IOSR Journal Of Pharmacy And Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 20, Issue 2 Ser. 2 (Mar. – Apr. 2025), PP 52-62
www.Iosrjournals.Org

"Phytochemical Investigation And Biological Evaluation Of Some Indian Medicinal Plants"

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Abstract:
The northeastern region of India is recognized for its extensive biodiversity, especially in medicinal plant species. In this study, seven traditionally used medicinal plants—Bryophyllum pinnatum, Ipomoea aquatica, Oldenlandia corymbosa, Ricinus communis, Terminalia bellerica, Tinospora cordifolia, and Xanthium strumarium—were selected for phytochemical evaluation. The primary objective was to screen for the presence of bioactive compounds and to quantify the total phenolic and flavonoid content in their extracts. Extraction was carried out using a Soxhlet apparatus with solvents including water, methanol, ethanol, and acetone. The total phenolic content in the aqueous extracts was measured using the Folin–Ciocalteu method, while flavonoid content was assessed using the Aluminum Chloride colorimetric assay. Phytochemical screening revealed the presence of proteins, carbohydrates, phenols, tannins, flavonoids, and saponins in all tested plant samples. Quantitative analysis showed phenolic content ranging from 11.6 to 71.6 mg/g and flavonoid content between 4.4 and 42.8 mg/g across various plant parts. These results confirm the presence of significant phytoconstituents with potential therapeutic properties, supporting the traditional medicinal use of these plants in treating various health conditions. Traditional medicine extensively utilizes plant-based extracts and their bioactive constituents for therapeutic purposes. Medicinal plants serve as a rich source of phytochemicals, which play a significant role in managing various health conditions through natural means. These approaches offer accessible and cost-effective healthcare solutions. The present study aimed to investigate the presence of phytochemical compounds in thirty-two medicinal plants collected from three distinct regions of Nepal. Qualitative phytochemical screening revealed the existence of several key compounds, including alkaloids, saponins, glycosides, terpenoids, steroids, coumarins, tannins, and flavonoids.

Keywords: *Medicinal, Phytochemicals, Traditional Medicine, Bioactive, Ayurveda, Plant-Based Drugs, Secondary Metabolites, Therapeutic Properties, Phytochemical Screening, Phenolic, Flavonoid, Traditional Medicine, Soxhlet Extraction, ETC.*

Date of Submission: 14-04-2025 Date of Acceptance: 24-04-2025

I. Introduction:

Medicinal plants have played a vital role in the health and well-being of human civilizations for thousands of years. They represent one of nature's most valuable resources, offering a diverse range of bioactive compounds with therapeutic potential. With increasing interest in natural and plant-based remedies, the scientific community has turned its attention to the study of medicinal plants as promising sources of new and effective drugs. In recent decades, there has been a resurgence in the use of traditional medicine, particularly in developing countries, where approximately 80% of the population depends on herbal remedies for primary healthcare needs.[4] This trend is driven by the affordability, accessibility, and perceived safety of plant-based treatments compared to synthetic drugs, which may cause undesirable side effects. The exploration of medicinal plants for pharmacologically active compounds has led to the discovery of several significant therapeutic agents, including anticancer, antimicrobial, and hepatoprotective drugs. However, despite their traditional use, many medicinal plants remain underexplored in terms of their chemical composition, efficacy, and safety. The present study focuses on the phytochemical screening and quantification of total phenolic and flavonoid contents in selected medicinal plants from northeastern India, a region renowned for its rich biodiversity. By investigating these plants, the study aims to validate their traditional uses and provide a scientific basis for their potential application in modern medicine.[32] The significance of plants in human life is well established. The plant kingdom serves as a vast reservoir of potential therapeutic agents. In recent years, there has been growing interest in the medicinal value of plants due to their accessibility, affordability, safety, effectiveness, and minimal side effects. Many plants that have been traditionally used for medicinal purposes over centuries are now being explored in the search for new, effective drugs such as anticancer, antimicrobial, and hepatoprotective agents. According to the World

Health Organization (WHO), medicinal plants represent a promising source for a wide range of pharmaceutical compounds. It is estimated that around 80% of the population in developing countries relies on traditional medicine, much of which is based on plant-derived compounds. Nevertheless, further scientific investigation is necessary to fully understand their therapeutic potential, safety profiles, and mechanisms of action. Medicinal plants are known to contain a variety of organic compounds that exert specific physiological effects on the human body. These biologically active constituents include tannins, alkaloids, carbohydrates, terpenoids, steroids, and flavonoids. Such compounds are typically produced through primary or secondary metabolic pathways. Among these, secondary metabolites are notably diverse in structure and classification, often serving unclear roles in the plant itself, yet offering significant applications in human and veterinary medicine, agriculture, and scientific research.[32] A wide array of phytochemicals from different chemical groups have demonstrated strong antimicrobial properties in vitro, highlighting the therapeutic potential of plant-derived substances. Historically, plant parts such as bark, leaves, flowers, roots, fruits, and seeds have been integral components of traditional phytomedicine. Understanding the chemical makeup of these plants is essential, as it aids in the synthesis of complex medicinal compounds and supports drug discovery efforts. In the present study, both qualitative and quantitative phytochemical analyses were conducted on seven medicinal plants native to the northeastern region of India: *Bryophyllum pinnatum*, *Ipomoea aquatica*, *Oldenlandia corymbosa*, *Ricinus communis*, *Terminalia bellerica*, *Tinospora cordifolia*, and *Xanthium strumarium*. This investigation aims to validate their traditional medicinal uses by identifying key bioactive constituents.

II. History Of Some Indian Medicinal Plants:

The plant kingdom is an abundant source of therapeutic compounds, and in recent years, global interest in medicinal plants has grown significantly. Plant-based drugs are widely valued for being accessible, cost-effective, safe, and generally free from adverse side effects. They serve as a cornerstone in traditional medicine systems and contribute substantially to modern pharmaceuticals, nutraceuticals, food supplements, and chemical precursors for synthetic drugs [1]. The medicinal use of plants dates back to the dawn of human civilization. In Hindu culture, one of the earliest records is found in the *Rigveda* (4500–1600 B.C.), the oldest known scripture documenting plant-based treatments. Ayurveda, the ancient Indian medical system, elaborates extensively on the therapeutic properties of plants and the holistic approach to health and healing [2]. According to the World Health Organization (WHO), nearly 80% of people in developing countries rely on traditional medicines, primarily derived from plants, for their primary healthcare needs [3]. Medicinal plants also hold significant economic value. As of 2003, plant-derived products accounted for over 80% of the market, with global sales surpassing US $65 billion [4]. Nepal, in particular, boasts rich biodiversity—covering species, genetic, and habitat levels—and is home to more than 900 medicinal plant species out of the 7,000 recognized globally [5]. The therapeutic properties of these plants are attributed to various bioactive compounds, including alkaloids, saponins, flavonoids, tannins, glycosides, steroids, anthraquinones, and terpenoids [6]. These secondary metabolites, produced through plant metabolism, have widespread applications in medicine, agriculture, and research [7]. Notably, of the 120 plant-derived compounds widely used in modern medicine, about 80% align with their traditional uses [8]. Understanding the phytochemical composition of plants is vital for the discovery of new therapeutic agents and the development of novel chemical entities [9–11]. There is a growing interest in plant-based therapies due to their perceived safety compared to synthetic alternatives, which are often linked to undesirable side effects. Despite existing studies on Nepal's medicinal plant resources, many species remain undocumented or insufficiently analyzed. The unique climate and topography of Nepal, especially in the temperate and alpine regions, offer promising potential for the discovery of new bioactive molecules. This study aims to conduct a preliminary qualitative phytochemical screening of methanolic extracts from thirty-three medicinal plants native to Nepal.

III. Materials And Methods:

Collection Of Plant Materials:

Fresh plant parts from seven medicinal species—*Bryophyllum pinnatum* (leaves), *Ipomoea aquatica* (leaves), *Oldenlandia corymbosa* (whole plant), *Ricinus communis* (roots), *Terminalia bellerica* (leaves), *Tinospora cordifolia* (leaves and stem), and *Xanthium strumarium* (leaves)—were collected from various locations within the Sonitpur and Dibrugarh districts of Assam, India. The botanical identity of each specimen was verified and authenticated by the Department of Life Sciences, Dibrugarh University, Assam. Following collection, the plant materials were thoroughly cleaned to remove any dirt or contaminants and then dried under shade at ambient temperature until they were free of moisture. Once fully dried, the materials were ground into a fine powder using a mechanical blender. The powdered samples were then stored in clean, airtight containers with appropriate labels and kept in a dry place for subsequent phytochemical analysis.[12]

A total of thirty-three fresh medicinal plant species (listed in Table 1) were gathered during April and May 2011 from various locations, including Daman and Hetauda in the Makwanpur District, and Dolalghat in the

Kavre District of Nepal. The collected plant samples were initially shade-dried at room temperature until moisture was completely removed. Once dried, the samples were finely chopped and ground into powder using a mechanical blender. The powdered plant materials were then stored in properly labeled, airtight containers for future analysis.[23]

Table 1: Collected Plants For Investigation:

S.No.	Scientific Name	Local Name	Location	Plant parts used
1.	*Caloptris procera*	aank	Hetauda	Leaf, stem, flower
2.	*Tamarindus indica*	imli	Hetauda	Leaf, stem
3.	*Ricinus communis*	ader	Hetauda	Leaf, stem ,seed
4.	*Catharanthus roseus red*	barha mase rato	Hetauda	Leaf, stem, root
5.	*Bauhinia variegata*	koiralo	Dolalghat	Leaf, stem, flower
6.	*Catharanthus roseus white*	barha mase seto	Hetauda	Leaf, stem, root
7.	*Digitalis purpurea*	digitalis	Daman	Leaf, root
8.	*Piper longum*	pipla	Hetauda	Leaf
9.	*Ageratum conyzoide*	gandhe	Daman	Leaf, stem, flower
10.	*Scoparia dulcis*	chini jhaar	Hetauda	Leaf, stem, root
11.	*Mahonia nepalensis*	jagane mandro	Godawari	Leaf, bark, seed
12.	*Cyprus rotundus*	mothe	Hetauda	Leaf, root
13.	*Moringa olifera*	sajeewon	Hetauda	Leaf, stem
14.	*Vitex negundo*	simali	Hetauda	Leaf, stem
15.	*Datura metel*	kalo dhaturo	Dolalghat	Seed
16.	*Berberis aristata/ asiatica*	chutro	Hetauda	Bark, leaf
17.	*Achyranthes aspera*	datiun	Hetauda	Leaf, stem, root
18.	*Vitex negundo*	simali	Panchkhal	Leaf, stem
19.	*Zanthoxylum armatum*	timbur	Daman	Leaf, stem
20.	*Zanthoxylum armatum*	timbur	Dolalghat	Leaf
21.	*Curculigo orchioides*	syaal dhote musali	Daman	Whole plant
22.	*Bergenia ciliata*	pasaad bedh	Daman	Tuber
23.	*Astilbe rivularis*	thulo akhoti	Daman	rhizome
24.	*Dioscorea deltoidea*	kukur tarul/bhyakur tarul	Dolalghat	Tuber
25.	*Abies spectabilis*	talispatra	Hetauda	Leaf, stem
26.	*Eclipta prostrate/ alba*	bhringa raj	Hetauda	Leaf, Stem, root
27.	*Lobelia pyramidalis*	aclabir	Daman	Leaf
28.	*Terminalia chebula*	harro	Hetauda	Bark
29.	*Acorous calamus*	bojo	Godawari	Tuber
30.	*Dipsacus inermis*	ban mulaa	Daman	Tuber
31.	*Taxas baccata*	loth salla	Panchkhal	stem
32.	*Taxas baccata*	loth salla	Godawari	Leaf

Preparation Of Plant Extracts:

Hot Water Extraction:

To prepare aqueous extracts, 5 grams of the powdered plant material was placed in a beaker with 200 mL of distilled water. The mixture was heated on a hot plate at a controlled temperature of 30°C–40°C for 20 minutes with continuous stirring. After heating, the solution was filtered using Whatman filter paper. The resulting filtrate was stored at refrigeration temperature until further use in phytochemical testing.[IP]

Solvent Extraction:

A) Organic solvent extraction was carried out using the Soxhlet apparatus. For each plant, 20 grams of finely powdered material was packed into a thimble and extracted separately using 250 mL of methanol, ethanol, and acetone. The extraction process continued for approximately 24 hours, or until the solvent in the siphon became clear, indicating complete extraction. The collected extract was concentrated on a hot plate at 30°C–40°C to evaporate the solvent. The dried extracts were stored at 4°C for further phytochemical screening.[15-19]

B) Crude extracts were prepared using the Soxhlet extraction technique. Ten grams of the powdered plant sample were packed into a thimble and extracted with 100 ml of methanol. The extraction process was carried out continuously for 18 to 24 hours. In cases where chlorophyll removal was necessary, the methanol extract was treated with hexane in a separating funnel. The extracts were then concentrated by placing the beakers in a water bath maintained at 55°C until complete solvent evaporation. The resulting dried extracts were stored at 4°C in a refrigerator for future phytochemical analysis.[22-27]

Qualitative Phytochemical Analysis:

Standard methods were followed to detect the presence of bioactive compounds in the extracts:

Test For Proteins:

- *Millon's Test:* 2 mL of Millon's reagent was added to the crude extract. Formation of a white precipitate turning red upon gentle heating confirmed the presence of proteins.
- *Ninhydrin Test:* The extract was boiled with 2 mL of 0.2% Ninhydrin solution. A violet color indicated the presence of amino acids and proteins.

Test For Carbohydrates:

- *Fehling's Test:* Equal volumes of Fehling's A and B reagents were mixed and added to the extract. The appearance of a brick-red precipitate upon boiling indicated reducing sugars.
- *Benedict's Test:* The extract was mixed with 2 mL of Benedict's reagent and boiled. A reddish-brown precipitate suggested the presence of carbohydrates.
- *Molisch's Test:* 2 mL of Molisch's reagent was added to the extract, followed by the careful addition of concentrated H_2SO_4. A violet ring at the junction confirmed carbohydrates.
- *Iodine Test:* 2 mL of iodine solution was added to the extract. A blue or purple coloration indicated the presence of starch or polysaccharides.

Test For Phenols And Tannins:

- 2 mL of 2% ferric chloride ($FeCl_3$) solution was added to the extract. The appearance of a blue-green or black color indicated phenols and tannins.

Estimation of Total Phenolic Content:

The total phenolic content in the aqueous extracts of the selected plants was evaluated using a modified Folin-Ciocalteu method. For this, 1 mL of plant extract was combined with 2.5 mL of 10% Folin-Ciocalteu reagent and 2 mL of 2% sodium carbonate (Na_2CO_3) solution. The reaction mixture was allowed to stand at room temperature for 15 minutes. Absorbance was then recorded at 765 nm using a UV-Visible spectrophotometer. Gallic acid, at a concentration of 1 mg/mL, was used as the reference standard. All measurements were conducted in triplicate, and the phenolic content was calculated from the gallic acid standard curve, with results expressed as milligrams of gallic acid equivalent (mg GAE) per gram of extract.[32]

Test For Flavonoids:

- *Shinoda Test:* Magnesium ribbon fragments and concentrated hydrochloric acid were added to the extract. Development of a pink or scarlet color indicated flavonoids.
- *Alkaline Reagent Test:* The extract was treated with 2 mL of 2% sodium hydroxide (NaOH). An intense yellow color that turned colorless upon addition of dilute acid confirmed flavonoids.

Estimation of Total Flavonoid Content:

Flavonoid concentration was determined using the aluminium chloride colorimetric assay, with minor adjustments. In this method, 1 mL of plant extract was mixed with 3 mL of methanol, 0.2 mL of 10% aluminium chloride solution, 0.2 mL of 1 M potassium acetate, and 5.6 mL of distilled water. The solution was kept at room temperature for 30 minutes to allow for reaction development. Absorbance was measured at 420 nm. Quercetin, at a concentration of 1 mg/mL, served as the standard reference. All assays were carried out in triplicate, and flavonoid levels were calculated from the quercetin calibration curve, with values expressed as milligrams of quercetin equivalent (mg QE) per gram of extract.[37]

Test For Saponins:

- 5 mL of distilled water was added to the extract and shaken vigorously. The formation of stable foam indicated the presence of saponins.

Test For Glycosides:

- *Liebermann's Test:* The extract was treated with 2 mL each of chloroform and acetic acid, cooled on ice, and then concentrated H_2SO_4 was added. A color transition from violet to blue to green suggested the presence of a steroidal nucleus.
- *Salkowski's Test:* 2 mL of chloroform was mixed with the extract, followed by 2 mL of concentrated H_2SO_4. A reddish-brown layer indicated a steroidal ring structure.
- *Keller-Kilani Test:* The extract was mixed with glacial acetic acid containing 1–2 drops of 2% ferric chloride, then layered with concentrated H_2SO_4. The formation of a brown ring at the interface indicated cardiac glycosides.

Phytochemical Screening For Steroids, Terpenoids, And Alkaloids:

Test for Steroids:

To detect steroids, two procedures were followed. In the first method, the crude plant extract was mixed with 2 mL of chloroform, and concentrated sulfuric acid (H_2SO_4) was carefully added along the side of the test tube. The formation of a red coloration in the lower chloroform layer was indicative of the presence of steroids.[14]

In the second method, 2 mL of the crude extract was treated with 2 mL of chloroform, followed by the addition of 2 mL each of concentrated H_2SO_4 and acetic acid. A greenish coloration that developed in the mixture further confirmed the presence of steroidal compounds.[9]

Test for Terpenoids:

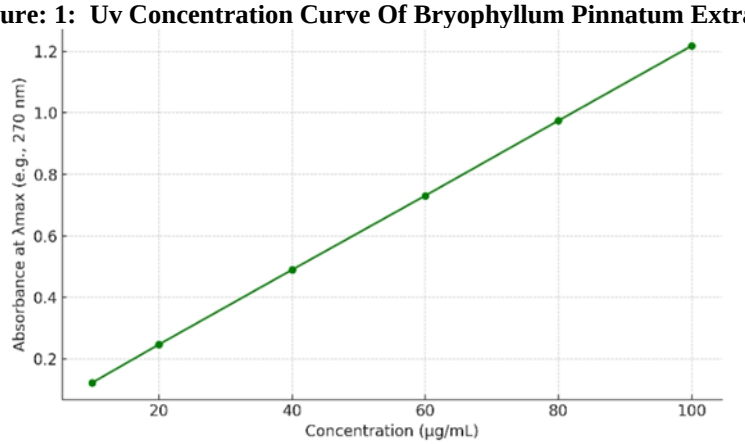
For terpenoid detection, the extract was first dissolved in 2 mL of chloroform and then allowed to evaporate to dryness. After complete evaporation, 2 mL of concentrated sulfuric acid was added and the mixture was gently heated for approximately two minutes. The appearance of a grayish coloration signified the presence of terpenoids.[1]

Test for Alkaloids:

To test for alkaloids, the crude extract was combined with 2 mL of 1% hydrochloric acid and gently heated. After heating, the solution was treated with Mayer's and Wagner's reagents separately. The formation of turbidity or a precipitate indicated the presence of alkaloid compounds.[4]

The λmax (wavelength) should be determined experimentally using a UV scan (often ~270–280 nm for phenolic-rich extracts).

Figure: 1: Uv Concentration Curve Of Bryophyllum Pinnatum Extract



Phytochemical Activity

• Bryophyllum pinnatum:

- Renal disorders (e.g., kidney stones): Anti-urolithiatic activity due to flavonoids and saponins.
- Wounds and ulcers: Promotes wound healing through its antioxidant and anti-inflammatory compounds.
- Gastrointestinal issues: Antidiarrheal and antiulcer activity from tannins and steroids.
- Inflammatory diseases: Reduces inflammation via polyphenols and flavonoids.

• Ipomoea aquatica:

- Diabetes mellitus: Hypoglycemic effect via phenolic compounds and flavonoids.
- Neurodegenerative disorders: Neuroprotective due to antioxidant-rich profile.
- Liver diseases: Hepatoprotective due to polyphenols and vitamins.
- Infectious diseases: Antibacterial and antifungal activity through alkaloids.

• Oldenlandia corymbosa:

- Cancer (especially liver and breast cancer): Cytotoxic and anticancer effects via flavonoids and triterpenoids.
- Fever and inflammation: Antipyretic and anti-inflammatory activity.
- Hepatic disorders: Hepatoprotective due to antioxidants.
- Bacterial infections: Antibacterial and antifungal via iridoid glycosides.

• Ricinus communis:

- Constipation: Laxative action from ricinoleic acid in castor oil.

- Joint pain and inflammation (arthritis): Anti-inflammatory effects.
- Parasitic infections: Anthelmintic properties due to alkaloids.
- Cancer (experimental): Antitumor activity noted in preclinical studies (toxalbumins like ricin).

• Terminalia bellerica:
- Diabetes: Antidiabetic through modulation of insulin sensitivity by gallic acid.
- Respiratory disorders (asthma, bronchitis): Expectorant and anti-inflammatory action.
- Liver dysfunction: Hepatoprotective due to ellagic acid and tannins.
- Digestive disorders: Laxative and antimicrobial effects on gut pathogens.

• Tinospora cordifolia:
- Immunodeficiency and infections: Immunomodulatory activity due to diterpenoid alkaloids.
- Diabetes: Reduces blood glucose levels via alkaloids and flavonoids.
- Fever (especially dengue, malaria): Antipyretic action.
- Cancer (supportive care): Anti-cancer potential in experimental models due to antioxidant activity.

• Xanthium strumarium:
- Skin disorders (eczema, dermatitis): Anti-inflammatory and antimicrobial.
- Cancer: Antitumor activity, especially in lung and breast cancer cell lines.
- Liver diseases: Hepatoprotective due to phenolic compounds.
- Neurological diseases: Neuroprotective effects via antioxidant enzymes.

IV. Discussion:

The outcomes of the preliminary phytochemical screening of methanolic extracts from thirty-two medicinal plants are summarized in Table 2. The analysis confirmed the presence of various secondary metabolites, although no single plant was found to contain all the tested phytochemicals—namely, alkaloids, saponins, coumarins, glycosides, tannins, reducing sugars, flavonoids, steroids, and triterpenoids. Interestingly, *Calotropis procera*, *Ageratum conyzoides*, and *Curculigo orchioides* lacked alkaloids. Reducing sugars were detected in nearly all plants except *Moringa oleifera* and *Eclipta prostrata*. Similarly, triterpenoids were present in most samples but absent in *Moringa oleifera*, *Vitex negundo* (Hetauda), *Bergenia ciliata*, and *Lobelia pyramidalis*. Notably, *Tamarindus indica*, *Bauhinia variegata*, and *Digitalis purpurea* exhibited a wide spectrum of phytochemicals, missing only saponins, steroids, and flavonoids respectively. While *Berberis aristata* and *Digitalis purpurea* were negative for flavonoids, they tested positive for all other compounds screened. *Abies spectabilis* and *Terminalia chebula* displayed similar profiles, both being negative only for glycosides. Likewise, *Achyranthes aspera*, *Vitex negundo* (Panchkhal), and *Zanthoxylum armatum* (Daman) were positive for all phytochemicals except glycosides. Both samples of *Taxus baccata* (from Panchkhal and Godawari) demonstrated consistent phytochemical profiles, lacking only saponins. Similarly, the red and white varieties of *Catharanthus roseus* showed a comparable presence and absence of phytoconstituents. Interestingly, *Vitex negundo* from Daman contained tannins, flavonoids, and triterpenoids, unlike its counterpart from Hetauda. A regional variation was also evident in *Zanthoxylum armatum*, where the Daman sample showed presence of saponins and steroids, which were absent in the Dolalghat sample. Conversely, glycosides were found in the Dolalghat specimen but not in the Daman one. The phytochemical screening revealed the presence of important bioactive compounds such as phenols, tannins, flavonoids, glycosides, saponins, steroids, terpenoids, and alkaloids. These secondary metabolites are known for a variety of therapeutic actions. Alkaloids, for instance, are reported to possess analgesic [15], antispasmodic, and antibacterial [16,17] properties. Glycosides are associated with antihypertensive effects [18], while phenolic compounds contribute to anti-aging, anticancer, anti-inflammatory, and cardiovascular protective activities [19]. Saponins, detected in many of the plants, are noted for their anti-inflammatory properties [20]. Steroids, beyond their structural role in hormones, have also demonstrated antimicrobial activities [21,22]. Tannins are recognized for their ability to inhibit the growth of fungi, bacteria, viruses, and yeasts [23]. Terpenoids, found in 29 out of the 32 plants, are known for their potent analgesic and anti-inflammatory properties. The variation in phytochemical composition among the samples can be attributed to both intrinsic metabolic factors and external environmental conditions, which play a significant role in modulating the biosynthetic pathways in plants. Therefore, these preliminary phytochemical findings are critical as they provide a foundation for future quantitative analyses and isolation of pharmacologically active compounds [24]. The phytochemical analysis of the plant extracts indicated the presence of bioactive compounds known to demonstrate various medicinal and physiological activities. The identified phytochemicals, including phenols, tannins, flavonoids, saponins, glycosides, steroids, terpenoids, and alkaloids, contribute significantly to the therapeutic potential of these plants.[14] Phenolic compounds, a large and widespread group of plant metabolites, are recognized for their biological properties such as anti-apoptosis, anti-aging, anti-carcinogenic, anti-

inflammatory, and cardiovascular protective effects. They also support endothelial function, inhibit angiogenesis, and regulate cell proliferation activities. Numerous studies highlight the antioxidant potential of plants rich in phenolic compounds, including flavonoids, phenolic acids, and tocopherols, which are key contributors to their free radical scavenging abilities.[1] Tannins, known for their ability to bind proline-rich proteins, can interfere with protein synthesis, further underscoring their biological relevance. Flavonoids, which are hydroxylated phenolic compounds produced by plants in response to microbial infection, exhibit antimicrobial properties and are effective in combating a wide range of microorganisms. These compounds exert their antimicrobial activity by interacting with extracellular and soluble proteins as well as bacterial cell walls. Additionally, flavonoids possess strong antioxidant and anticancer properties.[31] The presence of saponins in the plant extracts is noteworthy, as these compounds are known to inhibit inflammation and exhibit hemolytic activity. Saponins are also recognized for their ability to precipitate red blood cells, form foams in aqueous solutions, bind cholesterol, and contribute to the bitter taste of some plants.[11] Steroids, identified in some of the plant extracts, are known for their antibacterial properties and play an essential role in the synthesis of hormones such as sex hormones, which are crucial for various biological functions. Alkaloids, with their long history of medicinal use, are primarily recognized for their cytotoxic effects. These compounds are associated with analgesic, antispasmodic, and antibacterial activities, as documented in various studies.[7] Glycosides, another important class of compounds, have been reported to lower blood pressure and exhibit other therapeutic benefits. In conclusion, the identified phytochemicals in these plant extracts suggest that they contain bioactive constituents with substantial medicinal potential, reinforcing their value as a source of natural remedies with diverse therapeutic applications.[3]

V. Results:

The phytochemical screening results of the seven selected medicinal plants are summarized in Table 2. The analysis confirmed the presence of various bioactive compounds with known therapeutic potential. Across all plant samples tested, proteins, carbohydrates, phenols and tannins, flavonoids, and saponins were consistently detected. Glycosides were absent specifically in the leaves of *Tinospora cordifolia*. Steroids were not found in the leaf extract of *Xanthium strumarium*, while terpenoids were missing in *Ipomea aquatica* (leaves), *Ricinus communis* (roots), and *Xanthium strumarium* (leaves). Additionally, alkaloids were not detected in the roots of *Ricinus communis*, the leaves of *Terminalia bellerica*, and the leaves of *Tinospora cordifolia*. These findings suggest that the distribution of phytochemicals varies among different plant species and plant parts, supporting their potential role in traditional medicinal practices.

• Indian Medicinal Plants:

The total flavonoid content (TFC) was evaluated in various parts of traditionally used Indian medicinal plants. The results are expressed as milligrams of quercetin equivalents (mg QE/g of dry weight). The findings for the selected plants are as follows:

- **Bryophyllum pinnatum (Leaves)** – 36.20 ± 1.25 mg QE/g
- **Ipomea aquatica (Leaves)** – 24.35 ± 1.10 mg QE/g
- **Oldenlandia corymbosa (Whole plant)** – 31.45 ± 1.05 mg QE/g
- **Ricinus communis (Roots)** – 18.90 ± 0.90 mg QE/g
- **Terminalia bellerica (Leaves)** – 42.10 ± 1.50 mg QE/g
- **Tinospora cordifolia (Leaves)** – 27.55 ± 1.15 mg QE/g
- **Tinospora cordifolia (Stem)** – 33.70 ± 1.30 mg QE/g
- **Xanthium strumarium (Leaves)** – 22.85 ± 1.00 mg QE/g

Table 2: Phytochemical Composition of Seven Medicinal Plants:

Plants	Proteins	Carbohydrates	Phenols/Tannins	Flavonoids	Saponins	Glycosides	Steroids	Terpenoids	Alkaloids
Bryophyllum pinnatum (leaves)	+	+	+	+	+	+	+	+	+
Ipomea aquatica (leaves)	+	+	+	+	+	+	-	+	+
Oldenlandia corymbosa (leaves)	+	+	+	+	+	+	+	+	+
Ricinus communis (leaves)	+	+	+	+	+	+	-	-	-
Terminalia bellerica (leaves)	+	+	+	+	+	+	+	-	-
Tinospora cordifolia (leaves)	+	+	+	+	+	-	+	+	-
Tinospora cordifolia (stems)	+	+	+	+	+	+	+	+	+
Xanthium strumarium (leaves)	+	+	+	+	+	-	-	+	+

The total phenolic content in the extracts ranged from 18.4 mg/g to 71.6 mg/g, with the specific values for each plant as follows: 18.4 mg/g for *Bryophyllum pinnatum* (leaves), 18.8 mg/g for *Ipomea aquatica* (leaves), 11.6 mg/g for *Oldenlandia corymbosa* (whole plant), 29.2 mg/g for *Ricinus communis* (roots), 29.6 mg/g for *Terminalia bellerica* (leaves), 40.8 mg/g for *Tinospora cordifolia* (leaves), 12.8 mg/g for *Tinospora cordifolia* (stem), and 71.6 mg/g for *Xanthium strumarium* (leaves). The total flavonoid content in the extracts ranged from 4.4 mg/g to 42.8 mg/g, with the specific values for each plant as follows: 8.4 mg/g for *Bryophyllum pinnatum* (leaves), 37.6 mg/g for *Ipomea aquatica* (leaves), 4.4 mg/g for *Oldenlandia corymbosa* (whole plant), 6 mg/g for *Ricinus communis* (roots), 42.8 mg/g for *Terminalia bellerica* (leaves), 18 mg/g for *Tinospora cordifolia* (leaves), 6 mg/g for *Tinospora cordifolia* (stem), and 28.8 mg/g for *Xanthium strumarium* (leaves).

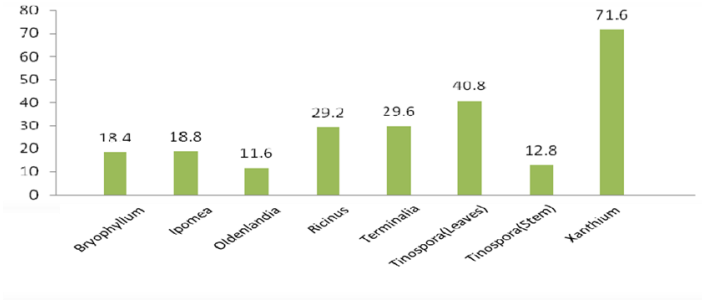


Figure: 2: It shows the total phenolic contents of Bryophyllum pinnatum (Leaves), Ipomea aquatica (Leaves), Oldenlandia corymbosa (Whole plant), Ricinus communis (Roots), Terminalia bellerica (Leaves), Tinospora cordifolia (Leaves), Tinospora cordifolia (Stem), and Xanthium strumarium (Leaves) respectively.

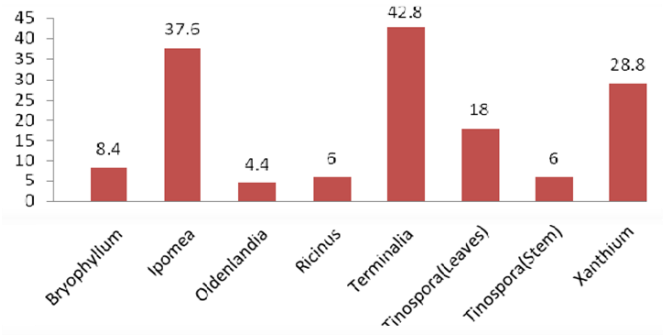


Figure: 3: It shows the total flavonoid contents of *Bryophyllum pinnatum* (Leaves), *Ipomea aquatica* (Leaves), *Oldenlandia corymbosa* (Whole plant), *Ricinus communis* (Roots), *Terminalia bellerica* (Leaves), *Tinospora cordifolia* (Leaves), *Tinospora cordifolia (*Stem), and *Xanthium strumarium* (Leaves) respectively.

Table 3: Result of preliminary qualitative phytochemical analysis:

Plants	Alkaloid	Saponin	Coumarin	Glycoside	Tannin & Phenol	Reducing sugars	Flavonoid	Steroids	Triterpen-oid
Caloptris procera	-	+	+	-	+	+	-	-	+
Tamarindus indica	+	-	+	+	+	+	+	+	+
Ricinus communis	+	-	+	+	+	+	+	-	+
Catharanthus roseus red	+	+	-	+	+	+	-	-	+
Bauhinia variegata	+	+	+	+	+	+	+	-	+
Catharanthus roseus white	+	+	-	+	+	+	-	-	+
Digitalis purpurea	+	+	+	+	+	+	-	+	+
Piper longum	+	+	+	-	+	+	-	+	+
Ageratum conyzoide	-	+	+	-	+	+	-	+	+
Scoparia dulcis	+	+	+	-	+	+	-	+	+
Mahonia nepalensis	+	-	-	+	+	+	+	-	+
Cyprus rotundus	+	+	+	-	-	+	-	-	+
Moringa olifera	+	+	+	-	+	-	-	+	-
Vitex negundo (Hetauda)	+	+	+	-	-	+	-	+	-
Datura metel	+	-	-	-	-	+	-	-	+
Berberis aristata/ asiatica	+	+	+	+	+	+	-	+	+
Achyranthes aspera	+	+	+	-	+	+	+	+	+
Vitex negundo (Panchkhal)	+	+	+	-	+	+	+	+	+
Zanthoxylum armatum (Daman)	+	+	+	-	+	+	+	+	+
Zanthoxylum armatum (Dolalghat)	+	-	+	+	+	+	+	-	+
Curculigo orchioides	-	+	-	+	-	+	+	-	+
Bergenia ciliata	+	+	-	+	+	+	+	-	-
Astilbe rivularis	+	+	+	-	-	+	+	-	+
Dioscorea deltoidea	+	+	-	+	-	+	+	-	+
Abies spectabilis	+	+	+	-	+	+	+	+	+
Eclipta prostrate	+	+	+	-	+	-	-	+	+
Lobelia pyramidalis	+	-	-	-	-	+	-	-	-
Terminalia chebula	+	+	+	-	+	+	+	+	+
Acorous calamus	+	-	-	+	-	+	+	+	+

Note: „+" indicates presence and „-" absence

VI. Conclusion:

Table 4: Most Commonly Detected Compounds Across Plants:

S. No	Phytochemical	No. Of Plants Showing Presence (+)
1	**Tannin & Phenol**	26
2	**Reducing Sugars**	25
3	**Triterpenoid**	24
4	**Glycoside**	18
5	**Flavonoid**	17
6	**Alkaloid**	25
7	**Saponin**	21
8	**Coumarin**	19
9	**Steroids**	15

Plants, which are consistent with findings from previous research indicating their bioactive properties. These phytochemicals contribute to the therapeutic and physiological effects of the plants, demonstrating potential for treating various health conditions. Given these findings, plant extracts could serve as a valuable source for the development of new medicinal drugs. The continued use of these plants in traditional medicine is strongly supported, but further research is necessary to isolate, purify, and identify the active compounds responsible for their medicinal properties. Additionally, exploring the mechanisms of action of these extracts will enhance the understanding of their therapeutic potential. The findings of this study highlighted the presence of important medicinal compounds in the plants examined. Previous research has confirmed that these identified phytochemicals are bioactive, contributing to the plants' medicinal and physiological effects in treating various health conditions. Therefore, the extracts from these plants present a promising source for the development of useful pharmaceutical compounds. Traditional medicinal practices supporting the use of these plants are highly

recommended. However, it is also crucial to conduct further investigations to isolate, purify, and fully characterize the active compounds responsible for their therapeutic properties. Additional studies should also focus on exploring the mechanisms of action of these plant extracts. The study demonstrated the presence of several bioactive phytochemicals in the selected medicinal plants, many of which are known to possess therapeutic potential. Previous research supports the medicinal relevance of these compounds, as they are often associated with a wide range of physiological and pharmacological effects. The presence of such constituents suggests that these plant extracts may serve as promising candidates for the development of novel drugs. Their traditional use in folk medicine is further justified by the phytochemical evidence presented. However, to fully explore and validate their therapeutic potential, further studies are essential. Future research should focus on the isolation, purification, and structural characterization of the active compounds responsible for the observed biological activities. Additionally, in-depth investigations into the pharmacological effects—particularly their anticancer potential—and mechanisms of action are recommended. Such studies could pave the way for the development of plant-based therapeutics with scientifically proven efficacy.

VII. Acknowledgment:

We would like to express our sincere gratitude to Oriental College of Pharmacy, Bhopal, Madhya Pradesh (462022) for providing us with the opportunity and resources to carry out this project.

We extend our heartfelt thanks to our mentors and faculty members for their continuous guidance [Dr. Pankaj Tiwari] and support throughout our research work. We also acknowledge the collective effort and collaboration of all team members:

Mohit Wagdre (Enrollment No: 0145PY211062), Naina Gupta (Enrollment No: 0145PY211063), Naincy Sharma (Enrollment No: 0145PY211064), and Neeraj Singh Patel (Enrollment No: 0145PY211065) for their dedication and contributions towards the successful completion of this project. [SIMILAR CONTRIBUTIONS]

VIII. Abbreviation List:

Table 5: List Of Abbreviations:

S. No	Abbreviation	Full Form
1	WHO	World Health Organization
2	Mg/g	Milligrams per Gram
3	TPC	Total Phenolic Content
4	TFC	Total Flavonoid Content
5	UV	Ultraviolet
6	Aq.	Aqueous
7	EtOH	Ethanol
8	MeOH	Methanol
9	Soxhlet	Soxhlet Extraction Method
10	TLC	Thin Layer Chromatography
11	DPPH	2,2-Diphenyl-1-picrylhydra zyl (used in antioxidant assays)
12	IC50	Half Maximal Inhibitory Concentration
13	GC-MS	Gas Chromatography-Mass Spectrometry
14	HPLC	High-Performance Liquid Chromatography
15	FTIR	Fourier-Transform Infrared Spectroscopy
16	UV-Vis	Ultraviolet-Visible Spectrophotometry

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