



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Review Article

Exploring *Ricinus communis* Bioactive Compound and Pharmacological Insights: A Comprehensive Review

Prakash Pralhad Sarwade¹, Kavita Narayan Gaisamudre (Sarwade)^{*2}, Snega Boopathy³, Arti Kumari⁴, Shakthi L⁵, Mohammed Numan Ahmed⁶, M. Geetha⁷

¹Associate Professor and Head, Department of Botany, Shikshan Maharshi Guruvarya R. G. Shinde Mahavidyalaya, Paranda Dist. Dharashiv Osmanabad, 413502, (M.S.) India.

²Assistant Professor, Department of Botany, Shriman Bhausaheb Zadbuke Mahavidyalaya, Barshi Tal. Barshi, Dist- Solapur 413401 Maharashtra, India.

³Department of Pharmaceutics, Saveetha College of Pharmacy, Saveetha Institute of Medical and Technical Sciences, Saveetha Nagar, Thandalam, Chennai, Tamil Nadu -602105, India.

⁴Department of Pharmacology, Assistant Professor, Faculty of Medical Science and Research, Sai Nath University, Ranchi, Jharkhand-835219, India.

⁵Department of Pharmacology, Dr.M.G.R.Educational and Research Institute, Velappanchavadi, Chennai-600077, India.

⁶Department of pharmacy, College of Pharmaceutical Sciences, Dayananda Sagar University, Bangalore, India.

⁷Assistant professor, Department of Microbiology, Sri bharathi arts and science college for women, Kaikkurichi, Pudukkottai, India.

ARTICLE INFO

Published: 20 Apr 2026

Keywords:

Ricinus communis,
phytochemistry, ricin,
pharmacological activity,
medicinal plants, bioactive
compounds

DOI:

10.5281/zenodo.19673823

ABSTRACT

Ricinus communis is a fairly important medicinal plant that has been widely recognized due to its wide range of pharmacological effects and rich phytochemical composition. This critical analysis aims to explore the bioactive compounds in *Ricinus communis* and critically evaluate its pharmacological characteristics based on available literature in the scientific community. The species is a rich source of biologically active compounds, including alkaloids, flavonoids, saponins, phenols, and especially the cytotoxic protein ricin, which has been of significant interest because of its dual therapeutic/toxicological properties. Pharmacological research on its biological properties has shown a wide spectrum of anti-inflammatory, analgesic, antimicrobial, antioxidant, hepatoprotective and anticancer effects. The castor oil is obtained by extraction of the seeds and has particular importance in the purgative, wound-healing and dermatological applications. Recent studies also highlight its possible role in the regulation of immune processes and

***Corresponding Author:** Kavita Narayan Gaisamudre (Sarwade)

Address: Shriman Bhausaheb Zadbuke Mahavidyalaya, Barshi Tal. Barshi, Dist- Solapur 413401 Maharashtra, India.

Email ✉: sarwadekp@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



in the modulation of molecular cascades that relate to chronic diseases. Despite its therapeutic potential, the presence of toxic elements needs careful dosage optimization and safety evaluation. This study is a synthesis of the existing literature on the phytochemical makeup, pharmacological properties, action mechanism, and safety of *Ricinus communis*, providing a scientific foundation on the potential pharmaceutical development and clinical use. In addition, it highlights the need to undertake advanced research focusing on the isolation, characterization, and clinical validation of its bioactive molecules so as to fully capitalize on its therapeutic potential.

INTRODUCTION

Medical plants have been the backbone of health care systems in various civilizations, and the foundation of traditional medicine practices, including Ayurveda, Traditional Chinese Medicine and Unani [1]. They are therapeutically relevant due to the availability of various bioactive phytoconstituents, such as alkaloids, flavonoids, terpenoids, glycosides, and phenolic compounds, and a broad range of pharmacological activity. Almost 25-30 percent of contemporary pharmaceuticals in the age of sophisticated synthetic chemistry are directly or indirectly of plant origin, and it is a testament to the long-term importance of botanical resources in drug discovery and development [2]. The growing health issues of chronic diseases worldwide, resistance to antimicrobial agents, and side effects of synthetic drugs have sparked a new wave of scientific interest in the use of medicinal plants. Natural products have been viewed as safer, more biocompatible, and with the potential to act on multiple biological targets at the same time [3]. The multi-targeted strategy is especially beneficial in the treatment of complex illnesses like cancer, diabetes, neurodegenerative diseases, and heart diseases, where single-target therapy may be inadequate. Besides, medicinal plants provide an excellent source of the discovery of new lead compounds. The development of methods including the use of high-performance liquid

chromatography, gas chromatography-mass spectrometry, and nuclear magnetic resonance spectroscopy among others have allowed a comprehensive phytochemical profiling of bioactive molecules, enabling the isolation and characterization of bioactive molecules [4]. Also, new techniques such as network pharmacology and molecular docking have helped to improve our knowledge of plant-based therapeutics by understanding their interactions on a molecular and systems level. Economically and ecologically, medicinal plants also play a great role in pharmaceutical, nutraceutical and cosmetic industries. It is thus important that sustainable use and protection of these resources are ensured and more so in places of biodiversity like India [5]. Nevertheless, issues like standardization, phytochemical composition variability and inadequate clinical validation still hamper their acceptance in the evidence-based medicine. In this regard, there is need to have systematic scientific testing of medicinal plants to help fill the gap between traditional knowledge and contemporary pharmacology. *Ricinus communis* is one of such plants whose therapeutic potential has received significant attention because of its wide range of therapeutic potential [6].

Ricinus communis or the castor oil plant is a genus in the family Euphorbiaceae and is commonly found in the tropical and subtropical areas worldwide [7]. It is a rapidly growing, evergreen shrub or small tree with large palmate leaf, spiny fruits and seeds that are highly oily. It is thought to have originated in Africa, but is widely grown in countries like India, Brazil and China because of its industrial and medicinal importance. The initial source of castor oil, a viscous, colorless-yellow oil that contains ricinoleic acid, is the seeds of *Ricinus communis*, and contains the ricinoleic acid that makes up about 85-90%. This differentiation of fatty acid gives castor oil some unusual



physicochemical characteristics, and it is very useful in pharmaceutical preparations, cosmetics, lubricants and bio-industrial agents. Traditionally, castor oil has been used as a laxative, an anti-inflammatory and emollient [8]. In addition to containing oil, *Ricinus communis* is a store of many bioactive compounds that are found in various parts of the plant, such as the leaves, roots, and seeds. The phytoconstituents include alkaloids, flavonoids, phenolic compounds, saponins and terpenoids, each of which adds to the pharmacological profile of the plant. Of this group, ricin- a very powerful toxalbumin which is found in the seeds- has sparked a lot of interest because it is both a toxic protein and a biomolecule which may be utilized in targeted cancer treatment [9]. *Ricinus communis* has a broad spectrum of biological effects which have been pharmacologically proved as anti-inflammatory, antioxidant, antimicrobial, antidiabetic, anti-cancer, hepatoprotective activities and wound healing. These functions are mediated by various pathways including inhibition of inflammatory mediators, free radical scavenging, enzymatic pathways regulation and cell signalling network interaction [10]. Although it has a long and rich history of usage in traditional medicine and holds future pharmacological potential, the therapeutic application of *Ricinus communis* has complicated issues related to safety especially the existence of ricin [11]. This requires meticulous processing, control of dosage and scientific validation to make sure that it is safe and effective. Moreover, change in phytochemical content with environmental and genetic variation creates difficulties in standardization and quality control. Current studies have been aimed at addressing these constraints by taking more advanced approaches of extraction, formulation methods and biotechnological intervention [12]. Nanotechnology delivery systems such as have demonstrated potential in increasing the

bioavailability and targeted delivery of plant-derived compounds, which increase their therapeutic efficacy and limit their toxicity [13]. The recent surge in interest of the use of plant-based therapeutics, along with the desire to have safer and more effective methods of treatment, has brought the necessity of in-depth scientific reviews that will bring together existing knowledge and define the future research pathways [14]. Despite the numerous studies that have been conducted on different facets of *Ricinus communis*, the information is still very fragmented with very little incorporation of phytochemical, pharmacological and mechanistic information. The purpose of this review is thus to present a systematic and thorough review of *Ricinus communis*, including bioactive compounds, pharmacological activities, mechanisms of action of the plant and therapeutic potential [15]. This work attempts to fill the gap between empirical use and evidence-based application by critically examining traditional knowledge and current scientific findings.

BOTANICAL DESCRIPTION AND TAXONOMY

Ricinus communis is a botanically and pharmacologically important plant of the family Euphorbiaceae with a distinctive taxonomic position as the single species of monotypic genus Ricinus. It belongs to Kingdom Plantae, Division Magnoliophyta (angiosperms), Class Magnoliopsida (dicotyledons), and Order Malpighiales based on its evolutionary relationship with flowering plants and a variety of secondary metabolite synthesis [16]. The morphological variability in the plant is remarkable and thus a wide range of cultivars are produced which vary in size, pigmentation, and oil yield. *Ricinus communis* is a perennial shrub or small tree with a morphological structure that is fast growing and which has heights of 2-5 meters;



yet in the best environmental conditions it can reach a greater height Fig.1 [17]. The stem is erect, hollow, glabrous and is likely to be green to reddish-purple in color given influences of genes as well as the environment and has a latex characteristic of members of the Euphorbiaceae. The leaves are very large, alternate and palmately lobed with 5-11 deep-cut segments, up to 60 cm in diameter, and are held by the long petioles; their glossy texture and color range: bright green to dark purple help to make the leaves not only physiologically efficient but also decorative [18]. It is a monoecious plant with male and female flowers on the same inflorescence forming terminal panicles, with male flowers occupying the lower part of the panicle and having many stamens, and female occupying the upper part and consisting of a tricarpellary ovary containing large feathery stigmas that serve as a pollinating structure [19]. It is a typical spiny, trilocular capsule which contains three seeds encased by a carpel and when it matures it explodes to open and spread the seeds. The seeds, often called castor beans, are oval shaped, smooth and glossy in a mottled shape of brown, black and grey colour and rich in oil content (up to 4060 percent), which is mainly ricinoleic acid, which gives them special physicochemical and pharmacological properties [20]. Nevertheless, the seeds also have ricin which is a very toxic toxalbumin and careful processing is required to make sure that it is used safely. The root system is well developed and mostly based on taproot and allows the root to uptake nutrients efficiently and is drought resistant which also adds to the adaptability of the plant. Geographically, *Ricinus communis* is a broadly distributed plant in tropical and subtropical areas and is thought to have originated in Africa, especially in Ethiopia, although it is now grown in large-scale in countries like India, Brazil, China and Thailand because of its industrial and medicinal significance [21]. India especially is a major producer and there is large

scale production in Gujarat, Rajasthan and Andhra Pradesh. The plant is adapted to warm climate (optimal temperature of 20° C to 30° C), well-drained sandy or loamy soils though it can grow in marginal lands, which have a relatively low fertility. It has a deep root system that enables it to withstand drought conditions rendering it to suit semi-arid areas but full sunlight is required to ensure maximum growth and oil production [22]. *Ricinus communis* is a common wild plant in wastelands, roadsides and disturbed habitats with an indication of its ecological strength and invasiveness in certain places. Nevertheless, its phytochemical composition, oil content, and overall biological activity are highly affected by the environmental conditions, including soil composition, climate, and agronomic practices [23]. Together, the taxonomic peculiarity, unique morphology, and extensive geographical adaptability of *Ricinus communis* highlight its significance as a useful tool in both traditional medicine and contemporary pharmacological studies [24, 25].



Fig.1: *Ricinus communis* plant

Ethnomedicinal and traditional uses

The ethnomedicinal applicability of *Ricinus communis* lies in the fact that it has been used over

the centuries in various healthcare systems of the world as a multidisciplinary medicine. This has been made possible by the fact that it has bioactive constituents including ricinoleic acid, flavonoids, alkaloids, and phenolic compounds that when combined with each other result in a wide range of biological activities. In ancient Ayurvedic, the plant is known as Eranda and is widely used as a purgative, anti-inflammatory, analgesic, and detoxing agent [26]. One of the most notable formulations is castor oil, which is extracted out of the seeds and is usually prescribed as an effective laxative to help in the treatment of constipation, bowel disorders and gastrointestinal conditions [27]. It is also applied in Panchakarma treatments, especially, in the treatment of Purgation, to get rid of the toxins and to restore physiological balance. Also, castor oil is commonly used externally as a massage oil to help ease joint pain, muscular stiffness, and inflammatory diseases like arthritis, because of its capacity to promote local circulation and decrease inflammation. *Ricinus communis* is a demulcent, resolvent and anti-inflammatory agent in the Unani system of medicine. It is usually taken to treat rheumatism, sciatica and other musculoskeletal diseases [28]. The leaves are commonly used as poultices or decoctions to treat swelling, pain and inflammation especially when dealing with localized infections and abscesses. Likewise, in traditional Chinese medicine and African folk medicine, the plant is used in different parts, such as the seeds, leaves, and roots to treat a diverse array of illnesses, like skin conditions, wounds, fever, and gastrointestinal disorders. *Ricinus communis* has a rich ethnomedicinal history, with the use of its leaves as an anti-inflammatory and antimicrobial agent. Fresh leaves are usually warmed and used as poultices on the affected parts to cure things like boils, ulcers and swellings. Their galactagogue properties are manifested in the use of leaf extracts to stimulate lactation in nursing mothers.

Moreover, leaf decoctions are occasionally used to treat respiratory illness, such as cough and bronchitis, because they have relaxing and expectorating properties [29]. Traditional medicine also makes use of the roots of the plant, but much rarer than the seeds and leaves. Root extracts are thought to have analgesic and anti-inflammatory actions and are applied in some areas in the treatment of lumbago, neuralgia and body pain in general. Root preparations are also used in other ethnomedical practices due to their possible antimicrobial and antiparasitic action. Besides its internal medicinal use, *Ricinus communis* is also very crucial in traditional dermatology. Castor oil is commonly employed as a moisturizer and emollient over dry and damaged skin, and in the treatment of various diseases (eczema, dermatitis, minor wounds, etc.). Its antimicrobial effect helps in wound healing through prevention of infection as well as promoting tissue regeneration. The oil is also used on the head to enhance hair growth, decrease dandruff and harden hair follicles, so it is a widely used ingredient in traditional cosmetic preparations [30].

Ricinus communis also has another outstanding traditional application in the reproductive and maternal health. In some cultures, castor oil has been applied in inducing labor but this is done cautiously as it has some adverse effects. It has also been used traditionally to treat menstrual distress and control the menstrual cycle which has been an indication of its effects on the smooth muscle activity [31]. *Ricinus communis* is culturally and economically important besides its medicinal uses. It is also frequently integrated into the traditional practices and rituals, especially in rural areas where herbal remedies continue to be part of primary healthcare. Its flexibility and easy cultivation also contribute to the increased availability and popularity of the plant. Although



with a long history of ethnomedical utilization, it should be noted that there are safety issues that accompany the therapeutic use of *Ricinus communis*, mainly because of potential presence of ricin in the seeds [32]. The conventional processing methods, including oil extraction and heat treatment, are also essential in the process of detoxification of the plant material as well as safe usage. It is therefore significant to incorporate the traditional knowledge with contemporary scientific validation to maximize the therapeutic potential of modern traditional knowledge with minimal risks [33]. To conclude, *Ricinus communis* is a highly versatile medicinal plant that has a long-standing history of ethnomedicinal use in different cultures and healthcare systems. Its wide range of use in gastrointestinal, musculoskeletal, dermatological, and reproductive health highlights its pharmacological importance [34]. There is more that can be learnt in the further investigation and scientific confirmation of these traditional applications and that may lead to the creation of new therapeutic agents based on this plant [35].

PHYTOCHEMICAL PROFILE OF *RICINUS COMMUNIS*

Ricinus communis has a very diverse phytochemical profile which supports its wide range of pharmacological and industrial uses. The plant is a valuable storehouse of primary and secondary metabolites that are spread throughout its seeds, leaves, roots, and stems, and each segment of the plant has a different chemical makeup. Generally speaking the phytochemical constituents are alkaloids, flavonoids, phenolic compounds, terpenoids, fatty acids, proteins, and a variety of minor bioactive molecules, which work together to give the phytochemical its therapeutic potential [36]. The seeds are especially distinguished by the high content of oil, and the

leaves and roots are supplemented with polyphenolic compounds and secondary metabolites related to the antioxidant and anti-inflammatory effects. High-performance liquid chromatography, gas chromatography-mass spectrometry, and nuclear magnetic resonance spectroscopy have allowed the identification and characterization of many phytoconstituents, giving a better understanding of their structural diversity and biological applications [37]. Alkaloids form one of the most significant groups of bioactive compounds found in *Ricinus communis* that have led to its pharma-cological activity. Other significant alkaloids that have been found in the plant are ricinine, one of the most studied compounds [38]. Ricinine is a pyridone alkaloid which has insecticidal, antimicrobial and central nervous system-modulating properties. Other minor alkaloidal compounds including N-demethyl ricinine, trace nitrogenous components have been reported in addition to ricinine, but their pharmacological functions are less well described. These are alkaloids which are mostly concentrated in the seeds and leaves and are thought to be involved in the plant defense mechanisms against herbivores and pathogens [39].

Another important group of phytochemicals in *Ricinus communis*, especially in the aerial parts and leaves is Flavonoid. These are compounds that are highly recognized as antioxidants and anti-inflammatory. Some of the important flavonoids that have been identified are quercetin, kaempferol, rutin, isorhamnetin and luteolin [40]. The biological effects of these molecules are mediated by activities like free radical scavenging, signaling pathway modulation, and inhibition of pro-inflammatory mediators. The abundance of these flavonoids is attributed to the therapeutic uses of the plant in oxidative stress related diseases, heart diseases and inflammation [41]. Moreover, flavonoids can be synergistic with other



phytoconstituents, which can result in an increase in the overall pharmacological activity of the plant. The antioxidant potential is also enhanced by the phenolic compounds in *Ricinus communis*. These are the gallic acid, ellagic acid, ferulic acid, caffeic acid, chlorogenic acid and p-coumaric acid. It is well known that phenolics neutralize reactive oxygen species (ROS) and thus prevent the oxidative damage of cellular components due to oxidative stress [42]. They also possess antimicrobial, anticancer and hepatoprotective properties. Phenolic compounds can be concentrated and have different proportions with regard to environmental conditions, maturity of the plants and the techniques used in extracting these compounds, which also affect the biological activity of the plant extracts. Another essential group of phytoconstituent present in *Ricinus communis* is terpenoids and triterpenes [43]. The main properties of these compounds are linked to the anti-inflammatory, antimicrobial, and anti-cancer activities. Terpenoids identified are: lupeol, 2-amyirin, 1-amyirin, taraxerol and ursolic acid. These triterpenes are reported to regulate inflammatory processes, prevent tumor cells proliferation, and improve wound healing. They are known to have a high pharmacological versatility and therapeutic potential in the plant [44].

The abundance of fatty acids especially in the seed oil is another characteristic unique to *Ricinus communis*. The major fatty acid is a hydroxylated monounsaturated fatty acid by the name ricinoleic acid and this is the major part of castor oil; it comprises 85-90% of the castor oil. This is a rare fatty acid that contributes most of the pharmacological attributes of the oil such as laxative, anti-inflammatory, analgesic and antimicrobial effects [45]. Oleic acid, linoleic acid, stearic acid and palmitic acid are some of the other fatty acids that occur in low amounts. Ricinoleic

acid has the following biological effects: modulation of prostaglandin receptors, promotion of intestinal motility, and blocking of inflammatory mediators. Its unique chemical composition with a hydroxyl functional group also gives castor oil great viscosity and polarity thus suitable in both pharmaceutical and industrial uses [46]. Besides the small-molecule phytochemicals, *Ricinus communis* also includes large quantities of proteins and toxalbumins, the most prominent of which is ricin. Ricin is a very powerful ribosome-inactivating protein which consists of two polypeptide chains (A and B chains) and is bound together by disulfide bond. The A chain has enzyme activity, which inhibits protein synthesis by depurinating ribosomal RNA, whereas the B chain enables the cellular entry binding to cell surface glycoproteins. This is because ricin is one of the most toxic naturally occurring compounds due to this dual mechanism of action [47]. Nevertheless, even though toxic, ricin has had significant attention in biomedical research, especially in the development of targeted cancer therapy where it has been incorporated in immunotoxins to specifically kill tumor cells. The rest of the proteins found in the plant are storage proteins, enzymes and small peptides that might play a role in its biological functions. Moreover, *Ricinus communis* also has other bioactive components saponins, glycosides, and sterols [48]. Phytosterols, such as 2-sitosterol and stigmasterol, have been discovered, and are characterized by their cholesterol-lowering and anti-inflammatory properties. Saponins play a role in antimicrobial and immune-modulatory mechanisms whereas glycosides could be involved in a host of pharmacological processes. It is presumed that a synergistic interaction of all these various phytochemicals will increase the overall therapeutic effect of the plant. It should be mentioned that the phytochemical composition of *Ricinus communis* depends on a number of factors

such as geographical location, climatic conditions, soil type, and methods of extraction [49]. Fluctuations in these parameters may cause variations in the concentration and distribution of bioactive compounds, and hence the reproducibility and standardization of plant-based formulations. Thus, thorough phytochemical characterization and quality management is critical to the creation of safe and efficient therapeutic products of this plant [50]. To summarize, the phytochemical composition of *Ricinus communis* is highly multifaceted and rich in bioactive substances, which are all related to its

pharmacological and industrial values. The therapeutic potential of this plant is characterized by the presence of alkaloids like ricinine, flavonoids like quercetin and rutin, phenolic acids like gallic and caffeic acid, triterpenes like lupeol and ursolic acid, fatty acids, which is mainly dominated by ricinoleic acid, and proteins like ricin [51]. The chemical diversity and biological activities of these constituents can be important in understanding the full promise of *Ricinus communis* in contemporary medicine, and in ensuring safety and efficacy with stringent scientific validation [52].

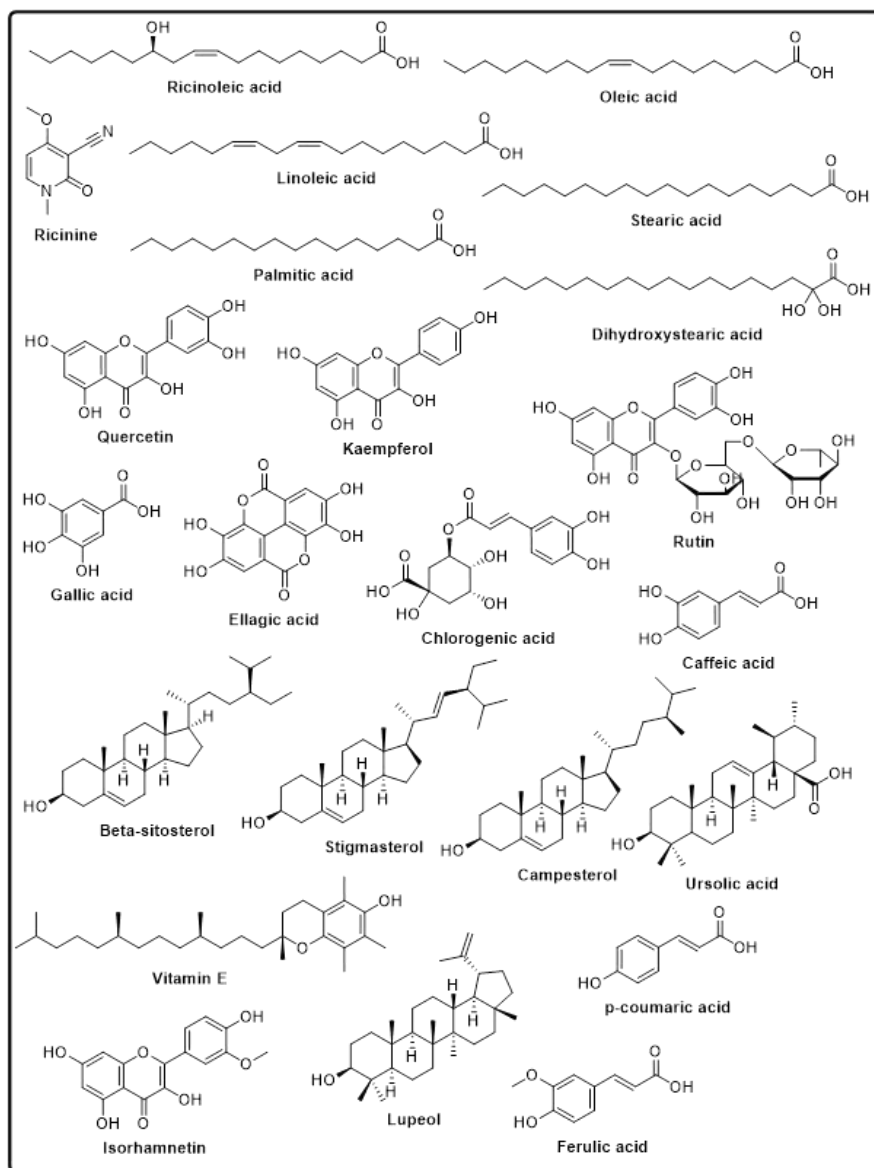


Fig.2: Phytoconstituents of *Ricinus communis*

PHARMACOLOGICAL ACTIVITIES OF *RICINUS COMMUNIS*

The pharmacological versatility of *Ricinus communis* is attributed to its rich and diverse phytochemical composition, encompassing alkaloids, flavonoids, phenolic acids, terpenoids, fatty acids, and bioactive proteins Fig.3 [53]. These constituents act through multiple

biochemical and molecular pathways, enabling the plant to exhibit a broad spectrum of therapeutic activities. Extensive in vitro and in vivo investigations have validated many of its traditional uses, positioning *Ricinus communis* as a promising candidate in the development of plant-based therapeutics. The following sections provide a detailed overview of its major pharmacological properties [54].

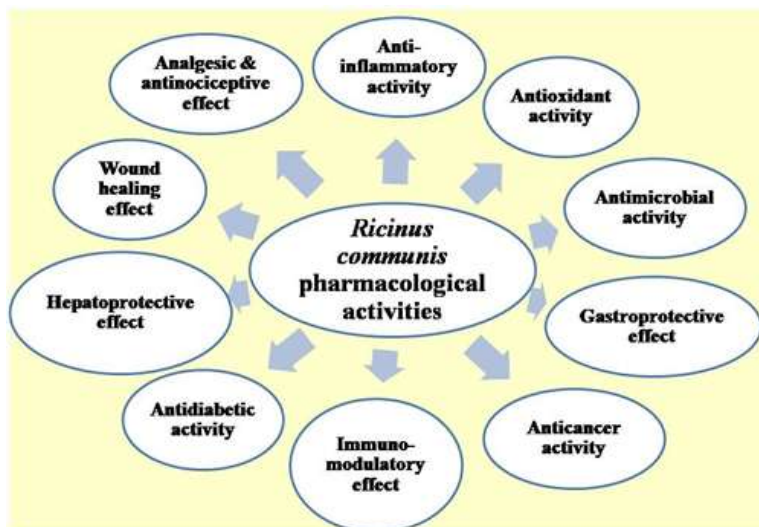


Fig.3: Pharmacological activities of *Ricinus communis*

Anti-inflammatory activity

Ricinus communis possesses the anti-inflammatory property as one of the most thoroughly studied pharmacological properties. Casts made of its leaves, roots, and seeds, and castor oil have shown considerable inhibitory properties against acute and chronic inflammatory events. This activity is mainly mediated by the primary bioactive compound ricinoleic acid that acts through the modulation of the inflammatory mediators which include prostaglandins and leukotrienes [55]. Mechanistically, EP3 prostaglandin receptors interact with ricinoleic acid, causing inflammation and edema formation to reduce. The presence of flavonoids like quercetin and kaempferol also increases anti-inflammatory effects by suppressing cyclooxygenase (COX) and lipoxygenase (LOX)

enzymes and thus preventing the production of pro-inflammatory cytokines like tumor necrosis factor-alpha (TNF- α), interleukin-1 (IL-1) [56]. Also, terpenoids, such as lupeol and ursolic acid, are involved in the inhibition of nuclear factor kappa B (NF- κ B) signaling pathways, which are at the heart of inflammation. All these effects have enabled *Ricinus communis* to be most effective in the treatment of diseases like arthritis, rheumatism, and inflammatory skin ailments [57].

Antioxidant activity

Oxidative stress is a significant causative agent in the pathogenesis of many chronic diseases, such as cardiovascular diseases, neurodegeneration, and cancer. *Ricinus communis* is a potent antioxidant that contains phenolic compounds and flavonoids like gallic acid, caffeic acid, rutin, and luteolin

[58]. These are free radical scavengers, which counteract reactive oxygen species and inhibit oxidative damage of cellular macromolecules, including lipids, proteins, and DNA. The antioxidant process includes direct and indirect processes. These phytochemicals directly give out hydrogen atoms or electrons to stabilize free radicals. They indirectly increase the action of endogenous antioxidant enzymes like superoxide dismutase, catalase and glutathione peroxidase. This bi-directional effect contributes to redox homeostasis and provides defense against oxidative stress-induced cellular damage. Research has revealed that *Ricinus communis* extracts remarkably decreases lipid peroxidation and enhances antioxidant enzyme activities, which contributes to *Ricinus communis* as a natural antioxidant agent [59].

Antimicrobial activity

Antimicrobial activity of *Ricinus communis* has been extensively studied against various bacterial, fungal and viral disease-causing organisms. The extracts of various plant sections have shown to have inhibitory effects against Gram-positive and Gram-negative bacteria, such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* [60]. The antimicrobial properties can be mainly credited to ricinine, flavonoids, saponins and phenolic acids. These phytochemicals carry out their antimicrobial effects in a variety of ways such as destabilizing the cell membranes of the microbes, blocking protein synthesis and disrupting the functioning of the nucleic acid [61]. Specifically, ricinine has been demonstrated to be insecticidal and antimicrobial; therefore, it is one of the defense mechanisms of the plant. Moreover, the oil produced by seeds has antifungal properties against species like *Candida albicans* and is thus applicable in treating fungus. The wide-spectrum

antimicrobial characteristic of *Ricinus communis* points to its possibility of substituting synthetic antimicrobial agents with a natural one [62].

Anticancer activity

The use of *Ricinus communis* in the treatment of cancer has been of great interest because of the availability of bioactive compounds that can regulate important cellular processes that promote the growth and progression of tumors. Even though Ricin is toxic, it has been widely researched in terms of its use in targeted therapy of cancer [63]. Ricin is a ribosome-inactivating protein that inhibits protein production in cancer cells, thus causing apoptosis. Conjugated with antibodies to form immunotoxins, ricin can be used selectively to target tumor cells with minimum harm to healthy tissues. Other phytochemicals have also been shown to have anticancer effects, including flavonoids (quercetin, kaempferol) and triterpenes (lupeol, ursolic acid), which can induce cell cycle arrest, induce apoptosis, and prevent angiogenesis. These compounds regulate signaling pathways, including PI3K/Akt, MAPK, and NF- in cancer cell survival and growth, which are essential. In addition, antioxidant activity helps to prevent the DNA damage and carcinogenesis. Taken together, these results indicate that *Ricinus communis* has potential as a source of new anticancer agents [64].

Antidiabetic activity

Ricinus communis has antidiabetic effects that have been shown in different experimental models and this means that it has the potential to be utilized in the treatment of diabetes mellitus. Plant extracts were found to decrease blood glucose levels, and increase insulin sensitivity and uptake of glucose in the peripheral tissues. This hypoglycemic effect is ascribed to occurrence of flavonoids, phenolic compounds, and alkaloids



which affect the metabolism of carbohydrates. Mechanistically, the compounds can prevent major enzymes in the synthesis of glucose like α -amylase and α -glucosidase, and hence lower the postprandial hyperglycemia. Also, antioxidant activities contribute to the reduction of oxidative stress linked to diabetes, which spares the destruction of pancreatic β -cells [65]. It is also proposed in some studies that *Ricinus communis* could increase insulin secretion and regulate the expression of glucose transporters, which could also help to maintain the glycemic control. These complex processes highlight its application in the treatment of diabetes [66].

Hepatoprotective effects

The antioxidant and anti-inflammatory effects of *Ricinus communis* are considered to be the major cause of its liver-protective effects. Plant extracts have been demonstrated to prevent hepatic tissue damage that is induced chemically by lowering oxidative stress and inflammation. Phenolic compounds and flavonoids are very important to stabilize hepatocyte membranes, to avoid lipid peroxidation and improve the activity of detoxification enzymes [67]. Diagnostic experiments have proved that treatment of *Ricinus communis* extracts lead to considerable decrease in liver enzymes like alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase, which are indicators of liver damage. Also, the plant helps to regenerate the destroyed liver cells and the overall liver functioning. These results confirm its classical application in the treatment of liver diseases and its possibility as a hepatoprotective agent [68].

Analgesic and antinociceptive effects

Ricinus communis is a highly analgesic and antinociceptive herb that can be used to relieve pain related to inflammatory disease and non-

inflammatory diseases. Plant extracts and castor oil have been demonstrated to decrease pain perception in experimental models probably by alteration of peripheral and central pain mechanisms [69]. Ricinoleic acid is one of the most important as it interacts with prostaglandin receptors and suppresses the production of pain mediators. Additional analgesic activities of flavonoids and terpenoids include the inhibition of inflammatory mediators and the regulation of neurotransmitter release. The joint effect of these compounds leads to a decrease in sensitivity to pain stimuli and an increase in pain management. These pharmacological findings support traditional uses, including topical application of castor oil in the treatment of joint pain, and muscle soreness [70].

Wound healing properties

The healing ability of *Ricinus communis* is well-known and consists of several stages of the healing process, such as inflammation, proliferation, and remodeling. The plant stimulates the contraction of wounds, collagen formation and regeneration of tissue, resulting in the rapid healing [71]. One such example is castor oil, which is commonly utilized due to its emollient and antimicrobial qualities, allowing the skin to stay moist and healing, yet avoiding infection. Flavonoids, phenolic compounds, and triterpenes are phytochemicals that promote fibroblast proliferation, angiogenesis, and extracellular matrix. Also, antioxidant effect minimizes oxidative stress in the wound area, which further promotes the process of tissue repair. All these effects render *Ricinus communis* a worthy agent in the healing of wounds, burns, and skin lesions [72].

Gastroprotective Activity

Gastroprotective properties of *Ricinus communis* are mainly linked to its potential to prevent the



damage of the gastric mucosa by stress, alcohol and nonsteroidal anti-inflammatory drugs (NSAIDs). The plant has displayed cytoprotective and anti-ulcer effects, which are mediated by the enhanced production of mucus, a decrease in the secretion of gastric acid and antioxidant properties [73]. Ricinoleic acid and flavonoids play a role in maintaining gastric mucosal integrity by increasing the synthesis of the prostaglandins and decreasing oxidative stress. Moreover, anti-inflammatory properties aid in the prevention of gastric inflammation and the development of ulcers. These qualities underlie the traditional application of castor oil in the treatment of gastrointestinal illnesses and digestive wellbeing [74].

Immunomodulatory effects

Ricinus communis has immunomodulatory effects which entail the control of the immune effects, leading to an increased capacity of the body to resist infections and diseases. Plant extracts are reported to regulate innate and adaptive immune responses through the activity of immune cells which include the macrophages, lymphocytes and natural killer cells. Flavonoid and saponin bioactive compounds are important in controlling the production of cytokines and immune signaling pathways [75]. These compounds have the ability to boost the immune responses in immunocompromised disorders and inhibit overproduction of inflammation in autoimmune disorders. Moreover, antioxidant properties help to stabilize the immune system by alleviating oxidative stress. *Ricinus communis* has a dual immunostimulatory and immunosuppressive effect which underlines its potential in immune-based therapy [76].

MECHANISM OF ACTION

The therapeutic activity of *Ricinus communis* is regulated by a multicomplexed network of molecular interactions due to various phytoconstituents in *R. communis* which include flavonoid, phenolic acids, alkaloid, terpenoids, fatty acids and proteins like ricin. The pharmacological action of these bioactive compounds occurs via regulation of cellular signaling pathways, enzyme systems, receptor interactions and oxidative stress pathways. An unusual multi-targeted mode of action of *Ricinus communis* that makes it unlike many traditional medicines and adds to its wide therapeutic index [77]. *Ricinus communis* has an effect on the molecular level on various pathways important in inflammation, cell survival, and apoptosis as well as immune regulation. Among the signaling pathways that are modulated is Nuclear factor kappa B (NF- κ B) pathway that is at the core of regulating inflammatory cells and the immune system. NF- κ B activation is inhibited by flavonoids like quercetin and kaempferol and also triterpenes like ursolic acid and lupeol, suppressing the expression of pro-inflammatory cytokines such as tumor necrosis factor- α (TNF- α), interleukins (IL-1 β , IL-6) and cyclooxygenase-2 (COX-2). Further, the bioactive compounds in the plant regulate the mitogen-activated protein kinase (MAPK) pathway, which participates in stress and inflammation responses in cells. These compounds can regulate cell proliferation, differentiation and apoptosis by modulating MAPK signaling cascades [78]. Another target is the phosphoinositide 3-kinase/protein kinase B (PI3K/Akt) pathway, especially in the anticancer activity scenario, where the regulation of this pathway results in the inhibition of tumor cell growth and induction of programmed cell death. Additionally, one of the ribosome-inactivating proteins known as ricin

causes its effect by depurinating a particular adenine base in the 28S rRNA of ribosomes causing permanent inhibition of protein synthesis and resulting in cell death [79]. This process has found applications in specific cancer treatments by the creation of immunotaxins. Besides signaling pathways, *Ricinus communis* exhibits important enzyme inhibition and receptor interaction. A number of phytochemicals serve as natural inhibitors of inflammatory, metabolic, and oxidative stress enzymes. An example is flavonoids and phenolic compounds that block enzymes such as cyclooxygenase (COX) and lipoxygenase (LOX) to inhibit the production of prostaglandins and leukotrienes involved in causing inflammation and pain. Several types of neurotransmitter-related enzymes may be affected by the presence of alkaloids like ricinine, which adds to neuromodulatory outcomes. Bioactive compounds can be used in the context of diabetes to suppress carbohydrate-hydrolyzing enzymes (e.g., alpha-amylase and alpha-glucosidase) and thus decrease glucose uptake and postprandial hyperglycemia [80]. Moreover, the components of *Ricinus communis* react with other cellular receptors to elicit their pharmacological activity. The fatty acid in castor oil is attributed as ricinoleic acid which has been shown to cause the stimulation of the prostaglandin EP3 receptors thereby increasing intestinal motility and anti-inflammatory effects. It has a familiar laxative and anti-inflammatory action which is mediated by this receptor. In addition, some triterpenes and sterols act on some nuclear receptors like peroxisome proliferator-activated receptors (PPARs), which control lipid metabolism, glucose homeostasis, as well as inflammation. These interactions add metabolic and anti-inflammatory advantages to the plant [81].

The other important feature of the mechanism of action of *Ricinus communis* is that it is an

important modulator of oxidative stress which is central to most of its pharmacological actions. The disproportion between the generation of reactive oxygen species and antioxidant defense mechanisms of the body results in oxidative stress causing cellular damage and disease development [82]. The abundance of flavonoids and phenolic acids and other antioxidant molecules make the plant effective in counteracting ROS and preventing oxidative damage to cellular components. These phytochemicals are able to be free radical scavengers by donating electrons or hydrogen atoms and this stabilizes the reactive species. Besides direct scavenging activity, *Ricinus communis* increases endogenous antioxidants defenses through enzyme induction of superoxide dismutase, catalase, and glutathione peroxidase. This dual pathway aids redox homeostasis and inhibits lipid peroxidation, protein oxidation and DNA damage. Moreover, the oxidative stress modulation is tightly connected to the regulation of such signaling pathways as NF-KB and MAPK, which emphasize the interdependence of these processes [83]. Through its antioxidative stress effects, *Ricinus communis* helps alleviate inflammation as well as adds to its hepatoprotective, cardioprotective and anticancer properties. Taken together, the mechanisms of action of *Ricinus communis* also point to a multi-faceted and synergistic mode of action, which includes the regulation of the main molecular targets, inhibition of important enzymes, interaction with particular receptors, and the regulation of the oxidative stress [84]. Such a combined strategy allows the plant to have a variety of pharmacological effects and reaffirms its potential as a useful source of therapeutic agents. The scientific explanation of these mechanisms gives it a scientific ground in regard to the traditional applications and also aids in the further exploration of the drug in modern drug discovery and development [85].



CHALLENGES AND LIMITATIONS

Having a good therapeutic potential, *Ricinus communis* still has a number of challenges and limitations that prevent its acceptance and conversion into evidence-based clinical practice. Toxicity, which is mostly linked with the presence of ricin, a very potent toxin in the seeds, is one of the most vital issues. Even the minimal amounts of the inadequately processed seeds may be life-threatening and lead to cytotoxicity and systemic poisoning. Despite the efficiency of industrial methods of extraction in detoxifying castor oil, it is important to make sure that all traces of ricin are eliminated, especially in pharmaceutical uses. This requires high quality control rules and standard processing procedures to ensure safety. The second significant drawback is the absence of standardization of composition on phytochemicals. The bioactive constituents content of *Ricinus communis* can be very different based on geographical position, climatic factors, soil type, maturity of the plant, and the method of extracting the constituents. Such variability leads to inconsistencies in pharmacological efficacy and reproducibility of results. Its use in a clinical setting is further complicated by the lack of universally accepted standards of identifying the plant material, the extraction processes, and formulation. There is also a challenge of limited availability of strong clinical evidence. Although many in vitro and in vivo experiments have been conducted to establish the pharmacological effects of *Ricinus communis*, there are few well-designed clinical trials on humans. This loophole limits the capacity to determine conclusive methodological dosages, safety plans and prolonged consequences. Regulatory agencies, therefore, tend to be reluctant to accept the approval of plant-based formulations without significant clinical substantiation. Moreover, bioavailability and pharmacokinetics are problematic in relationship

to the therapeutic potential of some phytoconstituents. Most bioactive compounds are not very soluble, do not absorb and are metabolized quickly hence may decrease their efficacy in vivo. Though new drug delivery systems like nanoparticles and liposomes may provide answers, they are yet to be explored and are not a common practice. Another hindrance to the development of therapeutics based on *Ricinus communis* is regulatory and quality assurance issues. The herbal product is likely to be regulated less than the synthetic drugs, causing inconsistency in the quality of the products, safety, and effectiveness. It is imperative that standardized guidelines and regulatory frameworks are put in place to maintain uniformity and confidence by consumers. Finally, there should be an approach to sustainability and environmental concerns, and extensive production and harvesting can disrupt the ecological balance. Phytochemical yield and quality can also be affected by variations in agricultural practices. It is essential to address these problems with comprehensive scientific methods, such as sophisticated techniques of analysis, standardized methods of cultivation and strict clinical assessment to fully realize therapeutic potential of *Ricinus communis* in contemporary medicine.

FUTURE PROSPECTIVES

The future of *Ricinus communis* is that it can be strategically combined with the current scientific developments in order to take full advantage of its pharmacological potential. As the use of plant-based therapeutics gains more interest, *Ricinus communis* will be relevant in the drug discovery of the next generation especially with its wide range of bioactive molecules and multi-targets. The use of nanotechnology-based drug delivery systems, including nanoparticles, liposomes, and nanoemulsions is one of the most promising



directions that can help increase the solubility, stability, and bioavailability of its phytoconstituents and reduce toxicity, particularly ricin concerns. Integration of artificial intelligence, computational methods, such as molecular docking, network pharmacology, and machine learning, is projected to speed up the process of finding new therapeutic targets and lead compounds based on *Ricinus communis*. Such tools can give more information on molecular interactions, predict pharmacokinetic characteristics and assist rational drug design thus saving time and cost in drug development. The other promising field is developing personalized and precision medicine, in which plant-derived compounds can be programmed to individual genetic and metabolism profiles. *Ricinus communis*, due to its multi-component nature, is particularly well adapted to such methods, as it can potentially modulate multiple pathways which contribute to complex diseases. Moreover, it will be essential to focus on clinical validation and translational research to take experimental results and translate them into practical applications of therapeutic value. To determine safety, efficacy, and dosage, it is necessary to design clinical trials, standardize extraction protocols, and have strong quality control measures. The yield and consistency of bioactive compounds may also be improved through sustainable cultivation and biotechnological interventions like plant tissue culture and metabolic engineering. The combination of these developments is likely to make *Ricinus communis* a promising candidate in developing pharmaceuticals and integrative medicine in the future.

CONCLUSION

Ricinus communis is a pharmacologically and scientifically important medicinal plant that has a wide range of therapeutic opportunities. It has a

rich phytochemical profile, including alkaloids (ricinine), flavonoids (quercetin and rutin), phenolic acids, triterpenes, and a fatty acid of unique structure (ricinoleic acid), a variety of biological activities. These are anti-inflammatory, antioxidant, antimicrobial, anticancer, antidiabetic, hepatoprotective, analgesic, wound healing, gastroprotective, and immunomodulatory activities, most of which have been substantiated by experimental research and traditional medicine. The multi-targeting capability of the plant to regulate various molecular targets and signaling pathways means that the plant can be used as a multi-target therapeutic agent, especially in the treatment of complex and chronic diseases. Although these characteristics are promising, the clinical development of *Ricinus communis* is still limited by a number of challenges, such as toxicity-related issues with ricin, phytochemical composition variations, the lack of clinical support, and standardization and regulatory approval issues. In order to overcome all these limitations, it is necessary to conduct extensive scientific validation, develop sophisticated methods of analysis and design effective and quality clinical trials in order to achieve safety, efficacy and reproducibility. Moreover, its bioactive compounds can be made more bioavailable and targeted by incorporating new technologies like nanotechnology-based drug delivery systems and computational pharmacology. Comprehensively, *Ricinus communis* has significant potential as a useful tool in drug discovery and pharmacology today. The key to unlocking the full therapeutic potential of traditional knowledge will be bridging the gap between the traditional knowledge and modern scientific research. The future research on mechanistic insights, clinical validation, and sustainable use is expected to open the path to a successful implementation of it in evidence-based medicine and pharmaceutical development.



REFERENCES

1. Ramothloa TP, Mkolo NM, Motshudi MC, Mphephu MM, Makhafola MA, Naidoo CM. Phytochemical composition and multifunctional applications of *Ricinus communis* L.: Insights into therapeutic, pharmacological, and industrial potential. *Molecules*. 2025 Jul 31;30(15):3214.
2. Martínez-González M, Ramos-López MA, Villagómez-Aranda AL, Rodríguez-Morales JA, Campos-Guillén J, Mariscal-Ureta KE, Amaro-Reyes A, Valencia-Hernández JA, Saenz de la O D, Zavala-Gómez CE. *Ricinus communis* as a Sustainable Alternative for Biodiesel Production: A Review. *Fuels*. 2025 Dec 2;6(4):90.
3. Anas M, Khattak WA, Sarfraz W, Khalid N, Naeem N, Farid M, Saleem MH, Khan KA, Khalid A, Ahmed T, Fahad S. EDTA-enhanced phytoextraction: leveraging *Ricinus communis* for the decontamination of Pb and Cd in agricultural soils. *Plant Growth Regulation*. 2025 Feb;105(1):215-28.
4. Ghidoli M, Ceriani M, Araniti F, Peconi M, Adani F, Pili R. Castor Bean (*Ricinus communis* L.) for Phytoremediation: Strategy to Improve and Integrate the Circular Economy. *Sustainability*. 2026 Apr 1;18(7):3419.
5. Raza H, Sultan MT, Abbas A, Mazhar A, Noman AM, Imran M, Hussain M, Mostafa EM, El-Ghorab AH, Ghoneim MM, Selim S. *Ricinus Communis*: Nutritional Importance, Health Benefits, and Industrial Applications. *eFood*. 2026 Feb;7(1):e70117.
6. Pandey SN, Kumar P, Verma H, Durgapal S, Singh B. Phytopharmacological Insights into *Ricinus communis*: A Comprehensive Overview. *Pharmacognosy Research*. 2025 Apr 1;17(2).
7. Megharaj KV, Shekhar TV, Pavithra MR, Sarfaraz MM. A systematic review on phytochemical constituents and pharmacological activities *Ricinus communis* plant. *Research Journal of Pharmacology and Pharmacodynamics*. 2025;17(1):47-51.
8. Goel V, Kumar V, Bajaj S, Garg K, Kamboj M, Chopra B. *Ricinus communis*: unlocking the potential of a medicinal powerhouse. *Current Functional Foods*. 2025 Jan 23.
9. Arya AK, Kumar G, Singh V, Afaq N, Shukla S, Singh S, Ratna P, Yadav M, Pandey S, Yadav AN. Unveiling the Antimicrobial Potential of *Ricinus communis*: A Comprehensive Review of Its Relevance to Surgical Site Infection (SSI) Pathogens. *Cureus*. 2025 Dec 21;17(12).
10. Fiume MM, Bergfeld WF, Belsito DV, Cohen DE, Klaassen CD, Rettie AE, Ross D, Snyder PW, Tilton SC, Heldreth B. Re-Review Summary of *Ricinus Communis* (Castor) Seed Oil and Ricinoleates as Used in Cosmetics. *International Journal of Toxicology*. 2025 Oct;44(3_suppl):117S-22S.
11. Kumar D, Nand S, Patel A, Nilofer, Singh S. Medicinal Properties of *Ricinus communis* L. Oil and Their Applications: An Overview. *Ricinus Communis: A Climate Resilient Commercial Crop for Sustainable Environment*. 2025 Mar 23:75-87.
12. Thejaswini C, Rao VR, Shubhashree MN, Naik R, Bhat S, Shiddamallayya N, Srikanth N, Acharya R. A narrative overview of pharmacological activities of Eranda (*Ricinus communis* L.) beeja (seeds) and taila (oil): Ayurvedic and scientific perspectives. *Journal of Drug Research in Ayurvedic Sciences*. 2025 Mar 1;10(2):120-9.
13. Vijayan R, Kanimozhi E, Manonmani V, Venkatachalam SR, Tilak M. Optimising castor (*Ricinus communis* L.) plant performance: novel approaches for coping



- with abiotic stress via seed treatment and foliar application. *Tropical Agriculture*. 2025 May 1;102(2):250-64.
14. Veličković AV, Rajković DD, Avramović JM, Jeromela AM, Krstić MS, Veljković VB. Advancements in biodiesel production from castor oil: A comprehensive review. *Energy Conversion and Management*. 2025 Apr 15;330:119622.
 15. Matlala ME, Lubisi NP, Chauke S, Kola E, Ramarumo LJ, Ndhlovu PT. Plant species used to treat various ailments in the North-West Province, South Africa: A systematic review. *Next Research*. 2025 Sep 1;2(3):100446.
 16. Kumar S, Verma S. Botany, Geographical Distribution, Cultivation Techniques, and Crop Productivity of *Ricinus communis* L. In *Ricinus Communis: A Climate Resilient Commercial Crop for Sustainable Environment* 2025 Mar 23 (pp. 19-33). Singapore: Springer Nature Singapore.
 17. Pandey SN, Kumar P, Verma H, Durgapal S, Singh B. Phytopharmacological Insights into *Ricinus communis*: A Comprehensive Overview. *Pharmacognosy Research*. 2025 Apr 1;17(2).
 18. Ramothloa TP, Mkolo NM, Motshudi MC, Mphephu MM, Makhafola MA, Naidoo CM. Phytochemical composition and multifunctional applications of *Ricinus communis* L.: Insights into therapeutic, pharmacological, and industrial potential. *Molecules*. 2025 Jul 31;30(15):3214.
 19. Van Dyk C. *Ricinus communis* L. var. *communis*. In *African Herbal Pharmacopoeia* 2026 (pp. 282-292). CRC Press.
 20. Goel V, Kumar V, Bajaj S, Garg K, Kamboj M, Chopra B. *Ricinus communis*: unlocking the potential of a medicinal powerhouse. *Current Functional Foods*. 2025 Jan 23.
 21. Peixoto LS, Peixoto YS. Genetic Variability and Breeding Opportunities in Castor Bean (*Ricinus Communis* L.). In *Ricinus Communis: A Climate Resilient Commercial Crop for Sustainable Environment* 2025 Mar 23 (pp. 35-63). Singapore: Springer Nature Singapore.
 22. Rubab S, Majeed S, Dawood S, Zafar M, Alotaibi MO, Ibadullayeva S, Bibi F, Khan Y, Amin A. Stem anatomical microcharacters and morphology as diagnostic botanical markers in Euphorbiaceae species. *The Science of Nature*. 2026 Apr;113(2):30.
 23. Badel JL, dos Santos DC, Neves YF, Sousa AA, Vidigal PM, Alfenas RF, Alfenas AC. Comprehensive pangenomic, phylogenetic, and genome comparison analyses demonstrate that the causal agent of castor bean (*Ricinus communis* L.) bacterial blight is a pathovar of the *Xanthomonas euvesicatoria* species. *Tropical Plant Pathology*. 2026 Dec;51(1):13.
 24. Fatalo T, Alkadir G. In Vitro Acaricidal Activity of *Croton macrostachyus* Leaf and *Ricinus communis* Seed Extracts Against Cattle-Infesting Ticks (*Rhipicephalus* spp. and *Amblyomma* spp.). *Veterinary Medicine International*. 2026;2026(1):1189650.
 25. Alcântara BM, Santos FR, Silva JA, Almeida-Bezerra JW, Costa JG, Silva DC, Furlan CM, Silva MA. Dominance of *Ricinus communis* in the Semi-Arid Region Mediated by Allelopathy. *Weed Research*. 2026 Mar;66(2):e70079.
 26. Raza H, Sultan MT, Abbas A, Mazhar A, Noman AM, Imran M, Hussain M, Mostafa EM, El-Ghorab AH, Ghoneim MM, Selim S. *Ricinus Communis*: Nutritional Importance, Health Benefits, and Industrial Applications. *eFood*. 2026 Feb;7(1):e70117.
 27. Megharaj KV, Shekhar TV, Pavithra MR, Sarfaraz MM. A systematic review on phytochemical constituents and

- pharmacological activities *Ricinus communis* plant. Research Journal of Pharmacology and Pharmacodynamics. 2025;17(1):47-51.
28. Paniagua-Zambrana NY, Bussmann RW, Kikvidze Z. *Ricinus communis* L. Euphorbiaceae. In *Ethnobotany of the Mountain Regions of Eastern Europe: Carpathians* 2025 Apr 24 (pp. 2379-2388). Cham: Springer Nature Switzerland.
 29. Pandey SN, Kumar P, Verma H, Durgapal S, Singh B. Phytopharmacological Insights into *Ricinus communis*: A Comprehensive Overview. *Pharmacognosy Research*. 2025 Apr 1;17(2).
 30. Kumar D, Nand S, Patel A, Nilofer, Singh S. Medicinal Properties of *Ricinus communis* L. Oil and Their Applications: An Overview. *Ricinus Communis: A Climate Resilient Commercial Crop for Sustainable Environment*. 2025 Mar 23:75-87.
 31. Ullah HU, Ibrahim M, Sara S, Bibi SB, Buddin SB, Ullah M, Zareef HZ. Traditional medicine in Wartair, District Malakand, Pakistan: An ethnomedicinal study of locally used plants. *Ethnobotany Research and Applications*. 2025 Mar 9;30:1-3.
 32. Gangurde VV, Kalarikkal VW, Rahangdale DY, Krishna N, Nagayya S, Bandi V, Singh AG, Devi LR, Bora D, Singh K, Srikanth N. Traditional medicinal plants used by ethnic communities in Senapati and Kangpokpi districts of Manipur, India: a quantitative assessment. *Discover Plants*. 2025 Mar 25;2(1):82.
 33. Raza H, Sultan MT, Abbas A, Mazhar A, Noman AM, Imran M, Hussain M, Mostafa EM, El-Ghorab AH, Ghoneim MM, Selim S. *Ricinus Communis*: Nutritional Importance, Health Benefits, and Industrial Applications. *eFood*. 2026 Feb;7(1):e70117.
 34. Goel V, Kumar V, Bajaj S, Garg K, Kamboj M, Chopra B. *Ricinus communis*: unlocking the potential of a medicinal powerhouse. *Current Functional Foods*. 2025 Jan 23.
 35. Berhanu T, Tewelde E, Yeshak MY, Bisrat D, Asres K. Anthelmintic Potential and In Silico Studies of Ricinoleic Acid from the Seed Oil of *Ricinus communis* L. *International Journal of Molecular Sciences*. 2025 Feb 14;26(4):1636.
 36. Zheng J, Suhono GB, Li Y, Jiang MY, Chen Y, Siddique KH. Salt-tolerance in castor bean (*Ricinus communis* L.) is associated with thicker roots and better tissue K^+/Na^+ Distribution. *Agriculture*. 2021 Aug 28;11(9):821.
 37. Landoni M, Bertagnon G, Ghidoli M, Cassani E, Adani F, Pilu R. Opportunities and challenges of castor bean (*Ricinus communis* L.) genetic improvement. *Agronomy*. 2023 Aug 7;13(8):2076.
 38. Drumond AA, Sales JD, Zuchi J, Camelo GN, Souza MM. Physiological quality of castor seeds (*Ricinus communis* L.) after processing. *Journal of Seed Science*. 2019 Jul 1;41(2):224-32.
 39. Herawati IE, Lesmana R, Levita J, Subarnas A. Determination and purification of ricin protein from *Ricinus communis* L. seeds using CLC (column liquid chromatography) and FPLC (fast protein liquid chromatography). *Indonesian Journal of Pharmaceutical Science and Technology*. 2021 Dec 8;8(3):118-24.
 40. Azadmard-Damirchi SO, Fathi-Achachlouei B, Alirezalu KA, Alirezalu AB, Hesari JA, Emami SH. Physiological and medicinal properties of castor oil. *Recent Progress in Medicinal Plants*; Studium Press (India) Pvt. Ltd.: Delhi, India. 2011.
 41. Mashela PW, Nthangeni ME. Efficacy of *Ricinus communis* fruit meal with and without *Bacillus* species on suppression of *Meloidogyne incognita* and growth of tomato.

- Journal of phytopathology. 2002 Aug;150(7):399-402.
42. Mabasa R, Malemela K, Serala K, Kgakishe M, Matsebatlela T, Mokgotho M, Mbazima V. Ricinus communis butanol fraction inhibits MCF-7 breast cancer cell migration, adhesion, and invasiveness. *Integrative Cancer Therapies*. 2021 Feb;20:1534735420977684.
43. Aremu AO, Pendota SC. Medicinal plants for mitigating pain and inflammatory-related conditions: an appraisal of ethnobotanical uses and patterns in South Africa. *Frontiers in Pharmacology*. 2021 Oct 22;12:758583.
44. Mboyazi SN, Nqotheni MI, Maliehe TS, Shandu JS. In Vitro Antibacterial and In Silico Toxicity Properties of Phytocompounds from Ricinus Communis Leaf Extract. *Pharmacognosy Journal*. 2020 Sep 1;12(5).
45. Qin L, Han J, Wang C, Xu B, Tan D, He S, Guo L, Bo X, Xie J. Key defatting tissue pretreatment protocol for enhanced MALDI MS Imaging of peptide biomarkers visualization in the castor beans and their attribution applications. *Frontiers in Plant Science*. 2022 Dec 16;13:1083901.
46. Badria F, El-Naggar M, Bar F. Chemistry, economic, and biological aspects of Ricinus communis plant. *Asian J. Res. Pharm. Sci. Biotechnol*. 2020;8:9-24.
47. Muñoz-Sánchez D, Pinto Y, Valencia-Hernandez JD, Lora-Suarez F, Sanchez JM, Gómez-Marín JE. In vitro activity of Ricinus communis (castor oil) on cysts of Entamoeba histolytica. *Phytomedicine Plus*. 2024 May 1;4(2):100538.
48. Khan Marwat S, Khan EA, Baloch MS, Sadiq M, Ullah I, Javaria S, Shaheen S. Ricinus communis: Ethnomedicinal uses and pharmacological activities. *Pakistan journal of pharmaceutical sciences*. 2017 Sep 1;30(5).
49. Krunal D, Rabinarayan A. Therapeutic importance of Eranda (Ricinus communis Linn.) in Ayurveda-a review. *Ayurpharm Int J Ayur Alli Sci*. 2013;2(9):281-95.
50. Said-Al Ahl HA, Hikal W. Antileishmanial derivatives of natural products from Ricinus communis. *Aswan University Journal of Environmental Studies*. 2022 Mar 1;3(1):41-75.
51. Mamoucha S, Tsafantakis N, Fokialakis N, Christodoulakis NS. Structural and phytochemical investigation of the leaves of Ricinus communis. *Australian Journal of Botany*. 2017 Feb 14;65(1):58-66.
52. Tuyen PN, Linh TT, Van Son D, Van Thang N, Van Son D, Trang NT, Chi HB, Ky ND, Phat NT, Duong HT. Phenolic compounds from the leaves of Ricinus communis Linn. *VNUHCM Journal of Science and Technology Development*. 2020 Aug 24;23(3):694-8.
53. Megharaj KV, Shekhar TV, Pavithra MR, Sarfaraz MM. A systematic review on phytochemical constituents and pharmacological activities Ricinus communis plant. *Research Journal of Pharmacology and Pharmacodynamics*. 2025;17(1):47-51.
54. Pandey SN, Kumar P, Verma H, Durgapal S, Singh B. Phytopharmacological Insights into Ricinus communis: A Comprehensive Overview. *Pharmacognosy Research*. 2025 Apr 1;17(2).
55. Chakraborty B, Nayaka S, Bhairappanavar CA, Kantli GB, Nagaraja SK. Network pharmacology and molecular simulation insights into the anti-diabetic and anti-inflammatory mechanisms of Ricinus communis. *Naunyn-Schmiedeberg's Archives of Pharmacology*. 2025 Dec 2:1-21.
56. Chen L, Deng H, Cui H, Fang J, Zuo Z, Deng J, Li Y, Wang X, Zhao L. Inflammatory responses and inflammation-associated diseases in organs. *Oncotarget*. 2017 Dec 14;9(6):7204.

57. Leo CH, Ou JL, Ong ES, Qin CX, Ritchie RH, Parry LJ, Ng HH. Relaxin elicits renoprotective actions accompanied by increasing bile acid levels in streptozotocin-induced diabetic mice. *Biomedicine & Pharmacotherapy*. 2023 Jun 1;162:114578.
58. Hasan H, Mohammed M, Haroon A. Determining the contents of antioxidants, total phenols, carbohydrate, total protein, and some elements in *Eucalyptus gomphocephala* and *Ricinus communis* plant samples. *Libyan Medical Journal*. 2025 May 12:222-31.
59. Asran AG, Harb N, Gomaa HA, El-dougDoug KA, Lotfy MF. Phytochemical Profiling, Cytotoxic, Antimicrobial and Antioxidant Potential of Healthy and Cucumber Mosaic Virus Infection of *Ricinus Communis* Leaf Extracts. *Scientific Journal of Agricultural Sciences*. 2025 Dec 1;7(4):95-114.
60. Arya AK, Kumar G, Singh V, Afaq N, Shukla S, Singh S, Ratna P, Yadav M, Pandey S, Yadav AN. Unveiling the Antimicrobial Potential of *Ricinus communis*: A Comprehensive Review of Its Relevance to Surgical Site Infection (SSI) Pathogens. *Cureus*. 2025 Dec 21;17(12).
61. Muhammad FE, Daniyan SY. Quantitative Phytochemical Analysis and Antimicrobial Activity of *Ricinus communis* Linn. Seed oil. *UMYU Scientifica*. 2025;3(1):200-7.
62. Megharaj KV, Shekhar TV, Pavithra MR, Sarfaraz MM. A systematic review on phytochemical constituents and pharmacological activities *Ricinus communis* plant. *Research Journal of Pharmacology and Pharmacodynamics*. 2025;17(1):47-51.
63. Tennalli GB, Yallappa S, Hungund BS, Joseph S, Divate MN, Upadhyaya K. Biogenic synthesis of copper oxide nanoparticles from *Ricinus communis* L. leaf extract and their cytotoxic and pro-apoptotic effects on tumor cell lines. *Results in Chemistry*. 2025 Nov 22:102896.
64. Saikia S, Muralidhar S, Nadumane VK. Comparative analysis of the cytotoxicity of two weeds, *Ricinus communis* L. and *Lantana camara* L. on HeLa cell line. *Indian J. Applied & Pure Bio*. Vol. 2025;40(2):941-51.
65. Rezaee A, Rahmanian P, Nemati A, Sohrabifard F, Karimi F, Elahinia A, Ranjbarpazuki A, Lashkarbolouki R, Dezfulian S, Zandieh MA, Salimimoghadam S. NF- κ B axis in diabetic neuropathy, cardiomyopathy and nephropathy: A roadmap from molecular intervention to therapeutic strategies. *Heliyon*. 2024 May 15;10(9).
66. BENARIBA N, FEKHIKHER Z, BRIXI-GORMAT R, BENRAMDANE H, YOUNI H, KOUAR I, MILOUDI H, MEHARRAR S, EL HACI IA, MEDJDOUB H, AZZ R. In vitro antioxidant and antidiabetic activities of the hydro-acetone extracts of *Ricinus communis* and *Teucrium polium* from Tlemcen area. *Journal of Natural Product Research and Applications*. 2023;3(02):34-46.
67. Nawab K, Shad AA, Bakht J. Exploring the hepatoprotective potential of *Ricinus communis* fractions: insights from biochemical, histopathological and molecular docking analysis. *Pak. J. Bot*. 2025 Aug 1;57(4):1549-56.
68. Naveen, A., V. Narapogu, P. John, S. Ubedulla and N. Pokala. 2016b. Evaluation of hepatoprotective activity of aqueous extract of *Andrographis paniculata* in wistar rats. *Intl. J. Pharmacol. and Clin. Sci.*, 5: 113-117.
69. Goel V, Kumar V, Bajaj S, Garg K, Kamboj M, Chopra B. *Ricinus communis*: unlocking the potential of a medicinal powerhouse. *Current Functional Foods*. 2025 Jan 23.
70. Megharaj KV, Shekhar TV, Pavithra MR, Sarfaraz MM. A systematic review on

- phytochemical constituents and pharmacological activities Ricinus communis plant. *Research Journal of Pharmacology and Pharmacodynamics*. 2025;17(1):47-51.
71. Abdul WM, Hajrah NH, Sabir JS, Al-Garni SM, Sabir MJ, Kabli SA, Saini KS, Bora RS. Therapeutic role of Ricinus communis L. and its bioactive compounds in disease prevention and treatment. *Asian pacific journal of tropical medicine*. 2018 Mar 1;11(3):177-85.
 72. Adebayo OC, Ogidi CO, Akinyele BJ. Nutritional value and safety of castor bean (*Ricinus communis*) seeds detoxified in solid-state fermentation by *Pleurotus ostreatus*. *Biofarmasi. J. Nat. Prod. Biochem*. 2019;17:51-60.
 73. Sarwade PP, Bongale MM, Mittal N, Chand S, Vijayalakshmi K, Khongshei R, Gaisamudre KN. A detailed study of *Hibiscus rosa sinensis* L: Phytochemistry, pharmacological activities therapeutic uses and its antimicrobial, antioxidant activities. *Asian Journal of Pharmaceutical Research and Development*. 2025 Feb 15;13(1):138-46.
 74. SR SK, Bongale MM, Sarwade PP, Vijayalakshmi K, Goswami M, Khongshei R, Gaisamudre KN. *Ocimum Sanctum*: Phytochemistry, Therapeutic Uses Pharmacological Activities and Its Anticancer Activities. *Asian Journal of Pharmaceutical Research and Development*. 2025 Apr 15;13(2):119-25.
 75. Gaisamudre KN, Sarwade PP, Sonwani K, Chand S, Mehta R, Pant NC. Exploring *Lantana camara*: A comprehensive insight into its bioactive constituents and therapeutic potential. *Asian Journal of Pharmaceutical Research and Development*. 2025 Dec 15;13(6):286-96.
 76. Sarwade PP, Gaisamudre KN, Kumar R, Gajendhini S. A Detailed Study of *Aloe Barbadensis* Phytochemistry, Taxonomy and Its Anticancer Activity.
 77. Cargnello M, Roux PP. Activation and function of the MAPKs and their substrates, the MAPK-activated protein kinases. *Microbiology and molecular biology reviews*. 2011 Mar;75(1):50-83.
 78. Leo CH, Ou JL, Ong ES, Qin CX, Ritchie RH, Parry LJ, Ng HH. Relaxin elicits renoprotective actions accompanied by increasing bile acid levels in streptozotocin-induced diabetic mice. *Biomedicine & Pharmacotherapy*. 2023 Jun 1;162:114578.
 79. Choi SS, Park J, Choi JH. Revisiting PPAR γ as a target for the treatment of metabolic disorders. *BMB reports*. 2014 Nov;47(11):599.
 80. Di Paola R, Crisafulli C, Mazzon E, Genovese T, Paterniti I, Bramanti P, Cuzzocrea S. Effect of PD98059, a selective MAPK3/MAPK1 inhibitor, on acute lung injury in mice. *International journal of immunopathology and pharmacology*. 2009 Oct;22(4):937-50.
 81. Dlodla PV, Mabhidha SE, Ziqubu K, Nkambule BB, Mazibuko-Mbeje SE, Hanser S, Basson AK, Pheiffer C, Kengne AP. Pancreatic β -cell dysfunction in type 2 diabetes: Implications of inflammation and oxidative stress. *World journal of diabetes*. 2023 Mar 15;14(3):130.
 82. Frasor J, El-Shennawy L, Stender JD, Kastrati I. NF κ B affects estrogen receptor expression and activity in breast cancer through multiple mechanisms. *Molecular and cellular endocrinology*. 2015 Dec 15;418:235-9.
 83. Gabryelska A, Karuga FF, Szmyd B, Białasiewicz P. HIF-1 α as a mediator of insulin resistance, T2DM, and its complications: potential links with obstructive sleep apnea. *Frontiers in Physiology*. 2020 Sep 9;11:1035.

84. Morris G, Walder K, Carvalho AF, Tye SJ, Lucas K, Berk M, Maes M. The role of hypernitrosylation in the pathogenesis and pathophysiology of neuroprogressive diseases. *Neuroscience & Biobehavioral Reviews*. 2018 Jan 1;84:453-69.
85. Ghosh P, Bhakta S, Bhattacharya M, Sharma AR, Sharma G, Lee SS, Chakraborty C. A novel multi-epitopic peptide vaccine candidate against *Helicobacter pylori*: in-silico identification, design, cloning and validation through molecular dynamics. *International journal of peptide research and therapeutics*. 2021 Jun;27(2):1149-66.

HOW TO CITE: Prakash Pralhad Sarwade, Kavita Narayan Gaisamudre (Sarwade), Snega Boopathy, Arti Kumari, Shakthi L, Mohammed Numan Ahmed, M. Geetha, Exploring *Ricinus communis* Bioactive Compound and Pharmacological Insights: A Comprehensive Review, *Int. J. of Pharm. Sci.*, 2026, Vol 4, Issue 4, 3252-3273. <https://doi.org/10.5281/zenodo.19673823>

