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Review Article

A Review on Wound Healing Activity of *Tridax Procumbens*, *Ficus Religiosa*, *Pelargonium Graveolens*

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ABSTRACT

Wound healing is considered to be the beneficial cellular and biological components that divide the scale in an effort to improve wound healing. Wound healing is defined as physiological phase and delayed wound healing will increase the risk of microorganism infection. Improved wound healing is done by reducing the time required for healing or to reduce the risk of miscarriage. So the researchers today are emphasizing on evolution & characterization of various plants & plant constituents against different diseases. The essential uses of many plants have been worked out & published but many useful and valuable plants are still unexplored upto date. There are some plants are *Tridax procumbens*, *Ficus religiosa* and *Pelargonium graveolens*. It has been used to treat wounds, skin disorder and to stop blood clotting in traditional medicines. It also has various pharmacological activities like hepatoprotective activity, anti-inflammatory, antidiabetic activity, hypotensive activity, immunomodulatory activity, dysentery, prevent falling of hair, promotes hair growth and antimicrobial activity against gram positive and gram negative bacteria. The phytochemical screening of these plants revealed the presence of chemical constituents like alkaloids, carotenoids, flavonoids (catechins & flavones), fumaric acid, tannins and saponins. The leaf of *Tridax procumbens* possess kaempferol, lutein, ferulic acid, tannins, stigmasterol & caffeic acid that shows antimicrobial, anti-inflammatory, antioxidant and anticancer activity.

INTRODUCTION

The current practice leads to the development of new wound care treatments, combining traditional healing agents with loading silver nanoparticles

into nanocabs, aloe elgin hydrogels, the use of advanced products in propolis and honey films coating hydrogel sheet. India has rich vegetation, which is widely distributed throughout the country. Herbal medicines are basis for the

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treatment and prevention of various diseases and condition in traditional practices such as Ayurveda, Unani and Siddha. The extracts from plants play an important role in traditional and Western medicine. Herbal medicine have been part of human development and health care for thousands of years. Plant-based herbs are commonly used in India and China. AWHO study reported that more than 80% of the world's population still rely on traditional medicine for various ailments. About 25% of medicinal plants in developed lands are based on plants and their derivatives, and the use of herbal remedies by indigenous peoples in rural areas in developing lands is well known[1].

a) Wound:

A wound is defined as an injury to the body (as from violence, accident, surgery) that typically involves laceration or breaking of a membrane such as the skin and usually damage to underlying tissues. There are two types of wounds :[2]

i. Open Wounds:

- **Incisions or Incised Wounds:** Caused by clean, sharp-edged object such as a knife, razor or glass splinter.
- **Lacerations:** A messy looking caused by tearing or crushing force. Lacerations and incisions may appear linear (regular) or stellate (irregular). The term laceration is commonly misused in reference to incisions.
- **Abrasions (Grazes):** Superficial wounds in which the topmost layer of the skin is scraped off. Abrasions are often caused by a sliding fall onto a rough surface such as asphalt, tree bark or concrete.
- **Avulsions:** Injuries in which a body structure is forcibly detached from its normal point of insertion. A type of amputation where the extremity is pulled off rather than cut off.

➤ **Puncture Wounds:** Caused by an object puncturing the skin, such as a splinter, nail or needle.

➤ **Penetration Wounds:** Caused by an object such as a knife entering and coming out from the skin.

ii. Closed Wounds:

➤ **Hematoma:** Is defined as a collection of blood outside of blood vessels. It occurs because the wall of the blood vessel (artery, vein or capillary) has been damaged and blood has been leaked into tissues. Hematoma is a term used to describe bleeding which has more or less clotted, different from hemorrhage which signifies active ongoing bleeding. A bruise is an example of hematoma. During surgery, hematomas are caused by an injury to the wall of blood vessels, promoting blood to seep into the surrounding tissues.

➤ **Crush Injury:** Caused by a great or extreme amount of force applied over a long period of time. Wound healing is a complex and dynamic process of replacing devitalized and missing cellular structure and tissue layers. The human adult healing process can be divided into 4 phases that's are hemostasis, inflammatory, proliferation and remodeling. Wound healing involves an interaction between epidermal cells, dermal cells, extra cellular matrix, controlled angiogenesis and plasma derived proteins which is all coordinated by an array of cytokines and growth factors.

b) Pathophysiology of Wound Healing: It consist 4 phases:

- Hemostasis
- Inflammation
- Proliferation
- Remodeling

Hemostasis phase: It is the mechanism that leads to cessation of bleeding from a blood vessel. It is a process that involves formation of fibrin that clots



the blood. This cascade culminates into the formation of a “plug” that close up the damaged site of the blood vessel controlling the bleeding.

Inflammation phase: Inflammatory phase focus on destroying bacteria and removing debris that prepare the wound bed for the growth of new tissues. During this phase, Neutrophils enter the wound to destroy bacteria and remove debris. These cells often increase between 24 & 48 hours after injury. As the white blood cells leave after three days, specialized cells called macrophages arrive to keep on clearing debris. These cells also secrete growth factors and proteins that attract immune system cells to the wound to facilitate

tissue repair. These phase lasts 4-6 days and is often associates with edema, erythema, heat and pain.

Proliferation phase: These phase focuses on filling and covering the wound. The proliferative phase consists of the 3 distinct stages: filling the wound, contraction of the margins and covering the wound which is also known epithelization. This phase lasts from 4-24 days.

Remodeling phase: During the remodeling phase the new tissue slowly gains strength and flexibility. In this phase, collagen fibers reorganize and increase in tensile strength of the tissue.

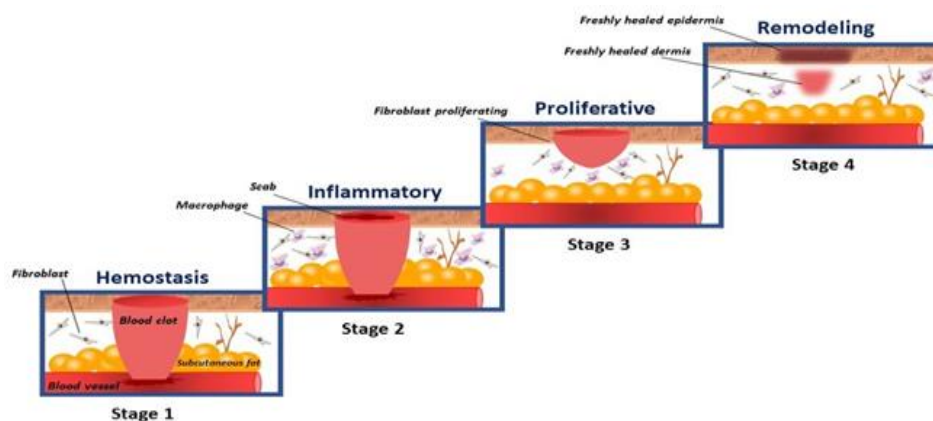


Fig.1. Phases of Wound Healing

1. Plant Profile

A. *Tridax procumbens*: The Tridax flower is called “Ghamra” and in English it is known as “Coat buttons” due to the emergence of flowers that have been widely used in the ayurvedic system of many diseases and are still being distributed to “Bhringraj” by a handful of authors who are a documented medicine for liver disease [1,2]. *T. procumbens* is weed that belongs to the family Asteraceae [4].

B. *Ficus religiosa*: It is commonly known as Peepal tree known to be a native Indian is a medicinally important tree species belonging to the Moraceae family [7,8]. This tree is popular indigenous system of medicine like Ayurveda, Siddha, Unnani and Homeopathy [9].

C. *Pelargonium graveolens*: It is commonly known as rose geranium is one of more than 250 species within the *Pelargonium* genus, belonging to the Geraniaceae family and that are native to the southern parts of Africa [12]



Fig.2 *Tridax procumbens*



Fig.3 *Ficus religiosa*



Fig.4 *Pelargonium graveolens*

i. **Taxonomical Classification:**

Table: Toxonomic Classification of *Tridax procumbens*, *Ficus religiosa* and *Pelargonium graveolens*

Toxonomic Classification	<i>Tridax procumbens</i> [1,2,3,6]	<i>Ficus religiosa</i> [7,9,10]	<i>Pelargonium graveolens</i> [13]
Kingdom	Plantae	Plantae	Plantae
Sub-kingdom	Tracheobionata	Viridiaeplantae	Tracheobionata
Division	Spermatophyte	Magnoliophyta	Magnoliophyta
Sub-division	Magnoliophyta	Spermatophytina	Spermatophyta
Class	Magnoliopsida	Magnoliopsida	Magnoliopsida
Sub-class	Asteridae	Dilleniidae	Rosidae
Order	Asterales	Urticales	Geraniales
Family	Asteraceae	Moraceae	Geraniaceae
Genus	<i>Tridax</i>	<i>Ficus</i>	<i>Pelargonium</i>
Species	<i>procumbens</i>	<i>religiosa</i>	<i>graveolens</i>

i. **Vernacular Names:**

Table: Vernacular Names of *Tridax procumbens*, *Ficus religiosa* and *Pelargonium graveolens*

Vernacular Names	<i>Tridax procumbens</i> [3,6]	<i>Ficus religiosa</i> [7,9,10]	<i>Pelargonium graveolens</i> [12,13]
English	Coat Button	Botree	Rose geranium
Hindi	Ghamra	Pipal	Ratanjyot
Sanskrit	Jayanti veda	Pippala	Indonesia: Daun Ambre
Oriya	Bishalya karani	Aswatha	Philippines: Malvarosa
Marathi	Dagadi pala	Peepal	
Telugu	Gaddi chemanthi	Ravichetta	Italy: Erba cancella
Tamil	Thata poodu	Ashwarthan	South Africa: Wildemalva
Malayalam	Chiravanak	Arayal	
Freanch	Herbe caille	Arbre de dieu	<i>Pelargonium</i> roast
Chinese	Kotobukigiku	Pu ti shu	Xiang ye

ii. **Biological Source:**

A. *Tridax procumbens*: It is found in the juice of fresh leaves.

Components used: Whole plant (leaf, stem, flower, root etc.) [5]

B. *Ficus religiosa*: It is found in stem, bark and leaves.

Components used: Whole plant (leaf, stem, bark, root, fruits) [7,8]

C. *Pelargonium graveolens*: It is an erect, much-branched shrub, leaves.

Components used: Whole plant, leaves, shrub. [14]

iii. **Local Source:**

A. *Tridax procumbens*: This plant is native to tropical America & is found in the tropics of Africa, Asia, Austrilia & India. It is a wild tree that is widely distributed throughout India [5]

B. *Ficus religiosa*: It is native to the Asia-tripocal (Bangladesh, India, Nepal, Pakistan, Chaina, Myanmar, Thailand, Vietnam & Iraq) & it is cultivated in wide tropical areas [10]

C. *Pelargonium graveolens*: It is native to Southern Africa, that has been introduced to Australia, eastern Africa, New Zealand, the Middle East & Island of Madagascar, and India & North Africa. [13]

iv. **Morphological Description:**

A. *Tridax procumbens*:

Leaves- Leaves are simple, opposite, entire, hairy & shortly petioled. It is 3-7cm long 45cm with long irregularly toothed margin.

Flowers- Flowers are small, tubular, whitish-yellow with hairs. It beare two types of flower-ray florest & disc florets with basal plants.

Fruit- It is hard achene coverd with stiff hairs & having a feathery, plume like white pappus at one end.

Seeds- Seeds have pendulous embryo, endosperm is absent.

Stem- Stem is herbaceous, cylindrical, decumbent & branched.

Root- *Tridax procumbens* has a tap root system. [3]

B. *Ficus Religiosa*:

Leaves- When the leaves first appear their colour is red-pinkish, but then they turn deep green and grow to about 12 to 18cm long. The alternate leaves are heart-shaped, shiny with an elegant tail-like tip which is often called a “drip-tip”.

Bark- Bark occurs in flat or slightly curved pieces, varing from 1-2.5cm or more in thickness; outer surface brown or ash colored.

Flowers- The small red flowers appear in February. The tree is dependent on its associated pollinator wasp, *Blastophaga quadraticeps* to set seed.

Fruits- Fruits are small, about half inch in diameter, similar to that of eye pupil. It is circular in shape & compressed. The tree fruits in May/June.[7,8,10]

C. *Pelargonium Graveolens*:

Leaves- It occurs in a variety of shapes & sizes, may be covered with fine hairs & may be rough, sticky or have a velvety texture. Leaf edges may appear ‘curly’ or ‘crisped’ in some species.

Flower- It occurs in a pseudo-umbel consisting of 1-50 individual flowers, but most have 5-10 florest. It may be white, pink, lavender, pale yellow or burgundy. [15]



2. Wound Healing Property:

A. *Tridax procumbens*: Leaf extract act by increasing granulation, hexosamine formation and hydroxyproline content of the granulation tissues of the wound thereby rapid collagen formation which leads to rapid wound healing. It increase rate of contraction, tensile strength and fasten epithelization of the burn wound by increasing biochemical tissue markers like hydroxproline, collagen & hexosamine. Histopathology, there is increase in granulation and dermal collagen content. There is also reduced polymorphonuclear leukocytes (PMNLs), congestion, oedema, mononuclear leukocyte infiltration that helps in healing of the wound.[2]

B. *Ficus religiosa*: Chronic non healing wounds result from the abnormal inflammatory response due to their lack of neutrophils which could affect wound repairing process. In the phase of inflammation and proliferation stage the repairing process delays the functionality of MMPs. That delay is due to the enormous tissue destruction, which causes the inflammatory cytokines & collagens to reduce the growth factor level in the wounds. [8]

C. *Pelargonium graveolens*:

Antibacterial & antiseptic: Geranium has antibacterial and antiseptic properties that can help with healing.

Coagulation: Geranium essential oil may helps minor wounds from bleeding by speeding up coagulation.

Blood vessel contraction: Geranium essential oil may help stop minor wounds from bleeding by causing blood vessels to contract.

Collagen fiber production: A study found that rats treated with a lipogel made from *Pelargonium graveolens* extract had increased collagen fiber production and maturation.

Epithelial repair: A study found that rats treated with a lipogel made from *Pelargonium graveolens* extract had significantly faster epithelial repair.

3. Properties And Methods:

Verification of plant material:

A. *Tridax procumbens*: Plant material was collected aerial part. The leaves are separated, dried and stored in a sealed container for further study.

Crop extraction: The collected leaves of *Tridax procumbens* Linn were washed and dried in the shade. Leaf extraction (cold maceration): 50gm of dried leaves of the plant. Apply 50gm dried portion to 250ml of ethanol/ ethyl alcohol/ chloroform/ methanol suspended it for 7days by stirring it from time to time. Sort by using the Whatman no.1 filter paper. [1]

B. *Ficus religiosa*: A fresh leaves were collected from the aerial part. Initially these were washed with fresh water to remove adhering dirt and foreign particles and dried at 35-40C in an oven.

Crop extraction: The dried leaves were crushed and grinded to get powder and weighed. The weighed powder was then placed with ethanolic solution in a cylinder. 500gm of powder in 1lit. of ethanol solution were macerated in 7days. The menstrum was removed and concentrated by vaccum distillation. Again the crude material was allowd to undergo maceration for 4days followed by 2days for complete extraction. The menstrum was collected and concentrated by vaccum

distillation and then air dried in an evaporating dish till constant weight was obtained. [11]

C. *Pelargonium graveolens*: The full-fledged vegetation *Pelargonium graveolens* a rose geranium grown in local area. Under tropical climate. The leaves were sun dried and made a suitable fine powder for experiment analysis.

Crop extraction: The pulverized plant material (10gm) was immersed in sufficient volume of each 100ml of methanol and ethyl acetate in an air tight flat bottom vessel for 3days with uneven shaking and stirring. The organic extracts were filtered and rotator evaporator to get final methanol and ethyl acetate crude extract. [14]

4. Phytochemical Features:

A. *Tridax procumbens*:

Leaf and other parts of *Tridax procumbens* are reported to contain flavonoids, alkaloids, carotenoids, hydroxycinnamates, lignans, benzoic acid derivatives, phytosterols, tannins, raw proteins, soluble carbohydrates and calcium oxide. [1] Flavonoids which are present in *Tridax procumbens* have the activity of anti-allergic, antiplatelet aggregation, antimicrobial, antiulcer, antiviral, hair growth. Antihepatotoxicity and wound healing. Kaempferol is the main flavonoid found in *Tridax procumbens* leaves. [2] The presence of fumaric acid, beta-sitosterol and petacyclic triterpenoid oleanolic acid has also been reported. Luteolin, glucoluteolin, quercetin and isoquercetin have reported in flower extracts. Some phytochemicals are found mainly in *Tridax procumbens* are 2,6-dihydroxyacetophenone, 2-o-b-d-glucopyranoside, echiodin, pinostrobin, dihydroechiodinin, tectochrysin-5-glucoside, methyl salicylate 5, glucoside, trimethoxyflavone, tectochrysin, 5,7,2-trimethoxyflavone, echiodin and andrographidine. [1,2,4,5]

B. *Ficus religiosa*:

Preliminary phytochemical screening of *Ficus religiosa* barks, showed the presence tannins, saponins, flavonoids, steroids, terpenoids and cardiac glycosides.

Bark: Phytosterols like, lanosterol, beta-sitosteryl-Dglucoside, bergapten, bergaptol and stigmasterol have been isolated from the petroleum ether and alcoholic extracts of the bark of *Ficus religiosa*. The bark comprise around 8.7% of total tannins content. Phenolic components, acid detergent fiber (ADF), neutral detergent fiber (NDF) and saponins have been identified in the inner bark of *Ficus religiosa*.

Fruits: Asparagine and tyrosine are the most abundant amino acids of the fruit pulp of *Ficus religiosa*. It also contain a considerable amount of flavonoids namely kaempeferol, quercetin and myricetin and other phenolic compounds.

Leaves: Leaves yield campesterol, stigmasterol, isofucosterol, alpha-amyrin, lupeol, tannic acid, arginine, serine, aspartic acid, glycine, theonine, alanine, proline, tryptophan, tyrosine, methionine, valine, isoleucine and leucine.

Seeds: It contains phytosterolin, sitosterol & its glycoside, albuminoids, carbohydrates, fatty matter and coloring matter.

C. *Pelargonium graveolens*:

The essential oil composition of *Pelargonium graveolens* was affected by crop duration & oil with best Citronellol. It is a complex mixture of over 120 monoterpenes & sesquiterpenes such as pinene, phellandrene, myrcene, limonene, germacerene and other organic compounds classified as terpenes, alcohols, esters, aldehydes, ketones & phenols etc., esters are citronellyl format and geranyl format. Monoterpenes are



linalool, citronellol, and geraniol. Ketones are menthone. Aldehydes are citronellal and geranial, coumarin. Other classes of chemicals including flavonoid methyl ethers and salicylic acid derivatives have been recorded in the leaf hairs or trichomes. It also includes phenolic acids, cinnamic acids, tannins, flavonoids and coumarins. The whole plant extract yield high quantity of essential oils. 32 compounds constituents 99.23% of geranium essential oil have been identified.[13,15]

5. Pharmacological Action:

A. *Tridax procumbens*:

- 1) **Hepatoprotective activity:** its hepatoprotective action was in d-galactosamine/lipopolysaccharide induced rats. D-gal N/LPS are hepatotoxic by its action of destroying liver cells. Its selectively blocks the transcription & indirectly hepatic protein synthesis causing endotoxin toxicity & leading to fulminant hepatitis within 8hrs of administration.
- 2) **Immunomodulatory activity:** Albino rats dosed with *Pseudomonas aeruginosa* when administered with ethanolic extract of leaves of *Tridax* showed stimulation of humoral immune response along with elevation in hemagglutination antibody titer. It also inhibited proliferation of *P. aeruginosa* along with significant increase in phagocytic index, leukocyte count & splenic antibody secreting cells.
- 3) **Wound healing activity:** *Tridax procumbens* opposed antiepitheization & tensile strength depressing effect of dexamethasone without affecting anticontraction & antigranulation action of dexamethasone. Aqueous extract was also effective in increasing lysyl oxidase, but to a lesser degree than whole plant extract. Further, it has been shown that extract of

leaves of *Tridax procumbens* promotes wound healing in rats in dead space wound healing model. The plant increases not only lysyl oxidase but also, protein & nucleic acid content in the granulation tissue, probably as a result of increase in glycosamino glycan content.

- 4) **Antidiabetic activity:** Aqueous and alcoholic extract of leaves of *Tridax procumbens* showed significant decreases in the blood glucose level in the model of alloxan induced diabetes in rats.
- 5) **Antimicrobial activity:** Methanolic extract of leaves of *Tridax procumbens* were found to be active against two tested fungi. The fungal strain of *A. niger* and *A. ocraceous* shows zone of inhibition 13mm & 12mm respectively where positive control produced zone of inhibition 11mm and 10mm respectively.
- 6) **Antiviral activity:** The therapeutic potential of *Tridax procumbens* extract were screened for antitrypanosomal properties in mice infected with *Trypanosoma brucei* by Abubakar et al & found insufficient anti trypanosomal activity, though stated that the modification of the detected phenolic compound may generate effective antitrypanosomal drug.
- 7) **Anti-inflammatory activity:** The anti-inflammatory action of leaf extract of *Tridax* was assessed on carrageen induced paw along with standard drug, Ibuprofen.
- 8) **Antioxidant activity:** Antioxidant prevents the damage done to cells due to free radical molecules released during normal metabolic process. The results of DPPH radical scavenging activity of *Tridax* against test sample & standard, gallic & ascorbic acid shows that *Tridax* possess very high percentage antioxidant activity, 96.70% at a concentrator of 250 µg/ml. it shows the reductive potential of 0.89mm. *Tridax* extract



may have hydrogen donors thus scavenging the free radical DPPH with High AA% of 96.70% at 250µg/ml which was observed to be higher than those of standard at concentration of 250µg/ml used. Thus *Tridax* plants are rich source of natural antioxidants.

- 9) **Anti-arthritis activity:** *Tridax* at 250 & 500 mg/kg has displayed significant antiarthritic activity comparable to that of indomethacin. The ethanolic whole plant extract of *Tridax* extracts an anti-arthritis activity by significantly altering the pathogenesis during FCA induced arthritis in female SD rats without exerting any side effect. [3,4,5]

B. *Ficus religiosa*:

- 1) **Analgesic activity:** Sreelekshmi et al. investigated the analgesic activity of the *F. religiosa* stem bark methanolic extract using the acetic acid induced writhing model in the mice. Aspirin were used as standards drugs. It exhibited reduction in the number of writhing of 71.56 and 65.93% respectively at a dose of 250mg/kg and 500mg/kg. the abdominal constriction is related to the sensitization of nociceptive receptors to prostaglandins. Thus suggested that extract showed the analgesic effect probably by inhibiting synthesis or action of prostaglandins.
- 2) **Anti-inflammatory activity:** The methanolic extract of stem bark of *Ficus religiosa* Linn. Was screened for its anti-inflammatory activity in Wistar albino rats and analgesic effect in Swiss albino mice. A significant inhibition of carrageen-induced rat paw oedema, comparable to that produced by indomethacin, the standard anti-inflammatory drug was obtained with all the three doses of the extract. A significant inhibition of acetic acid induced writhing in mice was observed with two doses of the extract.
- 3) **Wound healing activity:** The wound healing activity was investigate by excision and incision wound models using *F. religiosa* leaf extracts, prepared as ointment (5&10%) were applied on Wistar albino strain rats. Povidine iodine 5% was as standard drug. High rats of wound concentration, decrease in the period for epithelialisation, high skin breaking strength were observed in animals treated with 10% leaf extract ointment when compared to the control group of animals. It has been reported that tannins possess ability to increase the collagen content, which is one of the factor for promotion of wound healing.
- 4) **Antidiabetic activity:** The antidiabetic effects of an aqueous extracts of *Ficus religiosa* bark in normal glucose loaded hyperglycemic and streptozotocin (STZ) induced diabetic rats, at the dose of 25, 50 and 100 mg/kg were investigated. The effect was more pronounced in 50 and 100mg/kg than 25mg/kg. FRAE also showed significant increase in serum insulin, body weight and glycogen content in liver and skeletal muscle of STZ-induced diabetic rats while there are significant reduction in the levels of serum triglyceride and total cholesterol. FRAE also showed significant antilipidperoxidative effect in the pancreas of STZ induced diabetic rats.
- 5) **Immunomodulatory activity:** The immunomodulatory effects of alcoholic extract of the bark of *Ficus religiosa* (Moraceae) in mice was investigated. The study was carried out by various hematological and serological tests. Administration of extract remarkably ameliorated both cellular and humoral antibody response. It is concluded that the extract possessed promising immunostimulant properties [7]
- 6) **Antibacterial activity:** Aqueous and ethanolic extract of *Ficus religiosa* leaves

showed antibacterial effect against *Staphylococcus aureus*, *Salmonella paratyphi*, *Shigella dysenteriae*, *S. typhimurium*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *S. aureus*, *Escherichia coli*, *S. typhi*.

7) Antioxidant activity: The literature showed that the antioxidant properties of the extract of *Ficus religiosa* fruit and bark were done using different solvents. They were evaluated on the basis of oil stability index together with their radical scavenging ability against 1,1-diphenyl-2-picrylhydrazyl (DPPH).

8) Hypolipidemic activity: Dietary fiber content of food namely peepalbanti, cellulose and lignin were predominating constituents in peepalbanti, fed at 10% dietary level to rats, induced a greater resistance to hyperlipidemia than cellulose. Teent had the most pronounced hypocholesterolemic effect that appeared to operate through increased fecal excretion of cholesterol as well as bile acids. Dietary hemicelluloses showed a significant negative correlation with serum and liver cholesterol and a significant positive correlation with fecal bile acids. The dietary fiber influenced total lipids, cholesterol, triglycerides and phospholipids of the liver to varying extents.

9) Hypoglycemic activity: Oral administration of *Ficus religiosa* bark extract at the doses of 25, 50 & 100mg/kg was studied in normal, glucose-loaded, and STZ (streptozotocin) diabetic rats. The three doses of bark extract produced significant reduction in blood glucose levels in all the models. The effect was more pronounced in 50 & 10mg/kg than 25mg/kg. *Ficus religiosa* also showed significant increase in serum insulin, body weight and glycogen content in liver and skeletal muscle of STZ-induced diabetic rats, while there was significant reduction in the levels of serum triglyceride & total cholesterol. *Ficus religiosa* also showed significant antilipid

peroxidative effect in the pancreas of STZ-induced diabetic rats. The results indicate that aqueous extract of *F. religiosa* bark possesses significant antidiabetic activity. [9]

10) Antimicrobial activity: Ethanol extract of the *Ficus religiosa* was screened for antibacterial activity against *Enterococcus faecalis*, *Proteus vulgaris*, *Staphylococcus saprophyticus*, *Shigella flexneri*, *Shigella sonnei* and *Shigella dysenteriae*. The minimum inhibitory concentrations against these bacteria were within the range of 250-250µg/ml.

11) Acetylcholinesterase activity: Methanolic extract of the stem bark of *Ficus religiosa* inhibited the acetylcholinesterase enzyme, accordingly this indicated that the plant was beneficial in Alzheimer's disease treatment [10]

C. *Pelargonium graveolens*:

1) Cardiovascular system protection effects: Cardiovascular diseases (CVDs) affecting the heart or blood arteries are the main cause of death globally. CVDs are expected to kill about 23 million individuals per year by 2030. Importantly, geranium has been shown to have considerable antiatherosclerotic, antihyperlipidemic, antidiabetic and antihepatic steatotic effects on major CVD risk variables. Polyphenols in geranium have been proven in a recent research to protect against CVDs, such as, myocardial ischemia-reperfusion damage, heart failure, arrhythmia and hypertension. Geranium showed also hepatoprotective activity induced by free radicals.

2) Anti-atherosclerotic effect: Atherosclerosis (AS) is most typically found in the subintimal space (intima) of arteries and is caused by endothelial dysfunction and subintimal lipoprotein retention. Geranium and its primary terpenoids, including linalool

and geraniol have been shown to diminish Dil-ox-LDL. Uptake by RAW 264.7 Macrophages, reducelipopolysaccharide-Induced NFkB activation in RAW-Blue Macrophages and halting chronic inflammatory processes reactions via preventing foam cell formation by different mechanisms Targeting macrophages, metabolism and responses to oxidative stress and inflammation in atherosclerosis may therefore, constitute a therapeutic strategy for addressing this condition.

- 3) **Anti-hyperlipidemic effect:** Hyperlipidemia, described as elevated levels of blood lipids, is a well-known risk factor for cardiovascular diseases. The main fundamental mechanism of hyperlipidaemia resistance is related to suppressing and boosting lipid consumption, conversion and excretion. Linalool may lower plasma cholesterol levels by inhibiting the expression of 3-hydroxy-3-methylglutaryl-CoA reductase (HMGCR), a hepatic cholesterol production maker. Moreover, geraniol altered cholesterologenesis by reducing the amount of expression of membrane-related Ras proteins in the hetero-transplanted animals without affecting overall Ras protein levels.
- 4) **Antidiabetic effect:** Diabetics mellitus (DM) is now defined as altered lipid, protein and carbohydrate metabolism, as well as an elevated risk of vascular disease consequences. The reports explored *Pelargonium graveolens* antidiabetic properties as well as possible action mechanisms. The current study clearly demonstrates that geranium and its components not only have significant hypoglycemic effects, reduce lipid peroxidation processes and boost antioxidant defense mechanisms.
- 5) **Anticancer effect:** Cancer is world's second largest cause of death, killing 10million people by 2020. According to the World Health

Organization, cancer is responsible for approximately one in every six deaths worldwide. Geranium has found in studies to be beneficial against several human malignancies, including bladder cancer, breast cancer, cervical cancer, cholangiocarcinoma, colon cancer, stomach cancer, leukemia, ling cancer, melanoma and myeloma. [13]

- 6) **Antibacterial activity:** The antimicrobial activity of extracts of *Pelargonium* and their constituents is reported against bacterial (*Staphylococcus aureus*, *Streptococcus pneumonia*, *Escherichia coli*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Pseudomonas aeruginosa* & *Haemophilus influenza*), fungal (*Microsporum canis*, *Microsporum gypseum*, *Aspergillus fumigates*, *Mucor racemous*, *Rhizopus nigricans*) and pathogens as well as opportunistic yeasts such as *Candida albicans*, *Candida glabrata*, *Candida krusei* and *Cryptococcus neoforms*.
- 7) **Anti-tubercular activity:** Immune modular of the host is a potential course for antimycobacterial activity. Root extracts of *Pelargonium graveolens*, *Pelargonium reniforme* and *Pelargonium sidoides* evaluated for antitubercular assay by BACTEC method revealed that acetone, chloroform and ethanol extract of *Pelargonium reniforme* showed activity against *M. tuberculosis* exhibiting a minimum inhibitory concentration of 5×103mg/L. The reputed benefit of the two *Pelargonium* species in respiratory tract infections may be due in part to a stimulation of the immune system.
- 8) **Antifungal activity:** According to Food and Agriculture Organization (FAO), one quarter of the world's food crops are affected by mycotoxins each year. About five billion people in developing countries worldwide are at risk of chronic exposure to aflatoxins through contaminated foods and aflatoxicosis



has recently been recognized as sixth amongst the ten most important health risks identified by the world Health Organisation for developing countries.

- 9) **Antioxidant activity:** Polyphenols are the major plant compounds it free radical quenching and antioxidant activity. This activity is belived to be mainly due to their redox properties which play an important role in adsorbing and neutralizing free radicals, quenching singlet and triplet oxygen or decomposing peroxides.
- 10) **Anthelmintic activity:** Nematicidal activity of essential oil of *Pelargonium graveolens* and its major constituents namely citronellol, geraniol and linalool were determined against the root-knot nematode *Meloidogyne incognita*. Geraniol was found to be the most effective constituent followed by citronellol and linalool. The water distillate of the fresh flowers *Pelargonium endlicherianum* exhibit anthelmintic activity.
- 11) **Antiplasmodial activity:** The non-volatile extract of *Pelargonium panduriforms* (provenance SBG) exerted the greatest antimalarial activity against the choloroquine-resistant Gambian FCR-3 strain of *Plasmodium falciparum* by hypoxanthine incorporation assay. *Pelargonium citronellum* (provenance NBG), *Pelargonium citronellum* (provenance SBG), *Pelargonium quercifolium* (provenance SBG) and *Pelargonium radens* possessed similarly potent antimalarial activity. The *Pelargonium citrosa* leaf extracts having significant biting deterrency completely inhibited the larval, pupal and adult developments of malarial vector, *Anopheles stephensi*. The highly bioactive compounds of *Pelargonium citrosa* leaf extracts could be used to develop naturally occurring insecticides, an alternative to the expensive

and environmentally harmful organic insecticides. [15]

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