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Review Article

Phytopharmacological Insights into *Ricinus communis*: A Comprehensive Overview

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ABSTRACT

Medicinal plants are used in the traditional medicinal system and in Ayurveda globally. *Euphorbiaceae* is a large family which contains more than 3000 species. *Ricinus communis* or castor bean plant is well-known plant of Ayurveda. The herbal and natural medicines are the cost-effective and they have lesser side effects than currently available medicines in the market. *Ricinus communis* has many phytoconstituents such as ricinine, ricin A, ricin B, ricin C, ricinoleic acid, Y-sitosterol, fucosterol, stigmasterol, ricinus agglutin etc. which are responsible for various pharmacological activities. Traditionally, it has various pharmacological properties such as antioxidant activity, antifertility activity, antiulcer activity, antidiabetic activity, antimicrobial activity, hepatoprotective activity, immunomodulatory activity, bone regeneration activity, cytotoxic activity, anti-inflammatory activity etc. They also exhibited free radical scavenging potential along with repellent properties. The main objective of this review is to reveal all updated information's like phytochemicals, pharmacological activities of *Ricinus communis* by scientific evidences.

Keywords: *Ricinus communis*, Medicinal Plants, Phytochemicals, Pharmacological Activities, Herbal Medicines.

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INTRODUCTION

Plants are the rich source of various phytochemicals, carbohydrates, proteins, alkaloids, saponins, flavonoids etc. which are used in traditional medicine system for a long time. In traditional medicine, there are various natural, herbal and medicinal plants are used for their safety in many disorders and efficacy and *Ricinus communis* is also one of them. *Ricinus communis* is an indigenous and perennial flowering plant which is generally called as castor oil plant. It is a member of the *Euphorbiaceae* family. It is very important plant of traditional medicine. It has various phytoconstituents which are important for pharmacological activities. Every parts of this plants are useful. Its seed is not an authentic bean. Castor is primitive to the India, south-eastern Mediterranean Basin and Eastern Africa. India is the top seeds producers and seeds are the rich source of castor oil.[1-3]

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VERNACULAR NAMES

Ricinus communis L. is also referred to as "castor plant" and "palm of Christ" in Oriya. The plant is known as various names in different languages such as Verenda (Bengali), Endi (Hindi), Errandi (Marathi), Diveli (Guajarati), aamanakku, aimugi, amanakkam ceti (Tamil) alambuda, audla, aralu, avudala (Kannada), amandam, avanacu, avanakka, avanak (Malayamalam), Amanda, amangala, bhanda, chankuka, panchangulam, citra (Sanskrit), bedanjir (arand), hab-ul-as, bikh erandi, roghan baid, mghze tukhm arandi (Urdu), bedanjir, darakhte-bedanjir, darakhte-bedanjir-khurd (Persian), bazrul-khirvaa, khurva, bazrul-khirvaaus-saghir (Arabic) and aamudamu, amadum, amdi, aamudamu chrttu, amidapu (Telugu).[3-6]

TAXONOMIC CLASSIFICATION

Ricinus communis L. belongs to kingdom Plantae having order Malpighiales. The tribe Acalypheae belongs to the subfamily *Acalyphoideae* of the *Euphorbiaceae* family. It has 32 genera and 12 subgenera. *Ricinus communis* is the sole member of the monotypic genus Ricinus.

GEOGRAPHICAL DISTRIBUTION

Although it is primarily an African native, this plant is also grown in many other equatorial and subequatorial region of the earth. This is also found in India and it is cultivated at high level. Almost everywhere in the world where there is tropical and subtropical humidity, it has escaped cultivation and grown to become acclimated as weed.[5]

BOTANICAL DESCRIPTION

Ricinus communis is an ornamental plant which is a lanky glabrous, leafy, branching shrub that resembles a tiny tree. It may reach up to 39 ft. in height. Leaves are 15-45 cm long and reddish green in colour.[2-8]

Leaves

Leaves are stipulate, alternate, broad, long-petiole, nearly orbicular, peltate palmately veined with 12 deep lobes; lobes membranous, acute or acuminate, gland serrated and oblong to linear. Upper base is longer while lower base is shorter. Leaves are 15-45 cm long. Leaves are glossy which are green to purplish or reddish-green in colour with a large petiole. They are slightly flattened or cylindrical. 1-2 mm-diameter glands in the shape of saucers that are attached to the petiole.

Fruit

The fruit of *Ricinus communis* is greenish capsule, spiny, oval, bean like and its seeds have varying brownish mottling and are extremely toxic. Seeds of this plant have a warty adjunct and it is called as the ridge that is a kind of elaiosome. The ridge improves the dispersal of the seed with the help of ants.

Seeds

Seeds are oblong, carunculate and 1-1.5 cm long. They contain fleshy or oily endosperm and a testa that is smooth, hard, speckled and crustaceous. Embryo is thin which has flat immense cotyledons.

Root

The upper root provides off profuse branches. The braches of root are greyish in colour, straight and tortuous at the end. Surface of integrated root carries protensive corrugations entity at their end. Corrugations of this pant are deep and appear functioning lateral in the case of young roots. Fully developed lenticels arise erratically on mature roots. When they are younger, they are spherical, but as they age, they become longer.

Bark

The external surface has neat longitudinal wrinkles with shiny yellowish brown colour. It arises mostly in delicate elliptical portion which is four to seven millimeters (4-7 mm) wide. Scares are available as the elimination of rootless. The cork sheds escape shiny patches at a few areas. Internal region is slightly yellowish brown in colour. Astringent taste and fracture is slightly fibrous.

Habitat

Tropical Africa is where it originated. It flourishes in the drier parts of India, where the altitude ranges from sea level to roughly 1000-2000 m. It is harvested in the gardens, fields and also usually found run wild nearby habitations by waste lands and roadsides.

Season

Generally, it is appeared in the month of June-July but sometimes it may be appeared in the month of September-October. The annual types are growing mid of "Rabi" and eternal types are developing mid of "Kharif".

Morphology

Ricinus communis is a rapid-developing plant which has suckering eternal shrub likely 6 m or more than that but naturally it is not hard. Generally, it is harvesting for the production of oil at high amount. The colours of leaves are reddish to green which are 15-45 cm in length and it has the 5-12 wide lobes with coarsely irregular section. The flowers are 30-60 cm in length and the stems are differing in complexion. Fruit has 3-celled prickly capsule. Seeds have different colour and size. Seeds are 4-12 wide and 8-18 cm in length which have oval shape. Testa is soft, brittle and thin. Seeds of *Ricinus communis* are warty appendage which is known as caruncle.[2,3,6]

Pharmacognostical studies

Ash values are useful for assessing the quality and purity of unprocessed pharmaceuticals, particularly when they are in powder form. According to some analyses, combining sulfuric acid with the powdered crude medication prior to ashing is preferred and the resulting sulfated ash is typically less flammable than regular ash.[5,6] When the components of a drug cannot be easily calculated by any other method, extractive values of crude drugs are helpful for their evaluation. Additionally, these Figures reveal the makeup of a crude drug's ingredients.[8,9]

PHYTOCHEMICAL CONSTITUENTS

Ricinus communis contains various types of phytoconstituents such as saponins, glycosides, alkaloids, steroids, flavomoids etc. Every parts such as leaves, root, fruits, seeds etc. have the different chemical constituents which are very essential for pharmacological activities.[6,8-10]

Fatty acid

Ricinoleic acid (12-hydroxyoctadec-9-enoic acid), a fatty acid, was found in castor seed oil. Over 84% of the fatty acids contained are ricinoleic acid, while the more fatty acids are linoleic (7.3%), oleic (5.5%), palmitic (1.3%), stearic (1.2%) and linolenic (0.5%), respectively.[11]

Triacylglycerols

There are five identified strain of castor bean seed oil triacylglycerols: triricinolein, RRR (84.1%), RRdiricinoleoylstearoylglycerol, RRS (8.2%), diricinoleoyloleoyl-glycerol, diricinoleoyllinoleoylglycerol and diricinoleoylpal.[12]

Essential oil

Compounds including α-thujone (31.71%), α-pinene (16.88%), camphor (12.92%) and camphene (7.48%) have been identified during GC-MS analysis of *R. communis* crucial oil using capillary columns.[13]

Triterpenoid saponin

The Triterpenoid Saponin, 3-O-*β -Dglucoronopyranosyl-(1 three), was present in the *Ricinus communis* Seeds. The chemical name for this compound is α-Lrhamnopyranosyl-(1-2) -β-D-glucopyranosyl4,20-hydroxymethylolean-12-ene-28-oic acid.[14]

Flavonoid

The dried leaves of *R. communis* appearanced the existence of some flavones glycosides kaempferol3-Oβ-D-xylopyranoside, kaempferol-3-O-β-Dglucopyranoside, quercetin-3-O-β-D-glucopyranoside, kaem pferol-3-O-β-rutinoside and quercetin-3-O-βrutinoside.[40] Seed and leaf of *R. Communis* also confirmed the existence of flavonoids such as prunin 2'-o-para coumaroyl, prunin 6"-o-para coumaroyl.[14]

Protein

It contains one ricinus agglutin along with three proteins like Ricin A, B and C.[15]

Steroid

Brassicasterol and Campesterol were found in the entire *Ricinus communis* plant.[16]

Alkaloid

Alkaloids are found in the aerial sections of the *Ricinus communis* plant. In addition to ricinin (0.55%) and N-Demethylricinin (0.016%), the foundation of *Ricinus communis* revealed their presence. alkaloid found in plant leaves.[17]

Tannins

Ricinus communis leaf extracts indicated the presence of tannins, including gallic acid and catechin.[18]

Anthocyanins

Castor plant's stem bark revealed the existence of anthocyanins like cyanidin 3-O-βxylopyranoside-5-O-β-glucopyranoside (21%), cyanidin 3-O-β xylopyranoside-five-O-(6"'-Omalonyl-β- glucopyranoside) (79%) and cyanidin 3-O-β-xylopyranoside-5-O-(6"'- Omethylmalonate-β-glucopyranoside).[19]

Phytochemicals (present in parts of plant)

Seeds

Seeds of *Ricinus communis* contain fixed oil which abide the glycosides of stearic acid, isoricinoelic, dihydroxystearic acid, ricinine and ricinoleic acid. It also contains the Ricin A, Ricin B, Ricin C, Y-sitosterol, fucosterol, stigmasterol and ricinus agglutin. These chemical constituents have the potential of pharmacological properties.

Fruit

Ricinus communis's pericarp contains alkaloid which is ricinine. Seedling extract of the castor bean yields mixture of some diterpene hydrocarbon ent-beyerene [(+)-stachene], ent-sandaracopinaradiene, ent-kaur-ene, casbene and ent-trachylobane which are cell free extract. It also contains α-thujone, camphor, α-pinine, lupeol, camphene etc.

Leaves

Leaves of *Ricinus communis* are very important and contain the most of the phytoconstituents that are the important for distinct pharmacological activities. Leaves contain many phytochemicals like ricinine, gallic acid, gentistic acid, ellagic acid, quercetin, N-demethylricinine, kaempferol-3-O-β-D-glucopyranoside, kaempferol-3-O- β-D-xylopyranoside, quercetin-3-O- β-D-glucopyranoside, quercetin-3-O-β-D-xylopyranoside, quercetin-3-O-β-rutinoside, kaempferol-3-O-β-rutinoside etc.

Phytochemical structures

Table 1 shows the phytoconstituents of *Ricinus communis*.

PHARMACOLOGICAL ACTIVITIES

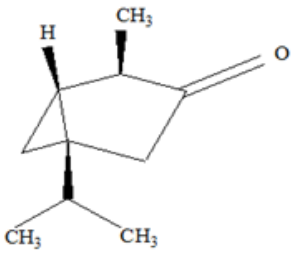
There are various types of pharmacological activities like antioxidant activity, antidiabetic activity, hepatoprotective activity, antimicrobial activity, antiulcer activity, wound healing activity, antinociceptive activity etc. of *Ricinus communis* are reported.

Figure 1 represents an overview of pharmacological activities of *Ricinus communis*.

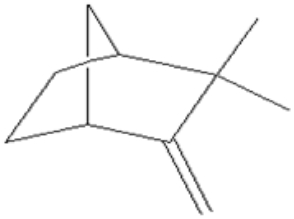
Table 2 shows the various pharmacological activities of *Ricinus communis*.

Immunomodulatory activity

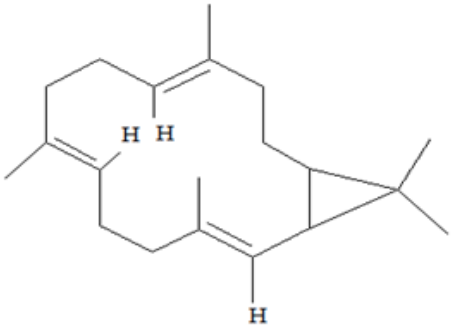
Generally, the animal and plant element immunomodulatory agents produce the immune response via activation of non-specific immune system against the pathogens of the human body. The phagocytosis is the engulfment through leucocytes of the microorganisms. Lastly, phagocytosis is the intracellular



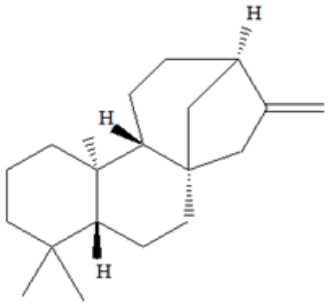
α-thujone



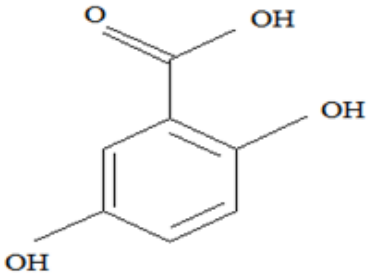
Camphene



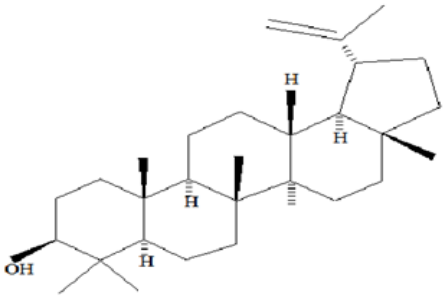
Casbene



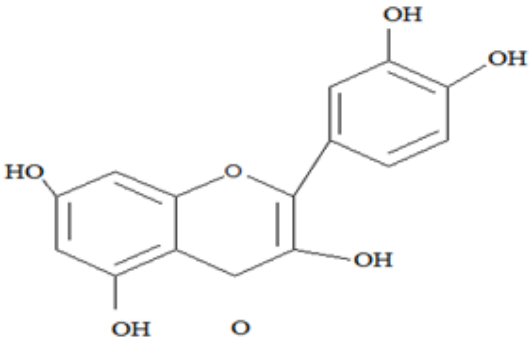
Ent-kaurene



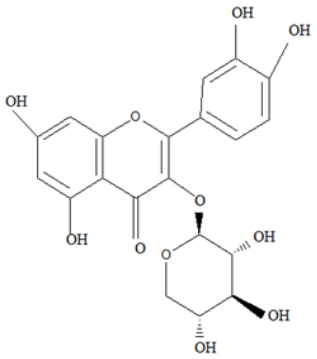
Gentistic acid



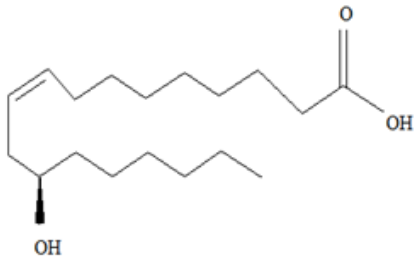
Lupeol



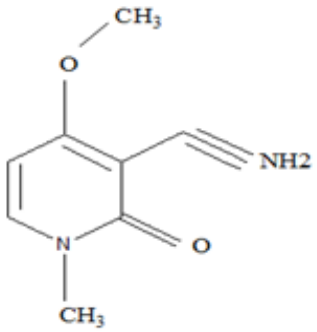
Quercetin

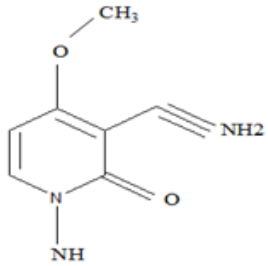


Quercetin-3-O-β-D-xylopyranoside



Ricinoleic acid





N-Demethylricinine

killing through the neutrophils of the pathogens. Leaves of this plant showed the significant increment the phagocytic action of the human neutrophils due to the presence of tannins and result showed the significant immunomodulatory activity.[20]

Anti-histaminic activity

Through the intraperitoneal method, mice were given dosages of 100, 125 and 150 mg/kg of this plant's ethanolic root extract to test its efficacy against clonidine-induced cataplexy. Result concluded that the ethanolic root extract of *Ricinus communis* has the potential of antihistaminic.[21]

Anti-tumor activity

Ricin A is isolated from this plant which is acquired the antitumor activity. It is more lethal to the tumour cells than non-mutate cells which is evaluated from the ED_{50} of the lectin against the non-mutate cells and tumour cells. It possessed the antitumor activity.[22]

Anti-nociceptive activity

The antinociceptive activity of the methanolic leaves extract of *Ricicnus communis* was examined against the formalin-induced tail immersion model, acetic acid-induced writhing method and paw licking method in mice. And this extract exhibited strong antinociceptive properties.[23]

Anti-ulcer activity

The seeds oil of the *Ricinus communis* were evaluated for the antiulcer at the doses of 500 and 1000 mg/kg against the ethanol, aspirin and pylorus ligation induced ulceration models. Result showed that the dose of 1000 mg/kg was more active than 500 mg/kg and also enhanced the mucosal defence because of its cytoprotective activity. So, overall it has been proved that *Ricinus communis* has the potential of antiulcer.[24]

Anti-implantation activity

The portion of dissolved ether of the methanolic extract of this plant were investigated at the doses of 600 mg/kg and 1.2 g/kg through subcutaneous route in the female rats and rabbits. Study revealed that the methanolic extract of *Ricinus communis* showed the potent estrogenic, anti-implantation activity and as well as antinociceptive activity.[25]

Anti-diabetic activity

The ethanolic extract of these plant's roots was tested for antidiabetic effectiveness against the subcutaneous alloxan-induced method in rats. This ethanolic extract of roots showed the potent effects on total lipid profile, kidney, liver functions and fasting blood glucose level but no significant effect changes on serum bilirubin, serum glutamate oxaloacetate transaminases, alkaline phosphate, serum glutamate pyruvate transaminases, total protein and creatinine were noticed at the dose of 10 g/kg.[26]

Antimicrobial and antibacterial activity

Some extracts of *Ricinus communis* which were acetone, ethanol, methanol, hexane and petroleum ether investigated for the antimicrobial property against the various microorganisms like *Staphylococcus aureus, Salmonella typhimurium, Bacillus*

Table 1: **Phytoconstituents of *Ricinus communis*.**

Parts	Phytoconstituents	References
Seeds	Ricin A, Ricin B, Ricin C, Y-sitosterol, fucosterol, stigmasterol, stearic acid, isoricinoelic, dihydroxystearic acid, ricinine and ricinoleic acid	[6,8]
Fruits	α-thujone, camphor, α-pinine, lupeol, camphene, ent-beyerene [(+)-stachene], ent-sandaracopinaradiene, ent-kaur-ene, casbene and ent-trachylobane	[6,8]
Leaves	Gallic acid, ricinine, gentistic acid, ellagic acid, quercetin, N-demethylricinine, kaempferol-3-O-β-D-glucopyranoside, kaempferol-3-O- β-D-xylopyranoside,	[6,8]
Bark	Quercetin-3-O- β-D-glucopyranoside, quercetin-3-O-β-D-xylopyranoside, quercetin-3-O-β-rutinoside	[9,10]
Root	Kaempferol-3-O-β-rutinoside	[9,10]

Figure 1: Overview of pharmacological activities of *Ricinus communis*.

subtilis, Aspergillus niger, Pseudomonas aeruginosa, Proteus vulgaris, Escherichia coli and *Candida albicans* by using the well diffusion method. Aqueous extract showed no significant effect.[27] The acetone and petroleum ether extracts showed the more significant inhibition than ethanol extract. The methanol and hexane extracts produced the maximum antimicrobial activity. In a different study, a 5 g/mL ethanolic extract of *Ricinus communis* leaves was tested against five strains of bacteria: *Proteus vulgaris, Pseudomonas aeruginosa, Escherichia coli* and two gram +ve strains, *Staphylococcus aureus* and *Bacillus subtilis*. When compared to the usual medication, gentamycin, this leaf extract had strong antibacterial action.[28,29]

Anti-inflammatory activity

Ilavarasan R. *et al.* evaluated the anti-inflammatory effect of *Ricinus communis* methanolic root extract against a cotton pellet granuloma and carrageenan-induced hind paw oedema model in Wistar albino rats at doses of 250 and 500 mg/kg orally. This *Ricinus communis* methanolic root extracts prevented lipid peroxidation in rat kidney and liver homogenates, which was brought on by ferrous sulphate and carbon tetrachloride. The *Ricinus communis* root extract in methanol has powerful anti-inflammatory effects on rats, both chronic and acute, according to the results.[30] The petroleum ether extract of *Ricinus communis* was examined by Banerjee S. *et al.* against the adjuvant and formaldehyde induced paw oedema paradigm in rats. The results showed that this extract greatly reduced paw oedema and also shown good analgesic efficacy.[22] In a different study, Saini A.K. *et al.* looked at the anti-inflammatory effect of methanolic leaf extract (250 and 500 mg/kg) and flavonoid fractions (25, 50 and 100 mg/kg) against cotton pellet-induced granuloma and carrageenan-induced paw oedema in Wistar rats. The findings indicated that the methanolic leaf extract has strong anti-inflammatory potential and flavonoid fractions predominated this activity in the extract.[31]

Hepatoprotective activity

The ethanolic leaf extract of *Ricinus communis* was evaluated for the choleretic, anticholestatic and hepatoprotective activity in albino rats by Visen P.K.S. *et al.* This extract showed the significant protective effect against the galactosamine-induced hepatic damage. They also examined the two pure compounds of *Ricinus communis* which were N-Demethyl-ricinine and ricinine. N-Demethyl-ricinine showed the better result than ricinine and it also showed the significant anticholestatic potential which was induced by paracetamol.[32] A study was carried out by Naveen A *et al.*, they evaluated the aqueous extract of *Ricinus communis* at the doses of 250 and 500 mg/kg against the carbon tetrachloride-induced hepatitis for the hepatoprotective activity. This extract showed the significant inhibition of ALT and AST levels. Dose of 500 mg/kg showed the better efficacy than 250 mg/kg.[33] Babu P. R. *et al.* investigated the hepatoprotective properties of methanolic *Ricinus communis* leaf extract against rat D-galactosamine (D-GalN) caused hepatitis. The level of serum indicators such Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Malondialdehyde (MDA) and Alkaline Phosphatase (ALP) significantly increased, they noticed. Catalase (CAT), Glutathione Peroxidase (GPx), Superoxide Dismutase (SOD) and glutathione reductase levels were also lowered by this leaf extract. Result proved that methanolic leaf extract of *Ricinus communis* has the potent hepatoprotective activity.[34] Another experiment is revealed by Prince *et al.*, they investigated the ethanolic leaf extract of *Ricinus communis* against the carbon

tetrachloride-induced hepatitis in rats at the doses of 250 and 500 mg/kg. Serum transaminases had markedly enhanced activity. Protein, glycogen and lipid peroxidation concentrations all dropped. Significant inhibition was seen in the depletion of glutathione and adenosine triphosphatase. This ethanolic extract of *Ricinus communis* leaf has the hepatoprotective activity.[35]

Anti-fertility activity

The 50% ethanolic extract of this plant was investigated for the antifertility action in male rats. There are many significant changes were observed such as reduction in the levels of testosterone, fructose, epididymal sperm counts and also altered the motility. This extract did not alter the AST and ALT levels which are the hepatic biomarkers. Result proved that the ethanolic extract has the potent anti-infertility activity.[36] The methanolic seed extract was tested for the alkaloids and steroids. Pituitary gland prevents the release of Follicle-Stimulating Hormone (FSH) and Luteinizing Hormone (LH) and releases gonadotrophins via negative and positive feedback processes. Both follicular maturation and ovulation were decreased by it. Because steroids were present, this methanolic seed extract demonstrated an anti-fertility impact.[37]

Antiasthmatic activity

The ethanolic root extract of *Ricinus communis* was evaluated against the mast cell degranulation and milk-induced leucocytes and eosinophilia model in the mice. This extract showed the significant inhibition in eosinophilia and leucocytes which was induced by milk at the dose of 100-150 mg/kg but dose 150 mg/kg showed the better efficacy than 100 m/kg when compared to dexamethasone. Ethanolic root extract prevented the release of histamine in anaphylactic action and it also maintained the mast cell. Result concluded that this ethanoic root extract showed the mast cell stabilizing potential and also exhibited the antiallergic activity.[38]

Molluscicidal and larvicidal activity

The *Ricinus communis* leaf extract was investigated against the *Lymnaea acuminata* and it produced the significant potential. Leaf and seed extract were examined against the *S. frugiperda* for molluscicidal activity and seed extract produced the better efficacy than leaf extract. The aqueous leaf extract was examined against some mosquitoes such as *Culex quinquefasciatus, Anopheles arabinesis* and *Callosobruchus chinesis* for the larvicidal activity and this extract proved that it has larvicidal action.[39]

Table 2: Pharmacological activities of *Ricinus communis*.

Sl. No.	Activity	Part used	Phytoconstituents	Animal model used	References
1	Antihistaminic	Roots extract	Ethanolic extract	Mice	[13]
2	Antitumor	Seeds extract	Ricin A	Cell lines	[14]
3	Antinociceptive	Leaves extract	Ethanolic extract	Mice	[15]
4	Antiulcer	Seeds extract	Oil	Rats	[16]
5	Anti-implantation	Leaves extract	Methanolic extract	Rats and rabbits	[17]
6	Antidiabetic	Roots extract	Ethanolic extract	Rats	[18]
7	Antimicrobial	Leaf extract	acetone, ethanol, methanol, hexane and petroleum ether	Bacteria	[19,20]
8	Anti-inflammatory	Leaf and roots extract	Flavonoids	Rats	[21-23]
9	Hepatoprotective	Leaf extract	Ethanolic extract	Rats	[24-27]
10	Anti-fertility	Leaf extract	Ethanolic extract	Rats	[28,29]
11	Antiasthmatic	Root extract	Ethanolic extract	Mice	[30]
12	Insecticidal	Seeds extract	Methanolic extract	bacteria	[32,33]
13	Antioxidant	Leaf extract	aqueous, ethanol, methanol, ethyl acetate, chloroform, n-butanol and n-hexane	Rats	[36-38]
14	Molluscicidal and larvicidal	Leaf and seeds extract	Aqueous extract	Mosquito	[31]

Insecticidal activity

Methanolic seed extract of *Ricinus communis* evaluated for the insecticidal action against adults *Callosobruchus maculatus*. This methanolic extract of seed showed the significant action on accumulative mortality of adults *Callosobruchus maculatus*.[40] Methanolic extract of leaf and seed were examined against the *Spodoptera furgiperda* and it was found that seed extract showed the better insecticidal action than leaf extract. The evaluation of leaf (hexane), fruit (acetone) and root (methanol) extracts were performed to control *Melanaphis sacchari* Zehntner (Hemiptera: Aphididae). Methanolic and acetone extract showed the less effective. But the hexane extract showed the highest efficacy than methanolic and acetone extract.[41]

Bone regeneration activity

The incorporation of alkaline phosphatase to *Ricinus communis* polyurethane by incubation in the synthetic body fluid enhanced the biological activities of *Ricinus communis* polyurethane. *Ricinus communis* polyurethane was investigated for biocompatibility and for its capability to prompt the regeneration of bones. Result concluded that the *Ricinus communis* polyurethane integrated with calcium phosphate or calcium carbonate could endorse the biocompatible materials and mineralization of matrix. The *Ricinus cummunis* polyurethane showed the protection when compared to demineralized bone which has a gradual reabsorption movement.[42,43]

Antioxidant activity

Through the use of free radical scavenging activity for antioxidant action, the ethanolic leaf extract of *Ricinus communis* was compared to the reducing power technique and 2,2-Diphenyl-1-Picrylhydrazil (DPPH) methods. *Ricinus communis* leaf extract in ethanol shown substantial reducing power and free radical scavenging activity. This experiment revealed that the leaf extract of *Ricinus communis* has the potential of antioxidant activity.[44] Seven extracts of *Ricinus communis* such as aqueous, ethanol, methanol, ethyl acetate, chloroform, n-butanol and n-hexane were examined for antioxidant action. Aqueous and methanol extract showed the good DPPH activity and the remaining extracts possessed less DPPH activity. This experiment proved that *Ricinus communis* extract has the potential of antioxidant activity.[45] The methanolic leaves extract of *Ricinus communis* were evaluated for *in vitro* and *in vivo* studies for antioxidant procedure at the doses of 250 and 500 mg/kg. This extract increased the level of catalase in kidney and liver. It also increased SOD level in the liver, ascorbic acid levels and decreased the TBARS significantly. Result concluded that methanolic leaves extract has a strong antioxidant activity.[46]

TOXICOLOGY

Based on the aforementioned variation, it is reasonable to assume that the majority of studies on the toxicity of ricin have used contamination compositions consisting of a compound of glycosylated ricin isoforms. Alternative purification methods, such as acid precipitation, which can affect [re-]folding, sugar elution, which may change B-chain binding, or salt conditions, all of which may produce varying purities and functional activities, have the potential to influence toxicology results.[47] Furthermore, the experimental system employed, such as the animal breed or group used, as well as the cell culture or *in vitro* test used, is associated to a certain degree of heterogeneity in toxicity findings.[48-50] Taking into account all of these factors, the following figures represent the best estimates for summarising a large amount of laboratory research. Ricin has a concentration- and time-dependent action.[47] The dose that causes death in 50% of mice (LD_{50}) was discovered to be among 2-8 g/kg body weight after intravenous injection of ricin into mice.[50-52]

A slightly greater dose of among 2.4 and 36 g/kg was required to kill 50% of mice subsequently intraperitoneal injection.[53] According to various mouse strain studies, the inhalational toxicity (measured in estimated LD_{50}) ranged from 2.8 to 12.5 g/kg.[54,55] Using the same delivery method, it was found that the LD_{50} for two distinct *R. communis* cultivars in rats ranged from 3.7 g/kg to 9.8 g/kg.[56,57] The determination of effective dosages in inhalational challenge tests is more challenging than that for injection since efficient transport into the deep lungs depends on a variety of variables, such as particle size, the solvent used and the technical specifications of the aerosol chamber.[58]

The least harmful route is oral absorption or intragastric distribution, which is about a thousand times less hazardous than parenteral injection or inhalation. There have been reports of dosages of 21.5 mg/kg and 30 mg/kg in mice.[59,60]

The plant also includes the dangerous low molecular weight alkaloid ricinine (MW=164.2 g/mol), in addition to the highly toxic ricin and the less deadly *R. communis* agglutinin. Ricine (CAS 524-40-3) is a piperidine alkaloid also known as 3-cyano-4-methoxy-N-methyl-2-pyridone. Tuson named it while looking for substances that could be used as medicines long before ricin was actually identified in the seeds of *Ricinus communis*.[61] Its chemical structure was then determined[62,63] and its production and metabolism were investigated.[64,65]

CLINICAL STUDIES

When analyzing case reports of human ricin poisoning, "effective" ricin doses can only be calculated using alteration in the range, weight and humidity content within the seeds; season, age and illness, all of which are obviously more varied than empirical contagious of animal models, as well as the stage of plant growth at the time of uptake.[66] In clinical studies, the amount of seeds

consumed that cause mild to severe symptoms, including death, ranges from a single seed to as much as 30 seeds.[66-68]

CONCLUSION

There are various medicinal plants which are used in traditional medicine system world widely. Natural or medicinal plants are the rich source of various phytochemicals, pharmaceutical products and they have the various significant therapeutic and pharmacological properties. The medicines are costly and they also have many side effects which are available in the market. Medicinal and natural plants are cost effective and they have less side effects. Many researchers and scientists explored that various types of naturally occurring medicinal plants which have the significant pharmacological and therapeutic properties. *Ricinus communis* is also one of them. *Ricinus communis* is also known as castor plant. It is an ornamental and essential plant which is extensively utilised in conventional remedy system. *Ricinus communis* is a potent medicinal plant which contains many phytochemicals constituents that are significant for distinct types of pharmacological properties. Every segment of *R. communis* like bark, leaves, root, fruits, flowers and seeds contain alkaloids, saponins, carbohydrates, flavonoids etc. *Ricinus communis* has the various essential chemical constituents such as ricinine, Ricin A, Ricin B, Ricin C, Y-sitosterol, fucosterol, stigmasterol etc. which are responsible for many pharmacological activities like antiulcer, antimicrobial, anti-inflammatory, antidiabetic, antioxidant, antiasthmatic etc. Many researchers have revealed that *Ricinus communis* has the significant potential of various pharmacological activities. This plant may be very crucial plant in future. The main aim of the present review is to explore the all and updated information of *Ricinus communis*. Here, all and updated information such as phytochemicals and pharmacological properties of *Ricinus communis* are well described and this information may be very useful for further research on this indigenous plant.

CONFLICT OF INTREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

RC: *Ricinus communis*; **AST:** Aspartate aminotransaminase; **ALT:** Alanine aminotransaminase; **MW:** Molecular weight; **LD:** Lethal dose; **ED:** Effective dose; **DPPH:** 2,2-diphenyl-1-picrylhydrazyl.

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