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# Qualitative analysis, total quantification of secondary metabolites & their characterization by TLC profile in the Leaf and Bark of *Ricinus communis* L.

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## ABSTRACT

*The particular phytocompound performs a relevant physiological mechanism in humans. Methanolic crude form of extract of Ricinus communis Linn. is a well-known herbal plant, which was analysed by qualitative and quantitative estimations. The analysis of total quantitative estimations of specific phytochemical constituents from Ricinus communis L. includes Alkaloids, Flavonoids, Phenols, Tannins & Steroids. Total average appropriate phenolic compounds were found in significantly larger amounts, especially in leaves & bark, which goes along with tannin concentration, alkaloid, steroids, & flavonoids. The maximum content of total phenolics (3.42 ± 0.8 Mg FCAE/gram DW) in leaves & (15.39 ± 2.32 Mg FCAE/gram DW) in bark, tannin (3.24 ± 0.95 Mg GAE/gram DW) in leaves & (8.3 ±0.051 Mg GAE/gram DW). A considerable quantity of total alkaloids was observed (2.50 ± 1.06 Mg AE/gram of DW in the leaf & (3.54 ± 0.67 Mg AE/gram DW) in bark, which followed the total concentration of steroid (2.34 ± 0.1 Mg FDE/gram DW) in leaves & (4.41 ± 2.64 Mg FDE/gram DW) in bark. Total concentration of flavonoid (1.85 ± 0.7 Mg QE/gram DW) in leaves & (6.8 ± 0.02 Mg QE /gram DW) in bark of Ricinus communis L. Phytochemical assessment was carried out through a range of qualitative approaches, and TLC studies were done with multiple solvent systems of varying polarity. Qualitative phytochemical determination by chemical tests indicates the presence of alkaloids, steroids, saponins, tannins, anthocyanins, coumarins, flavonoids, reducing sugars, glycosides, and phenols in plants. TLC profiling of these plants was carried out using different solvents in methanol extracts of Ricinus communis L., and it showed Distinct Rf values. Different solvent systems were observed under UV light to detect phytochemicals present in the extracts. (A) $CHCL_3C_6H_{14}C_2H_5OH$ (4:2:4) B) $CHCL_3C_6H_{14}H_2O$, PE, $C_4H_8O_2$ (4:2:2:4) (C) PE, $CHCL_3C_6H_{14}$(4:3:3).*

***Keywords:*** *Phytosterols, Polyphenols, Flavonoids, Alkaloids, TLC*

## Introduction

*Ricinus* is an oil-containing seed-producing annual or perennial shrubby plant in the family *Euphorbiaceae*. It is distributed across Equatorial and warm-temperature regions around the world [1]. The plant is the authentic source of oil, has extensive applications in the pharmaceutical, agricultural, and industrial sectors. Castor oil serves as a crude substance for making diverse products such as nylon, aeroplane petro-lubricants, working solutions, ointments, varnishes, dye, synthetic leather, detergent, plastic, perfumes, paint, and beautifying agents [2, 3], in addition to being utilized for biodiesel and biofuel production [4, 5]. Oil-extracted seed residue obtained by extraction is a great source of proteinaceous compounds & after Decontamination, is employed as a supplementary feed for cattle, poultry, sheep, & fish [6–8]. Moreover, the seed remnants are commonly used as organic manure [9]. Traditionally, Multiple components of the plant, including bark, leaves, roots, stems, seeds, flowers, and their oil, have been employed in traditional and medicinal practices. For example, castor preparations were commonly used as laxatives, in the treatment of inflammations and infections, as remedies for toothaches, and even as flavouring agents in prehistoric civilizations [10, 11]. The leaves of RC are reported to exhibit diverse therapeutic properties, such as effectiveness against jaundice, relief of stomach pain and flatulence, and antifungal activity against *Mycobacterium tuberculosis* and yeast. Additionally, the plant has demonstrated insect-repellent effects, helping to control mosquitoes, rust, aphids, whiteflies, and mites [12].

Recently, *Ricinus communis* has been reported to exhibit a wide spectrum of biological activities, including anti-microbial, antifungal, antidiabetic, anti-asthmatic, anticancer, antimalarial, anti-inflammatory, antioxidant, anticonvulsant, antinociceptive, anthelmintic, uterotonic, antifertility, laxative, anti-implantation, molluscicidal, antiulcer, bone-regenerative, antihistaminic, insecticidal, cytotoxic, hepatoprotective, & anti-arthritic properties [13]. Traditional herbal products derived from various plant parts have long been utilized as alternatives to synthetic drug formulations. They are often preferred because they are easily accessible, cost-effective, and considered relatively safe for use. Unlike many manufactured drugs, plant-derived biologically active compounds are generally associated with fewer side effects and demonstrate a broad spectrum of therapeutic applications [14–16].

## Material and Method

**Material of plant:** *Ricinus communis* Linn.

The chosen plant materials were taken from localized regions within the Wardha and Nagpur districts of Maharashtra, India. The plant specimens were collected from India. After collection, they were thoroughly washed with water to eliminate dust & debris, subsequently rinsed with mineralised water to eliminate residual impurities. Cleaning involved manual processes such as washing, peeling, and stripping leaves from stems to ensure the removal of extraneous matter. Manual cleaning is preferred to maintain the integrity of the plant material and to enhance the accuracy and reliability of subsequent phytochemical analysis.

**Identification of plant material**

1. A preliminary survey of the regional flora was conducted to locate and distinguish the selected plant species from other surrounding vegetation.
2. The collected plant material was initially identified up to the genus level based on morphological characteristics.
3. For confirmation and taxonomic validation, the identification was further verified by consulting taxonomic experts and cross-referencing with authenticated herbarium specimens from recognized herbaria within the source region.

**Preparation of plant extract:** The cleaned plant specimens were subjected to artificial drying under a hot-air oven operated at a constant temperature range of 40°C to 70°C for 6 to 8 hours. This controlled drying process ensured the removal of moisture without degrading the phytochemical constituents. Once completely dried, the plant materials finely dried plant material was pulverized with a mechanical grinder, and the resulting powder was stored in airtight containers under dry conditions for later extraction. and phytochemical analysis. Qualitative analysis of primary metabolites.

**Extraction and preliminary phytochemical screening:**

Chloroform, methanol, aqueous, and acetone extracts of powdered plant material were prepared and put through preliminary Bioactive plant compound analysis using standard qualitative procedures.

**I. Test for Carbohydrates**

**Molisch Test:** Approximately 2 mL of plant extract was taken over in a clean testing tube. 0.5 ml of an alcoholic solution of alfa naphthol was added, & mixture was shaken slowly. Subsequently, 2-3 drops of concentrated $H_2SO_4$ were carefully mixed. The formation of a violet or purple ring-like structure at the interface & confirms that carbohydrates are present in plant material.

**II. Test for Proteins**

**Biuret Test:** Approximately 2 mL of extract of the plant was placed in a testing tube of the experiment & 1 drop of 2 percent $CuSO_4$ solution was added which followed by 1 ml of ethanol (95 %). Subsequently, a small amount of KOH solution was introduced. The production of a pink/violet colour is nothing but the presence of proteins.

**III. Test for Amino Acids:** Approximately 1 ml of plant extract is taken in an experimental test tube, & two drops of freshly prepared 0.2% ninhydrin reagent. The mixture was gently boiled in a water bath. Purple/pink colour confirmed the free amino acids, peptides, or proteins in the plant sample.

**Qualitative Analysis of Secondary Metabolites**

**IV. Test for Alkaloids**

**Mayer Test**: A Few milliliters of extract of the plant is taken in an experimental test tube, and 1–2 drops of Mayer's reagent are carefully added at the edge of the test tube. The creamy white precipitation appeared to confirm that the alkaloids are present in the plant sample [17].

**Wagner Test**

Approximately 2 ml of extract of the plant is taken in an experimental test tube, & a few drops of Wagner's reagent are added. The red-brown precipitation indicated the alkaloids present in the plant sample.

**Dragendorff's alkaloid Test:** 5 mL extract of the plant, 2 mL HCl was added and mixed well. Then, 1 mL of Dragendorff's reagent was added to it. The formation of an orange/reddish precipitate confirmed the presence of alkaloids.

**V. Test for Glycosides**

**Borntrager's Test**

Approximately 2 ml of extract of the plant was taken in an experimental test tube, & added 3 ml of chloroform in it. Mixture shaken thoroughly & stays on the stand for separation. The chloroform layer was then collected, and an equal volume of dilute ammonia solution was added. The development of a pink to red colour in the ammoniacal layer indicated the presence of anthraquinone glycosides. The chloroform layer was then isolated, and an equal volume of 10% ammonia solution was added. The appearance of a pink or red coloration in the ammoniacal layer indicated the presence of anthraquinone glycosides.

**Test for Cardiac Glycosides**

**Keller–Killiani Test**:

Approximately 5 ml of the solvent extract was mixed with 2 ml of glacial acetic acid in a test tube. Then one drop of $FeCl_3$ solution was added, followed by the careful addition of 1 ml of concentrated $H_2SO_4$ at the edge of the test tube. The formation of a brown ring at the interface indicated the presence of deoxy sugars, which are characteristic of cardenolides. A violet ring may appear below the brown ring, and a greenish ring may form in the upper acetic acid layer, further confirming a positive result.

**V. Test for Phenol**

**Gelatine Test:** Approximately 5 ml of the plant extract was taken in a test tube, and 2 ml of 1% gelatin solution containing 10% NaCl was added. The formation of a white precipitate indicated the presence of phenolic compounds [18].

**Test for Phenolic Compounds and Tannins**

**Ferric Chloride Test**

To 5 ml of the plant extract in a test tube, a few drops of 0.1% $FeCl_3$ solution were added. The formation of a bluish-black coloration indicated the presence of hydrolysable tannins, while a brownish-green precipitate suggested the presence of condensed tannins [19].

**VI. Test for Flavonoids:** A portion of the aqueous filtrate of the plant extract was treated with 5 mL of dilute ammonia solution, followed by the addition of concentrated $H_2SO_4$. The appearance of a yellow coloration indicated the presence of flavonoids. The yellow colour typically disappeared upon standing, confirming a positive result.

**VII. Test for Steroids**

**Salkowski Test:** 1 ml of the plant extract, 10 ml of chloroform were added to a test tube. Then, 10 ml of concentrated $H_2SO_4$ was carefully added along the edge of the test tube to form two distinct layers. The appearance of a red colour in the upper chloroform layer and a yellow colour with green fluorescence in the lower acid layer indicated the presence of steroidal compounds.

**VIII. Quantitative analysis**

**Estimation of Total Tannin Content:** To determine the total content of tannin, 0.5 ml of the extract of the plant was mixed with 0.25 ml of folin–denis reagent, $Na_2CO_3$, and 3.5 ml of Dw. The mixture was incubated at normal temperature, and the absorbance was measured at 700nm within 30 minutes using a spectrophotometer. The total tannin content was calculated by a standard calibration of tannic acid equivalents mg TAE/gram [22, 23].

**Total estimation of Flavonoid Content:** To estimate the total content of flavonoid, 0.5 ml extract of the plant was mixed with 2 ml of DW & 0.15 ml of 5% $NaNO_2$ solution. After a few minutes, 0.15 ml of 10% $AlCl_3$ solution was added, followed by 2ml of 1 M NaOH. The final volume was adjusted with DW, & mixture was incubated at normal temperature. After 15 minutes, the absorbance was taken at 510nm using a spectrophotometer. The intensity of the pinkish-red coloration was directly proportional to the flavonoid concentration. The flavonoid total content was calculated by a standard calibration curve prepared using rutin mg RE/gram [24].

**Estimation of total phenolic content:** Total phenolic content was determined by 0.5 ml extract of the plant with 5 ml of 10% folin–ciocalteu reagent & 1 M $Na_2CO_3$, 4 ml in a 50 mL Volumetric Flask. The complete volume was adjusted with distilled water. Subsequently, 0.5 mL of the reaction mixture was taken, and the absorbance was measured at 760 nm using a UV-Visible spectrophotometer. A blank solution, prepared without plant extract, was used for baseline correction. The development of a blue coloration was proportional to the phenolic content. The total phenolic content was calculated from a standard calibration curve prepared using gallic acid and expressed as gallic acid equivalents (GAE) in mg GAE per gram of extract (mg GAE/g) [25].

**Total alkaloid estimation:** For total estimation of alkaloid content, 0.5 ml extract of the plant was mixed with 5 ml phosphate buffer at pH 4.7 and 5 ml of BCG reagent in a separation funnel. The mixture was vigorously shaken in 5 ml chloroform. The chloroform layer was separated, and the absorbance was taken at 470 nm in a spectrophotometer. A blank solution made without plant extract was used for baseline correction. The yellow colour intensity in the layer of chloroform is proportional to the alkaloid concentration. The calculation of total alkaloid content by using a curve of standard calibration prepared using atropine mg AE/gram [26].

**Estimation of statistical analysis of all secondary metabolites**: All quantitative estimations of secondary metabolites were analysed in three individual independent replicates, and reported as mean ± standard error. Statistical analysis & graph plotting were conducted using Microsoft Excel. ANOVA was used to evaluate the differences between means, and $P \leq 0.05$ statistical significance was considered. Additionally, correlation coefficient ($R^2$) values were determined to evaluate the strength and direction of these associations.

**TLC separation:** Thin Layer Chromatography was utilized for the separation & characterization of phytocompounds available in methanol and aqueous *Ricinus communis* L. extracts. A TLC chamber (a 100–150 mL capacity beaker) was prepared by ensuring it was completely dried. If not dry, it was rinsed only with the developing solvent to avoid contamination, never with water or unrelated solvents. A clean, dry strip of filter paper was placed vertically along the inner wall of the chamber to saturate the atmosphere with solvent vapour, ensuring uniform development and reducing solvent evaporation from the TLC plate. A small volume of the selected mobile phase solvent system was poured into the chamber to a depth of a few millimetres, ensuring the solvent level remained below the baseline on the TLC plate. The chamber was covered with a watch glass or a Petri dish to prevent solvent loss by evaporation. TLC was performed using silica gel 60 $F_{254}$ aluminium-backed plates (Merck, Germany), cut to a size of 6.5 cm × 5 cm. The aqueous and methanol extracts of *Ricinus communis* L. were diluted to a concentration of 100 mg/mL in the corresponding solvents, and 10 µL of each was manually applied to the TLC plates with a Hamilton 50 µL microsyringe. The application point was maintained at one cm above the basal edge & 1.5cm to the sides, with four replicate spots per plate, each spaced 1.5 cm apart. developed in a pre-saturated TLC chamber containing different mobile phase solvent systems. Distance maintained at 80mm. Further separation of spots was visualized using derivatizing agents such as iodine vapour, which allowed for the identification of various phytoconstituents based on their retention factor (Rf) values and coloration.

## Result

The successful qualitative and quantitative profiling of bioactive phytocompounds from *Ricinus communis* L. was found to be highly dependent on the solvent used for extraction. Various solvent extracts, like ethyl acetate & ethanol extracts, demonstrated the presence of secondary metabolites, including: flavonoid, glycoside, alkaloid, phenol, saponin, amino acid, steroid, tannin, terpenoid, quinone, coumarin, & anthraquinone. The leaves and seeds of *Ricinus communis* L. are shown, particularly those with antioxidant properties. The results indicate that ethanol and ethyl acetate extracts of *Ricinus communis* leaves and seeds contain higher concentrations of bioactive compounds, making them suitable candidates for further pharmacological and phytochemical research.

Presence (+ve) or Absence (–ve) of essential & specialised biomolecules with
Various solvents, as in the Extract of *Ricinus communis* L.

***Table 1: Qualitative analysis of primary and secondary metabolites in Ricinus communis L.***

| Sr. No. | Name of sample | Ethanol | Petroleum Ether | Chloroform |
|---|---|---|---|---|
| 1 | Carbohydrate | +ve | +ve | +ve |
| 2 | Amino acid | –ve | –ve | –ve |
| 3 | Protein | +ve | +ve | –ve |
| 4 | Steroids | –ve | +ve | –ve |
| 5 | Alkaloids | +ve | –ve | +ve |
| 6 | Flavonoids | –ve | +ve | –ve |
| 7 | Glycosides | –ve | –ve | +ve |
| 8 | Cardiac glycosides | – ve | –ve | +ve |
| 9 | Tannins | –ve | –ve | +ve |
| 10 | Phenols | –ve | +ve | –ve |

***Table No. 2: quantitative estimations of major secondary metabolites in leaf & bark of Ricinus communis L.***

| Secondary metabolites | Leaves | Bark |
|---|---|---|
| Phenols | 3.42 ± 0.8 mg/gm FCAE | 15.39 ± 2.32 mg/gm FCAE |
| Alkaloids | 2.50 ± 1.06 mg/gm AE | 3.54 ± 0.67 mg/gm AE |
| Flavonoids | 1.85 ± 0.7 mg/gm QE | 6.8 ± 0.02 mg/gm QE |
| Steroids | 2.34 ± 0.1 mg/gm FDRE | 4.41 ± 2.64 mg/gm FDE |
| Tannins | 2.24 ± 0.95 mg/gm GAE | 8.3 ±0.051 mg/gm GAE |

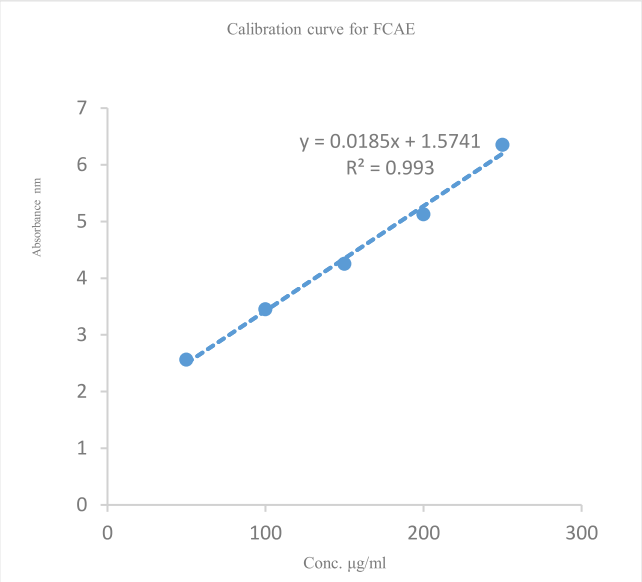


***Figure 2***

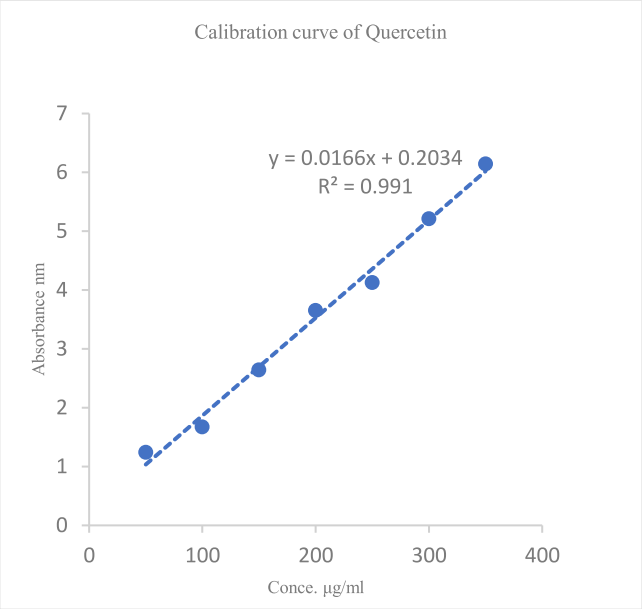


***Figure 3***

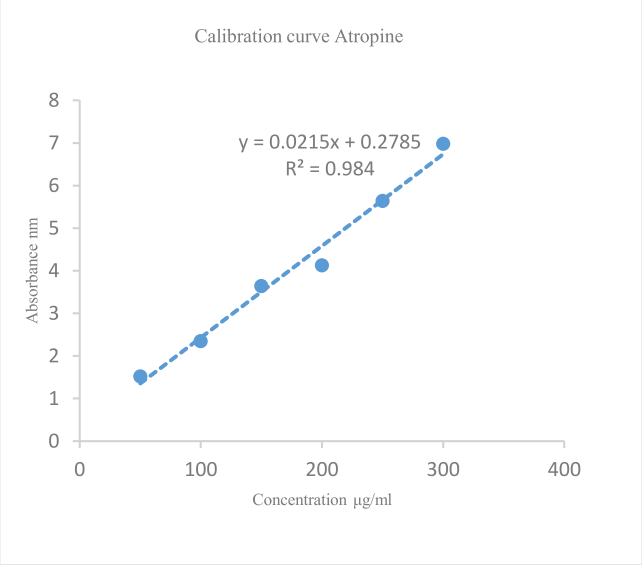


***Figure 4***

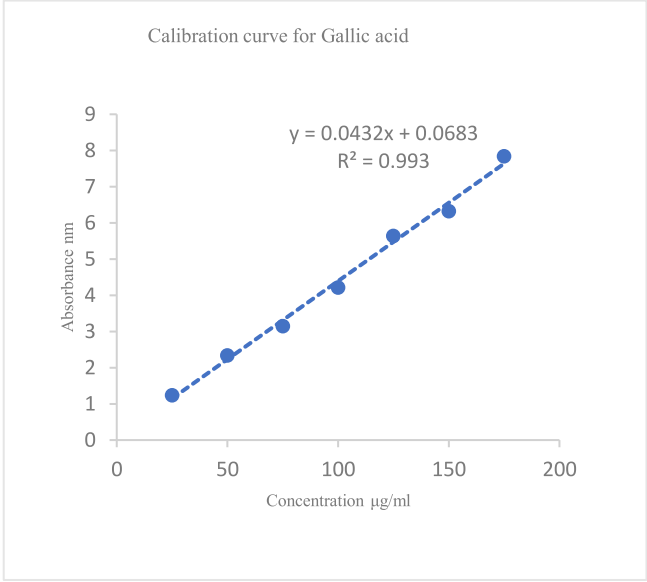


***Figure 5***

***Graphical representation of quantitative estimations of different secondary metabolites, Fig. 1 Calibration curve for phenol, Fig. 2 for flavonoid, Fig. 3 for alkaloid, Fig. 4 for tannin***

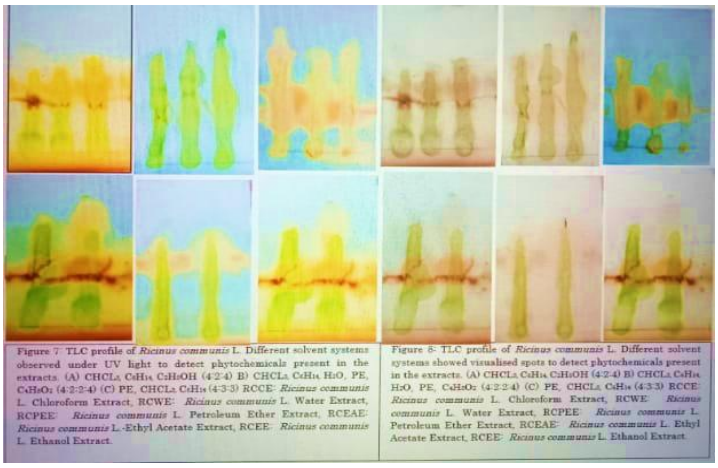

Figure 7: TLC profile of *Ricinus communis* L. Different solvent systems observed under UV light to detect phytochemicals present in the extracts. (A) $CHCL_3$ $C_6H_{14}$ $C_2H_5OH$ (4:2:4) B) $CHCL_3$ $C_6H_{14}$ $H_2O$, PE, $C_4H_8O_2$ (4:2:2:4) (C) PE, $CHCL_3$ $C_6H_{14}$ (4:3:3) RCCE: *Ricinus communis* L. Chloroform Extract, RCWE: *Ricinus communis* L. Water Extract, RCPEE: *Ricinus communis* L. Petroleum Ether Extract, RCEAE: *Ricinus communis* L.-Ethyl Acetate Extract, RCEE: *Ricinus communis* L. Ethanol Extract.

Figure 8: TLC profile of *Ricinus communis* L. Different solvent systems showed visualised spots to detect phytochemicals present in the extracts. (A) $CHCL_3$ $C_6H_{14}$ $C_2H_5OH$ (4:2:4) B) $CHCL_3$ $C_6H_{14}$ $H_2O$, PE, $C_4H_8O_2$ (4:2:2:4) (C) PE, $CHCL_3$ $C_6H_{14}$ (4:3:3) RCCE: *Ricinus communis* L. Chloroform Extract, RCWE: *Ricinus communis* L. Water Extract, RCPEE: *Ricinus communis* L. Petroleum Ether Extract, RCEAE: *Ricinus communis* L. Ethyl Acetate Extract, RCEE: *Ricinus communis* L. Ethanol Extract.

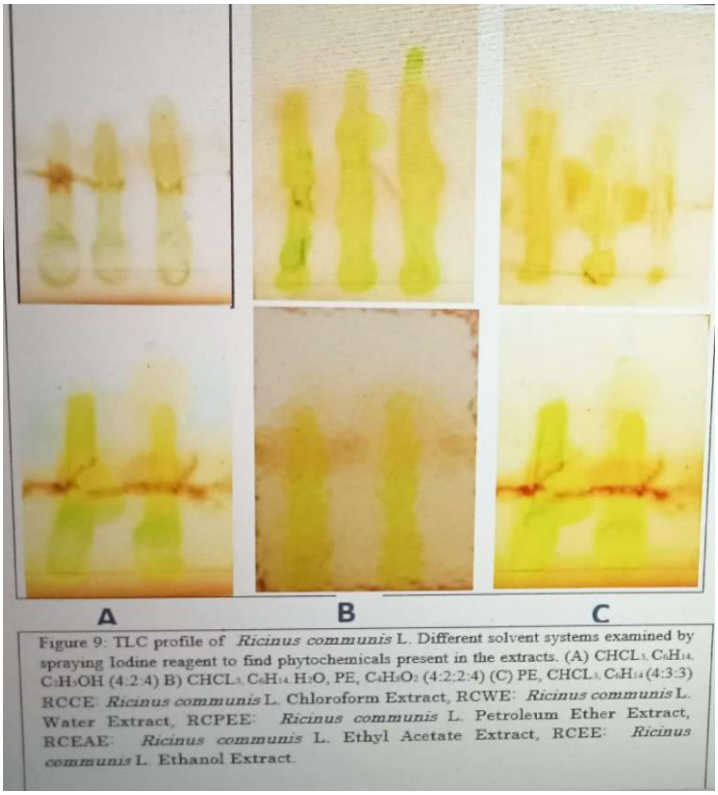


Figure 9: TLC profile of *Ricinus communis* L. Different solvent systems examined by spraying Iodine reagent to find phytochemicals present in the extracts. (A) $CHCL_3$ $C_6H_{14}$ $C_2H_5OH$ (4:2:4) B) $CHCL_3$ $C_6H_{14}$ $H_2O$, PE, $C_4H_8O_2$ (4:2:2:4) (C) PE, $CHCL_3$ $C_6H_{14}$ (4:3:3) RCCE: *Ricinus communis* L. Chloroform Extract, RCWE: *Ricinus communis* L. Water Extract, RCPEE: *Ricinus communis* L. Petroleum Ether Extract, RCEAE: *Ricinus communis* L. Ethyl Acetate Extract, RCEE: *Ricinus communis* L. Ethanol Extract.

**Discussion**

In the current exploration, the therapeutic leaf extract and bark extracts of *Ricinus communis* L. were collected from the Nagpur and Wardha districts (Figure 1). A qualitative phytochemical screening was carried out on these extracts using ethanol, petroleum ether, and chloroform as solvents (Table 1). The screening presence of ten phytocompounds, like flavonoids, cardiac glycosides, phenolics, tannic substances, alkaloidal constituents, proteins, amino acid derivatives, saccharides, steroidal compounds, and glycosidic constituents. Among the three solvents used, petroleum ether extracted eight out of ten tested phytochemicals, including carbohydrates, proteins, phenols, alkaloids, amino acids, steroids, tannins, and flavonoids. This result is consistent with earlier findings reported by [27], which also noted that the petroleum ether and ethanolic extracts indicated the occurrence of phytoconstituents, while the chloroform extract revealed six metabolites, namely sugars, alkaloids, glycosidic compounds, and cardiotonic glycosides. tannins, and phenols. These solvent plays an indispensable role in the extraction efficiency and spectrum of secondary metabolites obtained. Quantitative analysis confirmed that all major secondary metabolites were found in greater amounts in the extracts of *Ricinus communis*. Among them, phenolic content was the highest, followed by alkaloids, tannins, and flavonoids (Table 2). The estimation of total quantification of alkaloids was carried out using bromocresol green (BCG), a highly sensitive and specific spectrophotometric technique. BCG produces a yellow complex with alkaloids, which is completely isolated in chloroform at 4.7 pH. This dye, however, reacts selectively with alkaloids containing nitrogen in a heterocyclic structure, and does not react with amides or amines [28]. Tannin concentration was calculated as mg GAE/gram DW ($y = 0.0432x$, $R^2 = 0.993$). Tannins were found in higher concentrations in the bark than in the leaves, aligning with their known defensive role in plants. Tannins serve as anti-herbivory agents and natural toxins, particularly concentrated in the bark (between the epidermis and cortex) and in the upper epidermis of young leaves [29, 30]. Estimation of total phenolics was carried out using the Folin–Ciocalteu method, and results were expressed as mg Folin–Ciocalteu acid equivalents per gram dry weight (mg FCAE/g dw). The standard curve followed the equation $y = 0.0185x + 1.5741$ ($R^2 = 0.993$). The bark showed maximum phenolic content (15.39 ± 2.32 mg/g FCAE), while the leaves contained comparatively lower levels (3.42 ± 0.8 mg/g FCAE). This is consistent with the chemical structure of phenols, which absorb ultraviolet light due to their aromatic rings, making UV-visible spectrophotometry one of the most reliable techniques for phenolic quantification [31]. The FCR, comprising phosphor-tungstic acid ($H_3PW_{12}O_{40}$) & phosphor-molybdic acid ($H_3Mo_{12}O_{40}$), reacts to phenol hydroxyl groups in plant extracts to yield a blue-colour phosphortungstic–phosphomolybdic complex, which is spectrophotometrically detected at 760 nm. Total flavonoid estimation was carried out by the assay of $AlCl_3$, producing a yellow chromogenic complex measurable at 510 nm. Flavonoid concentration was articulated in mg QE/gram DW, based on the curve equation standard calibration $y = 0.0166x + 0.2034$ ($R^2 = 0.991$). The content of flavonoid was higher in the bark (6.8 ± 0.02 mg/g QE) compared to the leaves (1.85 ± 0.7 mg/g QE). These results support prior research showing that plants growing in tropical or high-altitude regions tend to accumulate more flavonoids than those in temperate zones. This accumulation is believed to be a protective mechanism against ultraviolet radiation, especially in the leaves, which are more exposed to sunlight [32].

**UV- visible spectrophotometry and TLC analysis**

The absorbance of alkaloids was assessed at 470nm using by spectrophotometer. Total alkaloid concentration was articulated as milligrams of atropine equivalents mg AE/g extract, following the procedure outlined by [33, 34]. For tannin estimation, at 725nm, absorbance was recorded using standard solutions, and results were articulated as mg GAE/g of extract [35]. Furthermore, TLC was employed as an analytical technique to separate and discriminate between multiple bioactive compounds across different solvent systems. The solvents tested included hexane, ethyl acetate, ethanol, and acetone. TLC results confirmed that each solvent system extracted distinct classes of phytochemicals, with variation in their Rf values, as detailed in Tables II and III. Ethyl acetate extracts showed higher Rf values for carboxylic acids, alkaloids, gum and mucilage, quinones, anthraquinones, phenols, and polyphenols. In hexane extracts, carbohydrates and starch exhibited higher Rf values. Ethanolic extracts revealed elevated Rf values for resins, gum and mucilage, alkaloids, carboxylic acids, quinones, chalcones, and anthraquinones. Acetone extracts demonstrated higher Rf values for alkaloids, flavonoids, phytosterols, phlobatannins, and xanthoproteins. Across the majority of extracts tested by TLC bioautography, alkaloids, quinones, and anthraquinones were consistently observed in ethyl acetate, acetone, and ethanol extracts, indicating their broad solubility and abundance in *Ricinus communis* L.

**Conclusion**

Phytochemical screening of the *Ricinus* plant demonstrated that petroleum ether and chloroform extracts contained higher concentrations of secondary metabolites compared to the ethanol extracts, based on standard qualitative tests. Further separation through TLC analysis confirmed that different phytochemicals exhibit distinct Rf values in various solvents, indicating solvent-specific affinity and polarity-dependent separation. It showed that solvent polarity strongly influenced the profiles obtained: non-polar solvents (petroleum ether, chloroform) tended to enrich non-polar secondary metabolites (e.g., terpenoids/steroids), whereas polar alcohols (methanol) favoured phenolics and flavonoids; standard qualitative tests consistently detected multiple classes across extracts. Thin-layer chromatography (TLC) further resolved these constituents, with clear, solvent-dependent differences in Rf values that reflect analyte mobile phase affinities and polarity-driven separation. Leaf extracts developed in chloroform: benzene, and ethanol showed flavonoid spots around Rf ≈ 0.46–0.58 (quercetin-like) and phenolic zones Rf ≈ 0.46–0.84 (gallic-acid), confirming the presence of flavonoids and phenolics; similar TLC approaches have identified quercetin & kaempferol derivatives from *Ricinus communis* leaves. These observations align with TLC practice in botanical screening, where distinct Rf signatures across solvent systems enable class and compound-level identification [36, 37]. These Rf values allowed precise identification of phytocompounds such as tannins, flavonoids, glycosides, alkaloids, quinones, & phenols, confirming their presence in the leaf and bark extracts. UV–Visible spectrophotometric analysis provided quantitative estimations, revealing that secondary metabolites are present in varying concentrations depending on the wavelength-

specific absorbance peaks. These variations support the conclusion that *Ricinus communis* L. contains diverse bioactive compounds with potential therapeutic applications [38]. The present study highlights the rich phytochemical profile and therapeutic potential of *Ricinus communis* L. leaf and bark extracts collected from the Nagpur and Wardha districts. Qualitative screening using ethanol, petroleum ether, and chloroform confirmed the presence of ten key bioactive compounds, with petroleum ether showing the highest extraction efficiency. Quantitative analysis revealed a predominance of phenols, followed by alkaloids, tannins, and flavonoids, with the bark generally containing higher concentrations than the leaves. Spectrophotometric assays validated the accuracy of quantification for alkaloids, tannins, phenols, and flavonoids, while Thin Layer Chromatography (TLC) analysis further confirmed the diversity of phytoconstituents extracted using various solvents [39]. Notably, ethyl acetate, acetone, and ethanol demonstrated broad-spectrum solubility for alkaloids, quinones, and anthraquinones, indicating their prevalence in *Ricinus communis* [40, 41]. These findings not only support the traditional medicinal use of the plant but also emphasize the selection of solvent in more yield of phytochemicals. The results suggest that *Ricinus communis* holds significant potential for advancing the development of phytopharmaceutical agents, particularly owing to its richness in phenolic compounds with recognized antioxidant, anti-inflammatory, anti-arthritic, and antimicrobial effects [42].

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