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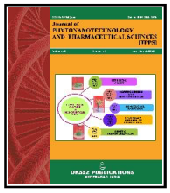

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Pharmacological uses of the plant *Trianthema decandra* (L.): A prospective review

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Abstract

The healthcare sector has a special place for natural products. As indicated by its use in numerous traditional and contemporary medical systems, the plant *Trianthema decandra* (L.) has gained attention as a possible medicinal source with significant advantages. As a result, we sought to compile an understandable summary of the pharmacological properties and traditional uses of the herb, *T. decandra* using the available literature and research. *Trianthema decandra* (L.), sometimes known as *Zaleya decandra* (L.), is a member of the genus Trianthema in the family Aizoaceae. The plant, an invasive weed that is native to tropical America, is also found in Australia, Burma, and Indo-Malaysia. It is sometimes found in Rajasthan, Uttar Pradesh, and Haryana within India. By offering a wide range of prospective evidence, this review paper will look more closely at the diverse pharmacological properties of *T. decandra*. It has been used to treat a variety of chronic and challenging illnesses, including cancer, cardiovascular disease, immunological modulator, hepatoprotective, diabetes, rheumatism, and anti-inflammatory, analgesic, and microbiological conditions. Due to the exorbitant expenses of contemporary allopathic care, traditional natural medicines have been and will continue to be a backbone in the majority of impoverished countries. We come to the conclusion that plant species have a richness of pharmacological capabilities and a great source of unique bioactive molecules among themselves.

1. Introduction

Nowadays, a lot of regularly used medications have herbal origins. Some are produced using plant extracts, while others are created to resemble a substance found in plants (Mukherjee *et al.,* 2008). *Trianthema decandra* (L.), also known as *Zaleya decandra* (L.) Burm. f., is a member of the Aizoaceae family and is referred to as Punarnani in Sanskrit and Gadabandi in Hindi. The global distribution of the plant includes Indo-Malaysia, Burma, and Australia. It may be found throughout Rajasthan, Uttar Pradesh, and Haryana in India. *T. decandra*, a glabrous weed with angular, striate, prostrate, or sub-erect leaves. Stems are elongate, prostrate, and not much-branched. Sub-fleshy, elliptic-oblong, rounded, and typically apiculate at the apex. The aperients in the root are reported to be beneficial for treating asthma, hepatitis, and menstrual cycle suppression. As an aperients, root-bark decoction is administered. The root is reported to be a particular treatment for orchitis when mixed up with milk and administered orally. One-sided headaches are relieved when the leaf juice is dropped (Kritikar *et al.,* 1999). The plant provides a reliable source of copper and zinc. In Andhra Pradesh, the roots are used as an eye tonic for cattle with eye injuries and disorders (Atukorala *et al.,* 1987).

1.1 Ethnopharmacology

Different systems of traditional medicine have accepted *Z. decandra* for the treatment of human illnesses and afflictions. Since ancient times, it has been used to treat a wide range of ailments, such injuries and burns, several contagious diseases and infectious diseases, fever, toothaches, hepatoprotective, analgesic, anti-inflammatory, and diabetic conditions, as well as other skin issues. It is also known to have curative properties. In Unani, *Z. decandra* and its species are employed in ancient medical systems like Ayurveda for their anti-inflammatory, anti-hyperglycemic, hepatoprotective, and antioxidant properties. Terpenoids, alkaloids, and flavonoids are just a few of the phytochemicals that have been identified in this genus but not in this species. Headaches may be treated with the leaf juice. Both hepatitis and asthma are treated with roots. A root-bark decoction is used as an aperient. Orchitis treatment involves using milk and crushed root (Chaudhri, 2004).

Figure 1: ***Zaleya decandra*** **(L.) Burm. f.**

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1.2 Phytochemistry

After undergoing phytochemical screening, the crude extracts from the pilot-scale extraction were found to include carbohydrates, glycosides, flavonoids, alkaloids, steroids, saponins, and terpenoids (Geethalakshmi *et al*., 2010). Using chromatographic and spectrophotometric methods, the bioactive components from *Z. decandra* were shown to include a total of 325 fractions, which were recovered from the silica gel column. In the TLC examination, the fractions 271-275th had a distinct spot with an Rf value of 0.62 cm, indicating a pure chemical. It has a maximum at 317 nm in the UV spectrum. Major functional groups are seen in the FTIR spectrum. The molecule is identified as oleic acid, which was isolated for the first time from *Z. decandra* based on the findings of NMR data (Malarvizhi *et al.,* 2016).

2. Pharmacological action

2.1 Anti-inflammatory activity

Using carrageenan, dextran, and mediator-induced models, the chloroform extract of *Z. decandra* was also assessed in acute and chronic situations. The release of histamine and 5-HT is thought to mediate the first phase of carrageenan-induced oedema, which is thought to be biphasic. The second phase is thought to be mediated by the release of kinin and prostaglandin. There was a maximum inhibition of 58.36% after three hours of medication administration in carrageenan induced paw edoema at the dosage of 200 mg/kg, indicating significant anti-inflammatory action. Histamine and serotonin have been linked to dextran induced paw odoema (Saravanan *et al.,* 2004).

Alkaloids, phytosterols, flavonoids, saponins, tannins, and phenolic substances were found in the chloroform and methanol extracts of the plant, according to preliminary phytochemical screening. *T. decandra*, a member of the Aizoaceae family, was tested for its ability to reduce inflammation using an *in vitro* technique called HRBC membrane stabilising action. The methanolic extract demonstrated superior activity to the chloroformic extract when we compared the HRBC membrane stabilising activity for both extracts in this approach. Both extracts demonstrated statistically significant (p<0.01) performance in a dose-dependent manner when compared to standard diclofenac sodium. The percentage of protection for methanolic extract and standard diclofenac sodium at 500 and 400 g was discovered to be 72.15 ± 1.58, 71.20 ± 0.89, 75.63 ± 0.81, and 71.51 ± 0.82, correspondingly (Veeresh *et al*., 2014).

2.2 Analgesic activity

The chloroform leaf extract of *Z. decandra* with hot plate and acetic acid-induced writhing response results in analgesic effects. It reacted in a dose-dependent way to thermic (heat) and chemical (acetic acid) pain stimuli. Whereas, peripheral analgesics are recognized to be ineffective on thermic pain stimuli, these two stimuli are a hallmark of central analgesics like morphine. The neoceptive process in the acetic acid-induced abdominal writhing, involves the rapid release of arachidonic acid by cycloxygenase and prostaglandin through biosynthesis. It shows that every dosage has a sizable antineoceptive effect, which might be produced by a decrease in the formation of a metabolite of arachidonic acid (Sampath *et al*., 2004).

2.3 Antidiabetic activity

Screening of plant extracts employing the α-amylase inhibition test was involved in developing *Z. decandra*'s antidiabetic efficacy. The *Z. decandra* extracts produced in petroleum ether, chloroform, and ethyl acetate were examined in the α-amylase inhibition assay. This, when applied to the non pre-incubation method, might be extended to find a possible antidiabetic activity. With a 60% inhibition at 3 min, chloroform extract was shown to have the greatest inhibitory impact on α-amylase. It was shown that ethyl acetate extract inhibited -amylase with a 47.48% reduction at 3 min. The experiment revealed that less starch was converted to maltose, according to decreased absorption intensity, and the experiment proved that the extract contains α-amylase inhibitory substances. This research might be used to create medications for diabetes and related symptoms (Geethalakshmi *et al.,* 2010).

The complex condition diabetes mellitus interferes with the metabolism of proteins, lipids, and carbohydrates. The treatment of diabetes mellitus involves the use of medicinal herbs. The goal of the current study was to assess the antidiabetic potential of *Z. decandra* roots in rats with diabetes brought on by alloxan. Throughout 15 days, oral administration of the root's ethanolic extract (200 mg/kg) significantly decreased blood sugar, cholesterol, triglycerides, protein levels, urea, creatinine, and peroxidation levels in diabetic rats. Experiment on the histology of rats with alloxan-induced diabetes revealed considerable alterations, including such necrosis and deterioration. Furthermore, it was shown that the *Z. decandra* extract administration had reversed these histopathological defects. The efficiency of the root extract in diabetic rats was demonstrated to be comparable to that of the widely used hypoglycemic drug glibenclamide (1.25 mg/kg) (Meenakshi *et al*., 2010).

Several diverse formulations employing medicinal plants are utilised to treat various illnesses, especially diabetes. The current study was carried out to analyse *in vivo* studies looking into the antidiabetic potential of the natural compounds in plant roots. The root extracts of 104 plants including *Z. decandra* were found to have definite anti-diabetic effects. The study's findings showed that flavonoids, phenolic compounds, alkaloids, and phytosteroids are the most common natural chemicals with antidiabetic effect in plant roots. Different mechanisms of action for controlling diabetes are possessed by phytochemicals in plant roots. Researchers have discovered that plant roots are a potential source of bioactive molecules that could be looked at to develop treatments for diabetes and its consequences (Ardalani *et al*., 2021).

2.4 Hepatoprotective activity

Aqueous extracts from the roots of *Z. decandra* were tested for their ability to prevent hepatotoxicity induced by carbon tetrachloride. To induce hepatotoxicity, male Wistar rats weighing 150-220 g were given equal dosages of carbon tetrachloride and olive oil i.p. once daily for seven days. Serum albumin, total protein, aspartate amino transferase, alkaline phosphatase, and alanine amino transferase were a few of the biological parameters employed to measure the extent of hepatotoxicity. The selected dosages were of 50 mg, 100 mg, 150 mg, and 200 mg/kg. Silymarin (25 mg/kg) is used as the standard for comparison. The results demonstrated that the liver damage brought on by carbon tetrachloride was reduced when *T. decandra* root aqueous extract was administered at dosages of 100 to 200 mg/kg (Sengottuvelu *et al.,* 2008).

2.5 Antibacterial activity

Using the disc diffusion technique, the antibacterial activity of *T.decandra* root methanolic extract was assessed against *Staphylococcus aureus* (NCIM 2079), *Bacillus subtilis* (NCIM 2063), *Escherichia coli* (NCIM 2065), *Pseudomonas aeruginosa* (NCIM 2036), and *Proteus vulgaris* (NCIM 2027) at a dose of 100 µg/disc. Chloramphenicol (30 µg/disc) is used as the standard for comparison. Significant antibacterial activity in the extract supports *T. decandra* root long-standing reputation as a potent remedy (Jaswanth *et al.,* 2002).

The Kirby-Bauer disc diffusion technique was used to examine the antibacterial properties of the synthesised nanoparticles. The wide range of applications for nanoparticles in markets such as medicine, chemistry, and energy has led to an increase in their commercial demand. In this study, a straightforward and environmentally friendly chemical process for producing gold and silver nanoparticles from *T.decandra* was developed. Stable gold or silver nanoparticles were produced quickly after *T. decandra* root extract was added to aqueous solutions containing chloroauric acid or silver nitrate. UV-Visible spectroscopy was used to examine the kinetics of the reduction of the gold and silver ions during the reaction. Gold nanoparticles were formed in a variety of shapes, including spherical, cubical, triangular, and hexagonal ones, according to field emission scanning electron microscopy, whereas silver nanoparticles were spherical. The dimensions of the silver and gold nanoparticles were 36-74 nm and 33-65 nm, respectively. Metallic gold and silver were found in the corresponding nanoparticles, as confirmed by energy dispersive X-ray and Fourier transform infrared spectroscopy. Eight different bacteria, including *S. aureus, S. faecalis, E. faecalis, E. coli, P. aeruginosa, P. vulgaris, B. subtilis, Y. enterocolitica,* and a fungus, *C. albicans*, were used to study the antimicrobial activity of the synthesized gold and silver nanoparticles. Based on a comparison of their sizes, silver nanoparticles are smaller than gold ones. Greater antimicrobial effects are produced by the smaller particles (Geethalakshmi *et al.,* 2012).

The naturally occurring substance flavonoid exhibits a wide range of pharmacological qualities, including antimicrobial activity. No target for action against flavonoid has yet been revealed, despite the fact that *P. aeruginosa* is inhibited by it. By using disc diffusion and minimum inhibitory concentration techniques, the anti *P. aeruginosa* activity of the 2-(3',4' dihydroxy-phenyl)-3,5,7-trihydroxy-chromen-4-one isolated from *T. decandra* was assessed. CDOCKER (Discovery Studio 2.0) was used for the molecular docking of the flavonoid isolated from *T. decandra*. The zone of inhibition for the flavonoid isolated from *T. decandra* was found to be 22 ± 0.04 mm at 20 µg/ml, while the zone for chloramphenicol was 23 ± 0.05 mm at 30 µg/ml. With MIC values of 39.05 µg/ml for the isolated flavonoid and 25 µg/ml for the standard control chloramphenicol, *P. aeruginosa* was discovered to be the most sensitive. Additionally, it was discovered that the flavonoid might potentially target the FAS II-hydroxyacyl-ACP (FabZ) of *P. aeruginosa* since it docked *in silico* successfully. Study has shown that a flavonoid isolated from *T. decandra* has anti *P. aeruginosa* activity, and it has also revealed a plausible mechanism of action by inhibiting the FabZ using *in silico* analysis (Geethalakshmi *et al.,* 2018).

2.6 Antifungal activity

Column chromatography was used to separate the essential oil from the chloroform leaf extract of *T. decandra*, and gas chromatography/mass spectrometry (GC/MS) was used to analyse it. A total of 23 elements were found, accounting for 99.98% of the oil. Eicosane (18.81%), tetracosane (16.17%), and other substances were the main components of *T. decandra* oil. Promising sources of antimicrobial activity include essential oils. *S. aureus*, *S. faecalis, E. faecalis, E. coli, P. aeruginosa, S. typhi, V. cholera, P. vulgaris, B. subtilis, Y. enterocolitica*, and fungi like *C. albicans* and *C. neoformans* were some of the chosen microorganisms. The essential oil has a diameter of inhibition zone ranging from 19 ± 0.01 to 24 ± 0.05 mm at a concentration level of 1 mg/disc, as determined by all 12 of the test organisms. Chloramphenicol and nystatin demonstrated diameter of inhibition zone ranging from 18 ± 0.05 to 23.6 ± 0.02 mm at a concentration of 30 µg/disc. The minimum inhibitory concentration of natural essential oil against species of bacteria and fungi ranged from 625 to 1250 µg/ml (Veeresh *et al*., 2016).

Gram-positive and negative bacteria, as well as *Fusarium* spp., were tested against *T. decandra* root and root callus extracts of various solvents, including petroleum ether, chloroform, ethyl acetate, and ethanol. Chloroform and ethanol based root callus extracts have shown notable efficacy against *B. subtilis* and *B. cereus*. The MIC for *S. aureus, S. epidermis*, and other species of gram negative bacteria such *P. aeruginosa, K. pneumonia*, and *Alcaligen* varies from 3.12 to 12.50 g/ml when compared to the root extract of *T. decandra* that comprises chloroform, ethyl acetate, and ethanol. The root callus extract of chloroform, ethyl acetate, and ethanol demonstrated efficiency against *F. verticilliodes, F. anthophilum, F. oxysporum*, and *F. proliferatum* with a lower MIC of 3.12 g/ml when matched to the root extract of *T. decandra*. The result demonstrates that root callus extract has higher antibacterial and antifungal activity than root extract (Radfar *et al*., 2012).

2.7 Aphrodisiac activity

The aphrodisiac activity of *T. decandra* methanolic extract was examined using an experimental model, *viz*., sexual behaviour under prolonged immobilization-induced stress in rats. According to OECD Guidelines No. 425, an oral administration of *T. decandra* alcohol extract to rats was used in an acute toxicity study to determine the LD_{50} up to a dosage level of 2000 mg/kg. The various doses were chosen to be $1/20^{th}$, $1/10^{th}$, and $1/5^{th}$ of the lethal dose. Two researchers concurrently monitored characteristics including mount latency, number of mounts, and thrusting in the model of prolonged immobilization-induced stress under the illumination of a 40 watt red lamp. *T. decandra* alcohol extract demonstrated aphrodisiac effects in a dose-dependent manner. The number of mounts, thrusts, and latency were significantly increased in the medium and high dosage treated groups. The findings revealed that *T. decandra* aerial portions had aphrodisiac properties, which may be explained by increased levels of testosterone, adrenaline, choline, and dopamine (Veeresh *et al.,* 2016).

2.8 Adaptogenic activity

Using experimentally induced stress models in mice and rats, the adaptogenic effect of *T. decandra* alcoholic extract was evaluated at different dosages. Experiments like oxygen starvation stress tolerance, swimming duration, cold-restrained stress, and forced swimming

stress were used to examine adaptogenic behavior. *W. sominifera* (100 mg/kg, p.o.) was used as the reference standard. The metrics anoxia stress tolerance time and swimming endurance time were measured, respectively, for anoxia-induced stress and swimming endurance models. The normal, stress-control, standard, and drug-treated groups' organ weights and levels of biochemical marker, on the other hand, were estimated for the other two models. Concurrent treatment with alcoholic extract at 100, 200, and 400 mg/kg led to a considerably longer period under anoxia stress than the control group in tests for anoxia stress tolerance and swimming endurance. Comparable results were obtained in both cold-restricted and forced swimming stress models, where concurrent treatment with alcoholic extract at various dosages led to a significant decrease in blood sugar, cholesterol, triglyceride, SGPT, and SGOT levels compared to stress control. All stress models show weight changes in the spleen, whereas the liver, kidney, and adrenal gland show greater weight changes. It was found that the adaptogenic activity of *T. decandra* alcohol extract may have also been influenced by the phytofragments found during GC-MS analysis (Veeresh *et al*., 2016).

2.9 Anticancer activity

T.decandra and *G. oppositifolius* are two herbs that Indian tribal people often use to treat cancer. Methanol extracts of *T. decandra* (METD) and *G. oppositifolius* (MEGO) were given intraperitoneally (i.p.) at a rate of 2 × 106 cells/mouse into adult swiss albino mice to test their anticancer efficacy. The mean survival time, tumour volume, life span, cancer cell count, haemoglobin level, RBC count, and white blood cell count were all examined to assess the anticarcinogenic properties of METD and MEGO at dosages of 100, 200, and 400 mg/kg, i.p., on mice. The lifespan of the tumor-bearing mice, as well as their RBC count and haemoglobin content, all increased significantly. In mice treated with METD and MEGO, the proportion of lymphocytes was likewise higher, and the amount of neutrophils was lower in the differential WBC count. In mice treated with METD and MEGO, the tumour volume and the proportion of living cells in ascitic fluid were both dramatically decreased. When compared to the conventional anticancer treatment, 5-fluorouracil (5-FU), administered intraperitoneally at a dosage of 2 mg/kg body weight, the results of the mentioned parameters showed that METD and MEGO considerably elicited potent anticancer activity (Kandar *et al*., 2012).

The effect of *Z. decandra* on the survival of HCT colon cancer cells *in vitro* has been studied using the MTT test along with acridine orange/ethidium bromide staining, cell viability, and apoptosis were evaluated. The permeability of the mitochondrial membrane was evaluated using rhodamine-123 staining. ELISA kits were used to evaluate the activity of caspases. Treatment with *Z. decandra* extract increased ROS generation in HCT cells and lowered mitochondrial activity, as seen by increased permeability of the mitochondrial membrane and a decrease in the reduction of tetrazolium salt. Cells treated with the extract showed the initiation of apoptosis as detected by acridine orange/ethidium bromide staining, which was associated with elevated levels of initiator and effector caspases in the conditioned medium. The author found that the, *Z. decandra* therapy showed potent apoptosis in HCT colon cancer cells (Deivasigamani *et al*., 2019).

The ethanolic extract of *Z. decandra* (EEZD), together with the ROS regeneration assay, measurement of mitochondrial membrane potential, determination of Caspase 3 and 9 levels, and AO/EtBr staining, were utilised to determine the cytotoxicity against PA-1 cells. To further isolate the active component responsible for the antiovarian cancer activity, the EEZD was fractionated based on TLC and HPTLC analyses. A variety of spectral analyses were used to isolate and characterise the isosterol that was obtained from the n-hexane fraction of EEZD. The anti-ovarian cancer activity of β-sitosterol was further studied. EEZD was discovered to have a strong cytotoxic impact on PA-1 cells based on the results of the MTT experiment. In PA-1 ovarian cells, EEZD has a clear dosage and time development impact; the IC_{50} value was estimated to be 230-55 g/ml at 24 h. The DCF-DA florescent test was used, and the results showed that *Z. decandra* (102.04 g/ml)-treated cells produced excessive ROS as revealed by elevated florescence. Rhodamine binding was decreased in the treated PA-1 cells, which indicated decreased mitochondrial activity. Caspase 3 and 9 calculations revealed that EEZD may inhibit ovarian cancer growth via a caspase-independent mechanism. The ROS-induced DNA destruction caused by *Z. decandra* in ovarian cancer cells is noticeable as stained by AO/EtBr and may be caused on by ROS-induced suppression of PARP-1 by *Z. decandra*'s compounds. According to the findings of the MTT experiment, the hexane fraction was further analysed for the isolation of the active ingredient. By reducing ROS generation, changing mitochondrial activity, and inducing apoptosis, β-sitosterol was extracted using a bioassay-guided method, which demonstrated exceptional anti-ovarian cancer action. Through increased ROS generation that changed the permeability of the mitochondrial membrane and decreased mitochondrial activity, *Z. decandra* encouraged the death of PA-1 ovarian cancer cells. By increasing the generation of ROS, changing the permeability of the mitochondrial membrane, and suppressing the activity of the mitochondria, the isolated beta-sitosterol induced the death of PA-1 ovarian cancer cells. These outcomes seemed to be the result of caspase-dependent mechanisms. The results supported further *in vivo* and clinical studies for a potential ovarian cancer treatment (Deivasigamani *et al.,* 2022).

2.10 Antiulcer activity

The ability of pet ether, ethyl acetate, ethanol, and aqueous extracts of *T. decandra* roots to restrict gastric acid secretion and defend the stomach mucosa from damage induced on by pyloric closure, swimming stress, acetic acid, and the cytodestructive chemical ethanol were investigated in rats. The dosage for the extracts was 200 mg/kg, while the dosage for the root's raw powder was 2 gm/kg p.o., and Famotidine (20 mg/kg, p.o.) was the reference medication used for comparison. Only in pyloric ligation and swim stress models did ethyl acetate extract and crude powder significantly reduce ulcer and secretory activity. All four extracts and crude powder demonstrated a noticeable cytoprotective benefit in rats with ethanol-induced peptic ulcer, with the ethyl acetate extract having a considerable impact on acetic acid-induced ulceration action (Jagannathan *et al*., 2012).

2.11 Antioxidant activity

T. decandra antioxidant activity was assessed using two methods: determining its total phenolic content and measuring its capacity to scavenge free radicals (DPPH). The Folin-Ciocalteu reagent was used to determine the total phenol content. For the purpose of determining the extract's capacity to scavenge DPPH free radicals, 1 ml of the extract was combined with 1 ml of Folin-Ciocalteu's reagent. Extracts were discovered to have the ability to scavenge DPPH radicals. The

ethyl acetate and methanolic extracts of *T. decandra* roots and leaves have been shown to have antioxidant activity. The results also showed that the leaves had more antioxidant activity than the roots (Sukantha *et al.,* 2012).

2.12 Toxicity study

Z. decandra has recently received attention for its pharmacological usefulness, including its hepatoprotective, antibacterial, antidiabetic, anti-inflammatory, and anticancer properties. *Z. decandra* has yet to be the subject of long-term toxicity research. In the current investigation, Wistar rats that received an initial dosage of 2000 mg/kg of ethanolic extract of *Z. decandra* (EEZD) orally gradually gained weight over time and seemed healthy with no signs of death. Even at the highest dosage of 500 mg/kg throughout the sub-chronic toxicity trial, the rats did not exhibit any notable weight gain or loss. Serum marker enzymes, biochemistry, and haematological parameters did not exhibit any dose-dependent changes in results. Furthermore, the histology micrographs demonstrated that the EEZD therapy had no negative effects on the tissue architecture of any of the important organs. As a result, the EEZD (500 mg/kg) is regarded as safe for 90 days. To support the results, more research into EEZD employing a more advanced pre-clinical model system is recommended by the current work. 39 phytoconstituents, including octadecenoic acid, hexadecanoic acid, and phytosterols including campesterol, sitosterol, and stigmasterol, were detected by the GC-MS analysis (Deivasigamani *et al.,* 2021).

2.13 Anticatract activity

T.decandra leaf methanolic extract was tested for its ability to prevent cataracts caused by galactose. The methanolic extract of *T. decandra* leaves (METD) protects against galactose-induced toxicity. Both *in vitro* and *in vivo* cataractogenesis were assessed. Rats were given a diet containing 300 g/l of galactose to induce cataracts. Three dosage levels, *viz*., 75, 150, and 300 mg/kg of body weight of METD were given orally. By adding galactose (30 mm/l) to the culture medium, rat lenses were put under osmotic stress. On the levels of glutathione (GSH) and polyols, the effects of METD (720 and 880 g/ml) were investigated. *In vivo*, METD dramatically slowed down the development and progression of cataract. The development of stage IV with lower dosages was delayed until the end of the study period in addition to the delay in reaching the different phases of cataract development. *In vitro*, lenses treated with METD 880 g/ml concentration had greater GSH levels and lower polyol levels. When compared to control, *in vivo* administration of 75 mg/kg considerably slowed the development and progression of cataract. In the experimental models, *T. decandra* slows the development of cataractogenesis. However, further research is needed to extend the therapeutic application in humans to prevent cataracts (Parmar *et al.,* 2019).

2.14 Anthelmitic activity

Z. decandra extract was used for its *in vitro* anthelmintic properties against the Indian earthworm *Pheretima posthuma*. Aqueous extract concentrations of 20, 30, 40, and 50 mg/ml were investigated. Drugs like albendazole were used as a standard. The parasite dies due to albendazole. The outcomes were presented in terms of the amount of time it took for paralysis as well as for *P. posthuma* to die. When compared to albendazole, the extract reached its peak potency at 50 mg/ml (Suresh *et al.,* 2016).

3. Discussion

This review's goal is to compile all pertinent data on the active botanical constituents, their structural makeup, and the biological activity of isolated or crude extracts of *Z. decandra* that have been previously reported in the published literature. Additionally, it seeks to clearly illustrate the patterns seen in research investigations using *Z. decandra*. *T. decandra* was found to contain mostly lignans, terpenes, flavonoid, and steroid. The scientific data on the pharmacological tests of this *T. decandra* alone or in a mixture with other plants demonstrates its medicinal volubility and need as a sustainable source of medicinally significant lead compounds (Latha *et al.,* 2021).

T. decandra has mostly been found to include flavonoids, which have been demonstrated to have promising anti-inflammatory, antimicrobial, analgesic, cytotoxic, antiproliferative, and antidiabetic properties. Many of the reported research studies included the use of cell culture models or diseases produced in lab animals. Therefore, additional evaluation of the suitability of the numerous bioactive compounds included in this *T. decandra* for therapeutic applications is still required. Even though several fundamental research studies have been conducted by numerous researchers worldwide, it is crucial to do further study using *T. decandra* (Vijayalakshmi *et al.,* 2022).

Since they are the foundation for compelling and repeatable pharmacological research, the specific phytochemical and pharmacological activity of this genus might reveal the individual bioactive compounds in *T. decandra* and their potential modes of action. We anticipate that this study will provide a succinct overview of the therapeutic potential of *T. decandra* and may assist future researchers who are interested in discovering innovative research leads and determining their clinical applicability *via* preclinical and clinical trials (Sivakumar *et al.,* 2022).

4. Conclusion

The medicinal herb *T. decandra* is well-known and effective. The current review study confirms the higher therapeutic value of *T. decandra*. The existence of phytochemical components and pharmacological effects demonstrated that the plant has the potential to play a key role in the future development of novel, efficient medicines. As a result, in order to identify and catalogue plants, thorough and methodical medical research is needed. This may be a useful means of promoting the traditional knowledge of herbal medicinal plants.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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