was synthesized by using leaf extract of *T. purpurea* which was rapid synthesis. Within few hrs gold ion makes contact with the leaf extract of *T. purpurea* and reduces AUCL4 in to fine gold nanoparticles. These nanoparticles potentially inhibit the growth of test organisms which were *Escherichia coli, E. faecalis, S. aureus and K. pneumoniae*. The gold nanoparticle conjugated with the Tetracycline antibiotics shows the high zone of inhibition in all the test organisms (Jisha *et al.,* 2012).

TOXICITY

Hussain *et al.,* (2012) performed acute toxicity test in swiss albino mice at the oral dose of 50, 300, and 2000 mg/kg and their behavioral changes and mortality was observed. For subcutaneous toxicity they took Wistar rats of either sex which were administrated with two doses 200 and 400 mg/kg and were observed for 28 days. They found that *T. purpurea* was well tolerated up to dose of 2000 mg/kg.

CONCLUSION

Main motto of this paper is to explore and provide information about the importance, recent advances and its therapeutic potential. As much as possible most of the information is provided over here. Due to its amazing chemical constituents it has several therapeutic as well as clinical applications such as antimicrobial, wound healing, antioxidant, anticancer etc. Biologically synthesized metal nanoparticles also drew attention towards them because of their cost effectiveness and therapeutic properties. Therefore *T. purpurea* is the plant of choice for future as its name given in Ayurveda ''Sarwa wran vishapah''.

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