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PHYTOCHEMICAL AND PHARMACOLOGICAL EVALUATION OF RICINUS COMMUNIS LEAVES GEL FOR HAIR GROWTH ACTIVITY

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Abstract:

Hair loss, medically known as alopecia, is a prevalent condition that affects individuals of various ages and genders, causing psychological distress and diminished self-esteem. The search for effective and safe remedies for hair loss has led researchers to explore natural sources, including plant-derived compounds. Ricinus communis, commonly known as the castor oil plant, has been historically used for its medicinal properties, and its leaves are known to contain a diverse range of bioactive compounds.

This abstract presents an overview of the research conducted to investigate the potential of Ricinus communis leaves as a natural remedy for hair loss. The study aimed to explore the phytochemical composition of the leaves, focusing on compounds that could promote hair growth, inhibit hair follicle regression, and provide overall hair health. Extracts from Ricinus communis leaves were obtained using various solvents, and their phytochemical profiles were analyzed using techniques such as gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC).

Furthermore, the research involved in vitro and in vivo experiments to assess the effects of Ricinus communis leaf extracts on hair follicle cells and animal models, respectively. The in vitro experiments included evaluating cell viability, proliferation, and expression of hair growth-related genes upon treatment with different concentrations of leaf extracts. In vivo experiments were conducted on animal models to observe changes in hair regrowth and overall hair health following topical application of formulated leaf extracts.

The findings of the study indicated that Ricinus communis leaf extracts contain a variety of compounds, including fatty acids, flavonoids, and phenolic compounds, which have been reported to possess potential hair growth-promoting properties. The in vitro experiments demonstrated enhanced cell viability, proliferation, and upregulation of key hair growth-related genes, suggesting a positive influence on hair follicle cells. The in vivo experiments revealed promising results, with observed improvements in hair regrowth and follicle health in the animal models treated with the formulated extracts.

In conclusion, the study suggests that Ricinus communis leaves hold promise as a natural source of bioactive compounds that could contribute to the development of hair loss treatments. However, further research is warranted to elucidate the mechanisms of action of specific compounds and to assess the safety and efficacy of formulations for human use. The exploration of plant-derived remedies, such as those derived from Ricinus communis leaves, opens new avenues for the development of innovative and sustainable solutions to address the global challenge of hair loss or alopecia.

Keywords: *Ricinus communis leaves, Castor leaves, Hair loss, Alopecia, Natural remedies, Herbal treatments, Traditional medicine, Phytochemicals, Castor oil, Hair growth, Scalp health, Folk remedies, Plant-based therapies, Ricinoleic acid, Essential oils, Topical application, Hair follicles, Herbal extracts, Traditional remedies, Ayurvedic treatments.*

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INTRODUCTION:

Human hair, an integral part of our bodies, is an intricate biological structure that holds secrets of our genetic makeup, evolutionary history, and forensic relevance. This paper delves into the multifaceted world of human hair, exploring its composition, growth patterns, and its pivotal role in forensics. From its growth phases to its potential as a reservoir of biological information, this research aims to unveil the remarkable science and significance woven into each strand of this unassuming yet complex element of the human body.[1]

- Distribution of Hair: Human hair grows all over the body except in specific areas like the soles of the feet, inside the mouth, lips, behind the ears, palms of the hands, certain external genital areas, the navel, scar tissue, and, except for eyelashes, the eyelids.
- Hair Structure: Hair is composed of a stratified squamous keratinized epithelium made of multi-layered flat cells. Keratin, a protein, is the primary component of hair, providing it with structure and strength.
- Hair Growth Cycle: Hair follows a specific growth cycle consisting of three phases: Anagen (growth phase), Catagen (transitional phase), and Telogen (resting phase). Each phase has distinct characteristics that determine the length of hair.
- Types of Hair: There are different types of hair in the body, including vellus hair and androgenic hair. Each type has its unique cellular construction and serves specific purposes, such as warmth and physical protection.
- Longest Hair Growth: Most humans grow the longest and thickest hair on their scalps, with some individuals, mostly males, having hair that can grow several feet long.
- Hair's Biochemical Composition: Hair is composed of highly structured keratin intermediate filaments stabilized by various covalent bonds, including isopeptide bonds and disulfide bonds. This composition makes hair physically robust and chemically resistant.
- Forensic Potential: Hair is considered an underutilized forensic substrate. It contains valuable biological information, including mitochondrial and fragmented nuclear DNA, proteins, and small molecules. Developing protocols for the analysis of hair should consider its biochemical and biophysical properties to release internal biomolecules effectively while minimizing analytical biases. [1]

Natural products in form of herbal formulation used for alopecia:

1. Aloe Vera, Ginseng, Saw Palmetto, Rosemary Oil, Onion Juice, Bhringraj (Eclipta Alba), Hibiscus, Green Tea, Coconut Oil.
2.

Compounds Responsible for hair growth activity

Minoxidil, Finasteride, Biotin, Caffeine, Keratin, Saw Palmetto, Essential Oils, Protein, Iron, Omega-3 Fatty Acids, Vitamins and Minerals:

It's essential to maintain a balanced and nutritious diet, manage stress, and practice good hair care habits to support healthy hair growth. [4]

MATERIAL, METHODS & DRUG PROFILE:

This chapter deals with material and methods used for extraction, their preliminary chemical screening and assessment of hair growth activity of *Ricinus Communis leves gel.*

Materials and Instruments

Table 5.1: Materials used for study

Sr. No.	Chemicals	Supplier
1.	Potassium Mercuric Iodide	Thomas Baker, Mumbai
2.	Iodine	Loba chemie Pvt. Ltd., Mumbai
3.	Potassium Iodide	Loba chemie Pvt. Ltd., Mumbai
4.	Potassium Bismuth Iodide	S. D. Fine Chem. Ltd., Mumbai
5.	Picric acid	Thomas Baker, Mumbai
6.	Sodium nitroprusside	Loba chemie Pvt. Ltd., Mumbai
7.	Sodium hydroxide	Loba chemie Pvt. Ltd., Mumbai
8.	Pyridine	S. D. Fine Chem. Ltd., Mumbai
9.	Ferric chloride	Thomas Baker, Mumbai
10.	Gelatin	S. D. Fine Chem. Ltd., Mumbai

11.	Lead acetate	Loba chemie Pvt. Ltd., Mumbai
12.	Nitric acid	S. D. Fine Chem. Ltd., Mumbai
13.	Copper acetate	S. D. Fine Chem. Ltd., Mumbai
14.	Sodium Chloride	S. D. Fine Chem. Ltd., Mumbai
15.	Methanol	Qualigens Fine Chemicals, Mumbai
16.	Ethanol	Qualigens Fine Chemicals, Mumbai
17.	Chloroform	Qualigens Fine Chemicals, Mumbai
18.	Folin-Ciocalteu reagent	Loba chemie Pvt. Ltd., Mumbai
19.	Fehling's solution	Central drug house ltd new Delhi

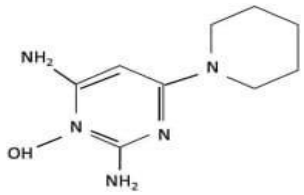
Instruments used in the investigation are listed in Table 5.2.

Sr. No.	Instruments	Supplier
1.	UV -Visible Spectrophotometer	Labindia 3000+
2.	Micro Centrifuge	REMI laboratory, Mumbai
3.	pH Meter	Accumax India, New Delhi
4.	Electronic Balance	Contech Instruments Ltd. , Mumbai
5.	Hot Air Oven	Oracle Equipments, New Delhi
6.	Vortex Apparatus	Ambros Lab Equipments, Ambala
7.	Rotary Vaccum Evaporator	Microtech Scientific Instruments, New Delhi
8.	Sonicator	Athena Technology, Thane

Standard Drug Profile:

Minoxidil:

Minoxidil was first introduced as an oral medication for the treatment of severe and recalcitrant hypertension in the 1970s.1 Coincidentally, physicians observed hair regrowth and generalized hypertrichosis in balding patients, which led to the development of a topical minoxidil formulation for treating androgenetic alopecia (AGA) first in male and then in female individuals. The 2% minoxidil solution was first launched in the market in 1986, followed by the 5% solution in 1993.2 Despite its global acceptance for over 30 years, the mechanism underlying the hair growthpromoting effects of minoxidil remains to be fully elucidated. (Poonkiat Suchonwanit et al, 2019)



Structure of Minoxidil

Mechanism of Action:

Inhibition of androgen effects on the androgen-sensitive hair follicles. Direct stimulation of the hair follicles: Minoxidil may act as an 'epidermal growth factor' on matrix cells delaying their aging, thus prolonging the duration of the anagen phase via the activation of the beta-catenin pathway. (Talel Badri et al, 2015)

Side effects of Minoxidil:

- Acne at site of application.
- Burning of scalp.
- Facial hair growth.
- Increased hair loss.
- Inflammation or soreness at root of hair.

- Reddened skin.
- Swelling of face.

Selection of Plant:
The plants have been selected on the basis of its availability and folk use of the plant. Gathering sufficient information from various articles and journals it was concluded that there is scope to explore some more pharmacological activities in the plant *Ricinus Communis* . Hence it was selected for further studies.

Collection and Authentication of Plant material:
- Collection - Leaves of *Ricinus Communis* were collected from local market of Bhopal in the month of January, 2021.
- Authentication of Plant – Identification and authenticated by Dr Saba Naaz Head of the Department Botany at the Safia college of science, Bhopal (M.P) The plant part specimen was submitted as herbarium with Voucher specimen no (237/Saif/Sci/Clg/Bpl)

Drying:
Drying of fresh plant parts was carried out in under the shade.
Storage:
Dried leaves of *Ricinus Communis leves* were preserved in plastic bags, closed tightly and powdered as per the requirements.
Extraction procedure:
Following procedure was adopted for the preparation of extract from the shade dried and powdered herbs:

Defatting of plant material
86.5 gram of leaves dried powdered of *Ricinus Communis Leves* were coarsely powdered and subjected to extraction with petroleum ether by soxhlation method. The extraction was continued till the defatting of the material had taken place.

Extraction by soxhlation method:
Defatted dried powdered of *Ricinus Communis* has been extracted with hydroalcoholic solvent (ethanol: aqueous, 75:25) using soxhlation method for 48 hrs, filtered and dried using vacuum evaporator at 40°C (Mukherjee, 2007; Kokate, 1994).

Determination of percentage yield:

The percentage yield of each extract was calculated by using following formula:

$$\text{Percentage yield} = \frac{\text{Weight of Extract}}{\text{Weight of powdered drug}} \times 100$$

Phytochemical Screening:

Phytochemical screening: Phytochemical examinations were carried out for all the extracts as per the standard methods.

Detection of alkaloids: Extract were dissolved individually in dilute Hydrochloric acid and filtered.

Mayer's Test: Filtrates was treated with Mayer's reagent (Potassium Mercuric Iodide). Formation of a yellow precipitate indicates the presence of alkaloids.

Wagner's Test: Filtrates was treated with Wagner's reagent (Iodine in Potassium Iodide). Formation of brown/reddish precipitate indicates the presence of alkaloids.

Dragendroff's Test: Filtrates was treated with Dragendroff's reagent (solution of Potassium Bismuth Iodide). Formation of red precipitate indicates the presence of alkaloids.

Hager's Test: Filtrates was treated with Hager's reagent (saturated picric acid solution). Presence of alkaloids confirmed by the formation of yellow coloured precipitate.

Detection of carbohydrates: Extract was dissolved individually in 5 ml distilled water and filtered. The filtrates were used to test for the presence of carbohydrates. **Fehling's Test:** Filtrates was hydrolysed with dil. HCl, neutralized with alkali and heated with Fehling's A & B solutions. Formation of red precipitate indicates the presence of reducing sugars.

Detection of glycosides: Extract was hydrolysed with dil. HCl, and then
subjected to test for glycosides.

Legal's Test: Extract was treated with sodium nitropruside in pyridine and sodium hydroxide. Formation of pink to blood red colour indicates the presence of cardiac glycosides.

Detection of saponins

Froth Test: Extract was diluted with distilled water to 20ml and this was shaken in a graduated cylinder for 15 minutes. Formation of 1 cm layer of foam indicates the presence of saponins.

Foam Test: 0.5 gm of extract was shaken with 2 ml of water. If foam produced persists for ten minutes it indicates the presence of saponins.

5.Detection of phenols

Ferric Chloride Test: Extract was treated with 3-4 drops of ferric chloride solution.
Formation of bluish black colour indicates the presence of phenols.

6. Detection of tannins

Gelatin Test: To the extract, 1% gelatin solution containing sodium chloride was added. Formation of white precipitate indicates the presence of tannins.

7. Detection of flavonoids

Alkaline Reagent Test: Extract was treated with few drops of sodium hydroxide solution. Formation of intense yellow colour, which becomes colourless on addition of dilute acid, indicates the presence of flavonoids.

Lead acetate Test: Extract was treated with few drops of lead acetate solution.
Formation of yellow colour precipitate indicates the presence of flavonoids.

8. Detection of proteins

Xanthoproteic Test: The extract was treated with few drops of conc. Nitric acid.
Formation of yellow colour indicates the presence of proteins.

9. Detection of diterpenes

Copper acetate Test: Extract was dissolved in water and treated with 3-4 drops of copper acetate solution. Formation of emerald green colour indicates the presence of diterpenes (Maheshwari et al., 2019).

Thin layer chromatography:

Thin layer chromatography is based on the adsorption phenomenon. In this type of chromatography mobile phase containing the dissolved solutes passes over the surface of stationary phase. Each solvent extract was subjected to thin layer chromatography (TLC) as per conventional one dimensional ascending method using silica gel 60F254, 7X6 cm (Merck) were cut with ordinary household scissors. Plate markings were made with soft pencil. Glass capillaries were used to spot the sample for TLC applied sample volume 1-micro litre by using capillary at distance of 1 cm at 5 tracks. In the twin trough chamber with different solvent system toluene: ethyl acetate: formic acid (5:4:1) for quercetin and toluene: ethyl acetate: formic acid (7:5:1) for gallic acid solvent system used (Sajeeth at el., 2010). After pre-saturation with mobile phase for 20 min for development were used. After the run plates are dried and sprayed freshly prepared iodine reagents were used to detect the bands on the TLC plates. The movement of the active compound was expressed by its retention factor (Rf), values were calculated for different samples.

Detection and Calculation of R_f Value

1. Once the chromatogram was developed the R_f Value of the spot was calculated using the formula:

$$R_f = \frac{\text{Distance traveled by solute}}{\text{Distance traveled by solvent}}$$

5.7 Quantitative studies of phytoconstituents

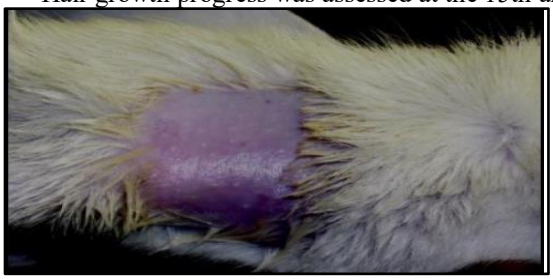
5.7.1 Total phenol content estimation

Principle: The total phenol content of the extract was determined by the modified folin-ciocalteu method (Parkhe et al., 2019).
Preparation of Standard: 10 mg Gallic acid was dissolved in 10 ml methanol, various aliquots of 10- 50µg/ml was prepared in methanol.
Preparation of Extract: 10 mg of dried extract was dissolved in 10 ml methanol and filter. Two ml (1mg/ml) of this extract was for the estimation of phenol.
Procedure: 2 ml of extract and each standard was mixed with 1 ml of Folin- Ciocalteu reagent (previously diluted with distilled water 1:10 v/v) and 1 ml (7.5g/l) of sodium carbonate. The mixture was vortexed for 15s and allowed to stand for 10min for colour development. The absorbance was measured at 765 nm using a spectrophotometer.
5.7.2 Total flavonoids content estimation
Principle: Determination of total flavonoids content was based on aluminium chloride method (Mishra et al., 2017).
Preparation of standard: 10 mg quercetin was dissolved in 10 ml methanol, and various aliquots of 5- 25µg/ml were prepared in methanol.
Preparation of extract: 10 mg of dried extract was dissolved in 10 ml methanol and filter. Three ml (1mg/ml) of this extract was for the estimation of flavonoids.
Procedure: 1 ml of 2% $AlCl_3$ solution was added to 3 ml of extract or each standard and allowed to stand for 15min at room temperature; absorbance was measured at
420 nm.
5.8 Pharmacological activity of extract *Ricinus Communis leves gel* for hair growth Assessment of hair growth activity.
1. Animals:
- Male Wistar albino rats weighing 220-240g were used for the hair growth studies.
- The rats were placed in cages and kept in standard environmental conditions with a temperature of 23°C ± 10°C and relative humidity of 60% ± 10%.
- They were fed with a standard diet from Hindustan Liver and allowed free access to drinking water for two days before the study.
2. **Hair Growth Activity Test**:
- A quantitative model was used to assess hair growth in the rats.
- The rats were divided into four groups, with two rats in each group.
- A 2cm2 area on the dorsal portion of all rats was shaved to remove hair before starting the treatment.
- **Group 1** served as the control, receiving no drug treatment.
- **Group 2** was treated with 1mL of a 2% Minoxidil ethanolic solution applied over the shaved area once a day (standard treatment).
- **Group 3** was treated with the herbal extract of Ricinus communis leves gel at a single dose level once a day.
- **Group 4** was treated with the herbal extract of Ricinus Communis leves gel at a double dose level once a day.
- The treatment was continued for 30 days, and the hair growth pattern was observed qualitatively and recorded.
3. Qualitative Studies on Hair Growth:
- The researchers qualitatively studied the hair growth pattern in the rats during the 30-day treatment period.
4. Determination of Hair Length and Weight:
- The length and weight of the hair in the treated rats were determined as part of the hair growth assessment.
5. Application of Extract and Primary Skin Irritation Study:
- A 0.5g quantity of the herbal extract was applied as a test substance to an area of approximately 6 cm2 of skin on the rats.

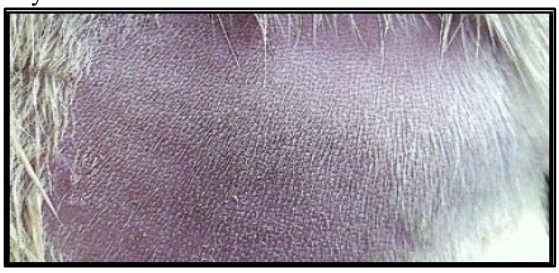
- The skin was covered with a gauze patch, and it was held in contact with the skin using a semi-occlusive dressing for 1 hour.
- After 1 hour, the gauze patch was removed, and observations were recorded.
- Control animals underwent the same process, but they were applied with a control substance that did not contain the herbal mixture.
- The extract was applied to the skin once a day for 7 days, and any sensitivity or reactions were observed and recorded.

6. Hair Growth Observations:

- Hair growth initiation was noted at the 7th day.
- Hair growth progress was assessed at the 15th and 30th days of treatment.



At 0 Day



Hair growth initiation at 7th Day

Hair growth at 15th Day

Hair growth at 30th Day

EXPERIMENTAL WORK, RESULTS AND DISCUSSION

Determination of percentage yield**:**

Yield of Extraction: To obtain the percentage yield of extraction is very important phenomenon in phytochemical extraction to evaluate the standard extraction efficiency for a particular plant, different parts of same plant or different solvents used. The yield of extract obtained from samples using hydroalcoholic solvent is depicted in the table 6.1.

Table 6.1: % Yield of *Ricinus Communis* extract

S. No.	Extracts	% Yield (w/w)
1.	Pet. Ether	3.58%
2.	Hydroalcoholic	6.52%

Percentage yield of pet. ether and hydroalcoholic extract of *Ricinus Communis* exhibited in 3.58 and 6.52% respectively.

Phytochemical screening of extract of *Ricinus Communis:*

Small portion of the dried extracts was subjected to the phytochemical tests using standard methods to test for alkaloids, glycosides, saponins, flavonoids

and phenol separately for extracts of all samples. Small amount of each extract was suitably resuspended into the distilled water to make the concentration of 1 mg per ml. The outcomes of the results are discussed in the table

Table 6.2 Phytochemical screening of extract of *Ricinus Communis*

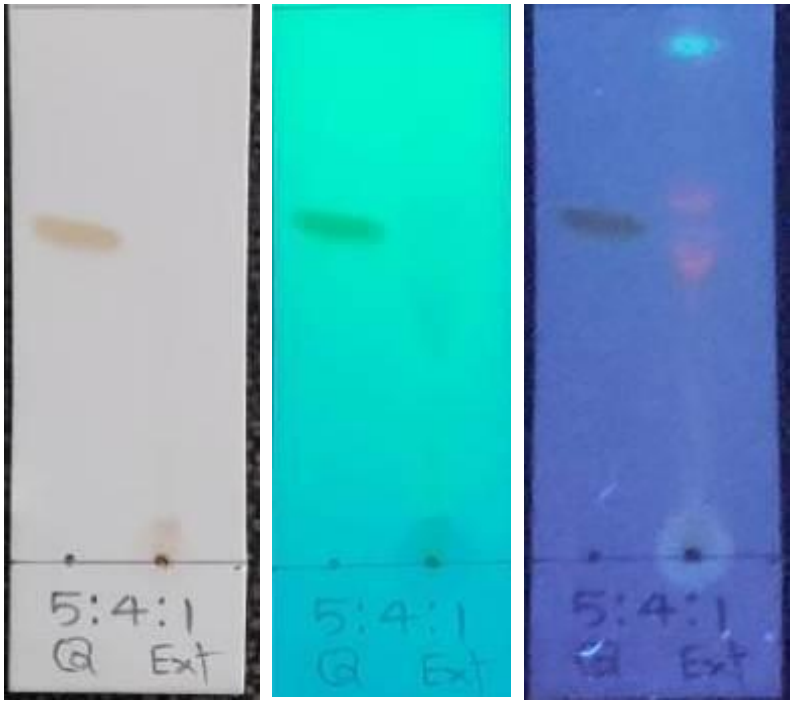
S. No.	Constituents	Hydroalcoholic extract	Observation
1.	**Alkaloids** Dragendroff's test Hager's test	 -ve -ve	 Green coloured Not yellow coloured
2.	**Glycosides** Legal's test	 -ve	 Green coloured
3.	**Flavonoids** Lead acetate Alkaline test	 -ve +ve	 Yellow colour but no precipitate Yellow colour
4.	**Phenol** Ferric chloride test	 +ve	 Black coloured
5.	**Proteins** Xanthoproteic test	 +ve	 Yellow coloured
6.	**Carbohydrates** Fehling's test	 -ve	 Sky coloured precipitate
7.	**Saponins** Foam test	 +ve	 Layer of foam
8.	**Diterpenes** Copper acetate test	 +ve	 Green coloured
9.	Tannins Gelatin Test	 +ve	 White colour precipitate

Results of phytochemical screening were found to be flavonoids, phenol, tannins, proteins and saponins were detected in hydroalcoholic extracted of *Ricinus Communis.*

Results of Thin layer chromatography :

Table 6.3 *Ricinus Communis* extract R_f Value & Identification of Flavonoids Compound

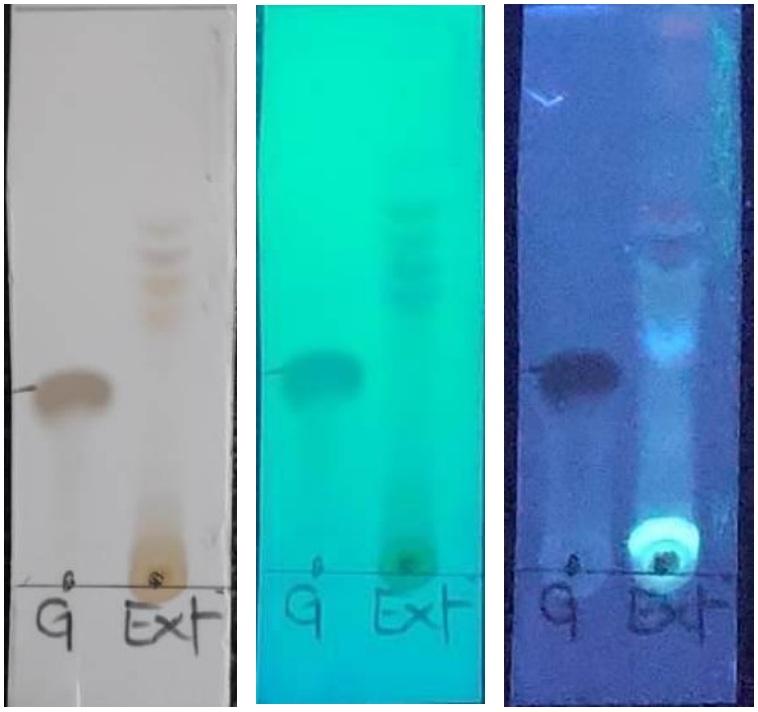
S. N.	Mobile phase	Light	Spot Distance	Rf value	Identified Compound
1	Toluene: Ethyl acetate: Formic acid (5:4:1 v/v/v) Dis. Travelled by mobile phase= 5cm (Hydroalcoholic extract)	Normal UV Light	2.3	0.46	Flavonoid Compound may present
		Short UV Light	2.7	0.54	
		Long UV Light	2.5 2.9 4.8	0.5 0.58 0.96	



Normal Light Short U.V Long U.V Spot-1= Quercetin Spot-2= Hydroalcoholic extract of *Ricinus Communis*

Table 6.4 Ricinus Communis extract Rf Value & Identification of Phenol Compound

S. N.	Mobile phase	Light	Spot Distance	Rf value	Identified Compound
2	Toluene: Ethyl acetate: Formic acid (7:5:1 v/v/v) Dis. Travelled by mobile phase= 5cm (Hydroalcoholic extract)	Normal UV Light	2.4 3.0 3.4 3.7 4.2	0.48 0.6 0.68 0.74 0.84	Phenolic compound may present
		Short UV Light	2.3 2.6 3.0 3.4 3.8	0.46 0.52 0.6 0.68 0.76	
		Long UV Light	2.3 2.6 2.9 3.3 3.5	0.46 0.52 0.58 0.66 0.7	



Normal Light Short U.V Long U.V Spot-1= Gallic acid Spot-2= Hydroalcoholic extract of *Ricinus Communis*

Results of estimation of total phenol and flavonoids content of *Ricinus Communis* extract
Estimation of total phenol content (TPC):
Total phenol content was expressed as mg/100mg of gallic acid equivalent of dry extract sample using the equation obtained from the calibration curve: **$y = 0.021x + 0.002$, $R^2 = 0.999$,** where X is the gallic acid equivalent (GAE) and Y is the absorbance.

Table 6.5; Preparation of calibration curve of Gallic acid

S. No.	Concentration (µg/ml)	Mean Absorbance
1	10	0.227
2	20	0.434
3	30	0.649
4	40	0.855
5	50	1.097

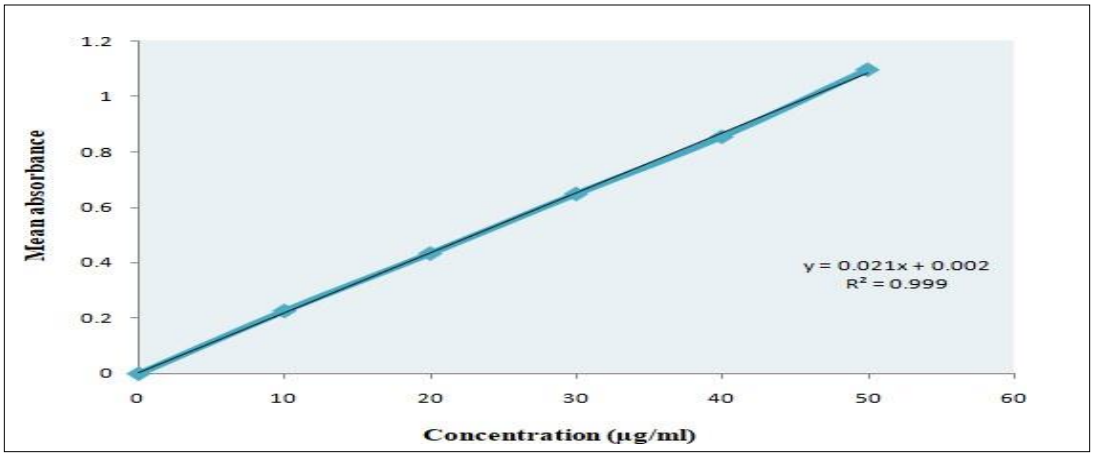


Figure 6.1 Graph of calibration curve of Gallic acid

Estimation of total flavonoids content (TFC):

Total flavonoids content was calculated as quercetin equivalent (mg/100mg) using the equation based on the calibration curve: **y = 0.036x + 0.002, R^2=0.999**, where X is the quercetin equivalent (QE) and Y is the absorbance.

Table 6.6 Preparation of calibration curve of Quercetin

S. No.	Concentration (µg/ml)	Absorbance
1	5	0.185
2	10	0.362
3	15	0.543
4	20	0.732
5	25	0.896

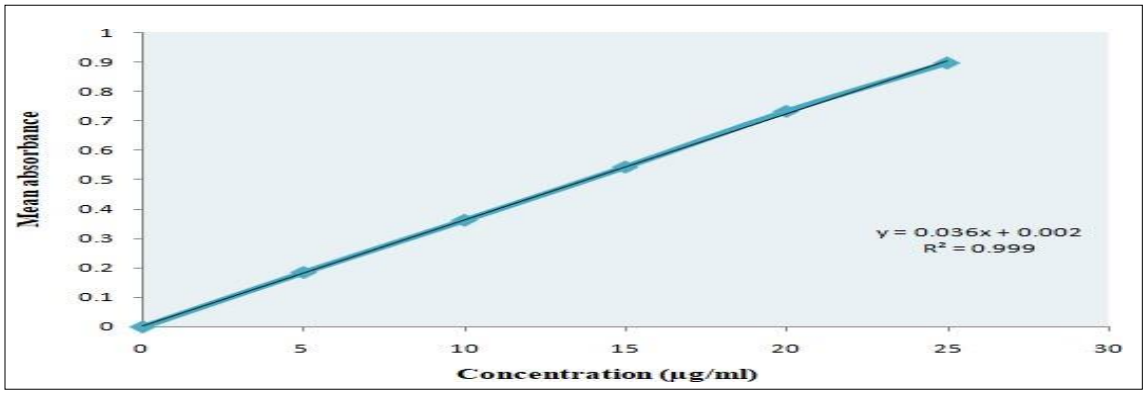


Figure 6.2: Graph of calibration curve

Table 6.7 Estimation of total phenolic and flavonoids content of *Ricinus Communis* extract

S. No.	Total phenol content (mg/100mg of dried extract)	Total flavonoids content (mg/ 100 mg of dried extract)
1.	0.659	0.852

The presence of phytochemicals (Phenols, Flavonoids) was quantitatively screened. The extract quantitative analysis revealed total phenolic content (equivalent to gallic acid) of 0.659mg/100 mg. The total content of flavonoid (equivalent to quercetin) was found 0.852mg/100 mg in *Ricinus Communis*.

Qualitative studies on hair growth:

The minimum time taken before visible hair growth on the shaven skin and the minimum time taken to completely grow new hair on the denude skin were observed physically and selected results. Treatment with herbal extract at lower and higher dose resulted in the shortest hair growth starting time and hair growth completion time. Treatment with herbal extract at lower and higher dose as well as standard 2% minoxidil reduced the time for hair growth completion while the (Table 6.8-6.9).

Table 6.8 Length of hair on experimental group

Group	Treatment	Day 15	Day 30
Group 1	Control	5.1 ± 0.12	7.5 ± 0.12
Group 2	Standard	6.5 ± 0.23	11.91 ± 0.23***
Group 3	Herbal extract of *Ricinus Communis Leves* (At single dose level)	5.50 ± 0.21	11.00 ± 0.24**
Group 4	Herbal extract of *Ricinus Communis Leves* (At double dose level)	5.70 ± 0.21	11.70 ± 0.24**

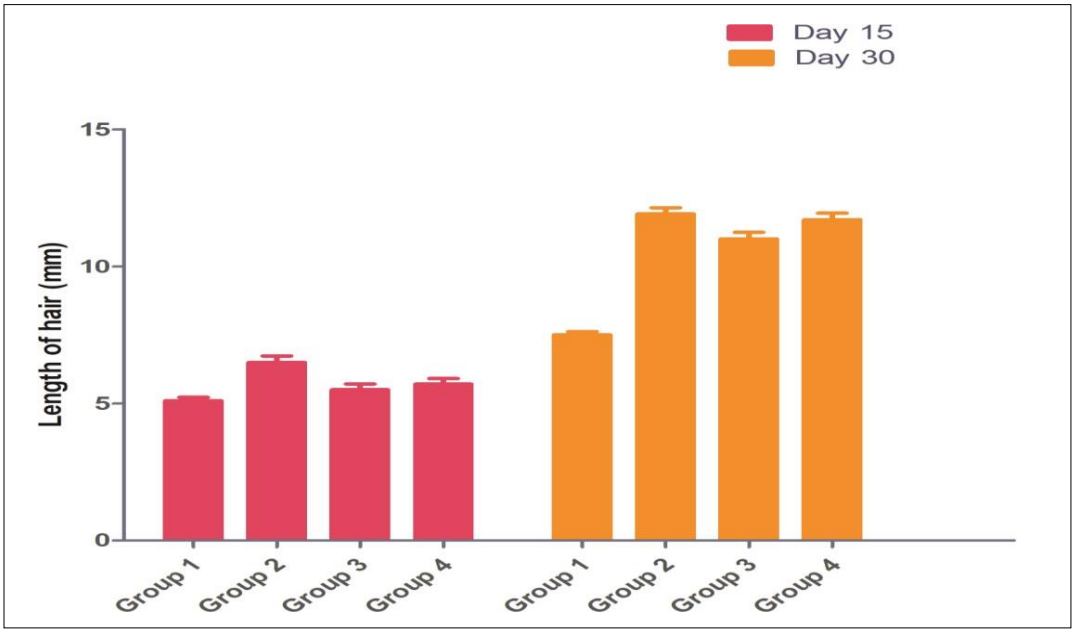


Figure 6.3: Length of hair on experimental groups

Table 6.9: Hair weight measurements after treatment

Group 1	Group 2	Group 3	Group 4
Control	Standard	Herbal extract (At single dose level)	Herbal extract (At double dose level)
41.01± 2.00	56.50 ± 2.00***	50.44 ± 2.50**	53.84 ± 2.51***

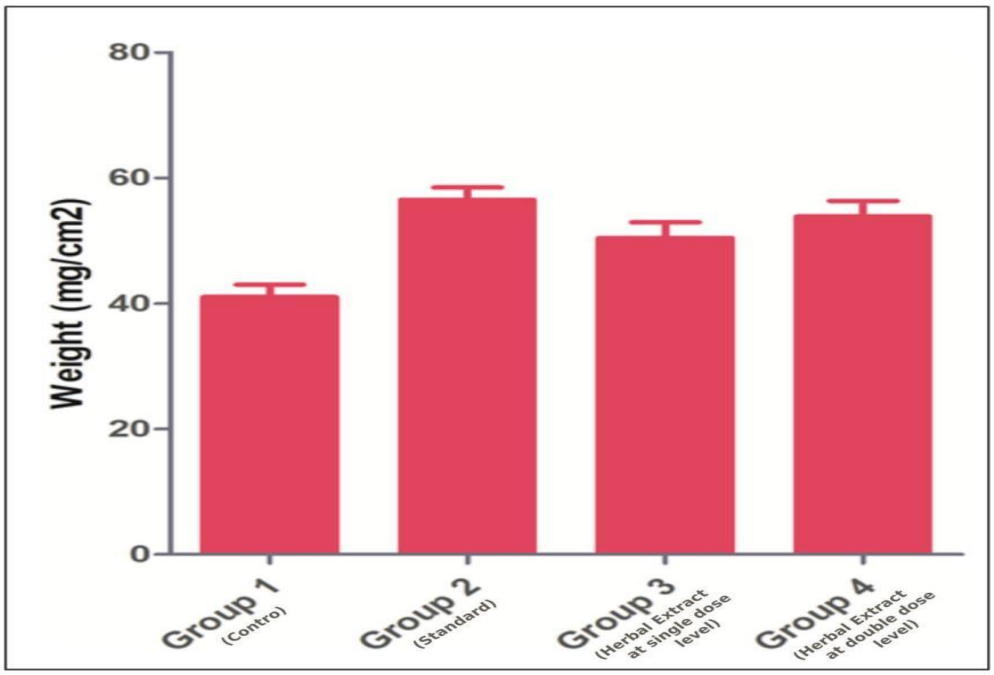


Figure 6.4 Hair weight measurements after treatment

Table 6.10: Skin irritation study results

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	A	A	A	A	A	A	A
Standard	A	A	A	A	A	A	A
Herbal Extract at single dose level	A	A	A	A	A	A	A
Herbal Extract at Double dose level	A	A	A	A	A	A	A

A – No reaction, B – Slight patchy erythema, C –Slight but confluent or moderate but patchy erythema, D – Moderate erythema, E – Severe erythema with or without edema.

The gel was non-irritant upon application on to the skin (Table 6.10). The control and experimental albino rats showed no signs of tremor, convulsion and reflex abnormalities. The food intake per day had also found normal during 7 days repeated dose dermal toxicity evaluation.

SUMMARY AND CONCLUSION:

It appears you're discussing the yield and phytochemical composition of a hydroalcoholic extract obtained from Ricinus Communis leaves.

Yield of Hydroalcoholic Extract: The yield of the hydroalcoholic extract from Ricinus Communis leaves was determined to be 6.52% w/w. This means that for every 100 grams of the leaves, the extract obtained weighed 6.52 grams.

Phytochemical Screening: Phytochemical screening involves testing plant extracts for the presence of various bioactive compounds. In the case of the Ricinus Communis leaves extract, the following compounds were identified:

lavonoids: Flavonoids are a class of secondary metabolites found in plants. They have antioxidant properties and are associated with various health benefits.

Phenol: Phenolic compounds are also antioxidants and can contribute to the overall antioxidant capacity of plant extracts.

Tannins: Tannins are polyphenolic compounds with astringent properties. They can bind to proteins and other molecules, and have been studied for their potential health effects.

Proteins: The presence of proteins suggests that the extract contains components of the plant's cellular structure and may have nutritive or biological properties.

Saponins: Saponins are glycosides that can produce a foamy lather when shaken in water. They have various biological activities and are known for their potential cholesterol-lowering effects and immune-modulating properties.

Table no. 6.5 showed total phenolic content 0.659 (mg GAE/100mg) and total flavonoid content 0.852 (mg QE/100mg).

Extractable phytochemicals have proven to be an excellent source of medication for many ailments. Plant extract derived medication is usually associated with fewer side effects in the body and lower production cost. In this study, herbal extract have proven to be a strong hair growth stimulant when tested in albino rats. Results obtained after 30 days of topical application with separated phytochemicals show significant hair growth in the group of albino rats treated with herbal extract. Apart from a visible increased hair length above the controls and the standard drug, the group of albino rats treated with herbal extract had heavier hair as well as the biggest follicle size after 30 days of receiving treatment. Hair growth was fast in standard compared to herbal extract basing on the measured parameters.

If the diverse forms of alopecia are to be put into consideration, herbal extract has potential therapeutic effect on nonhormonal forms such as chemotherapy induced alopecia, traction alopecia and some forms of nonhormonal alopecia areata. The condition affects because of the high levels of testosterone in males. Testing for the herbal extract effect on androgenic alopecia will require other animal models like stump tailed macaque which develops similar scalp baldness due to the generation of androgens in its body.

Although mechanistic studies of how flavonoid glycosides in *D. senecioides* promote hair growth are still underway, it is important to discuss how other similar extracts have worked to promote hair growth. Studies on *D. senecioides* extracts , investigated the anti-inflammatory and antioxidant properties of the plant extracts. These properties are crucial in triggering proliferation of hair follicle cells leading to

hair growth. On hair growth promoting effects of antioxidants and anti- inflammatory extracts of *Rosemarinus officinalis* and *Altheae officinalis* supported the idea. The mechanism involves follicle stem cells resuscitation by the cleansing removal of microinflammations which emerge from stress and exposure to free radicals. Removal of microinflammations results in cell viability and multiplication of follicle cells. Having flavonoids as active hair growth stimulant is a double blessing in that they are also very good antioxidants.

Herbal extract have exhibited remarkable hair growth stimulation in albino rats. Its hair growth activity was found to be greater than other phytochemicals and results indicated that herbal extract from the plant are a promising source of lead compounds for alopecia medication. The activity of the herbal extract on albino rats was shown to increase with an increase in concentration dose.

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