WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 13, Issue 20, 125-140. Review Article ISSN 2277–7105

PHARMACOGNOSTIC STUDY, PHYSICO-CHEMICAL STANDARDS AND PHARMACOLOGICAL ACTIVITIES OF CURCUMA CAESIA (BLACK TURMERIC)

Manjusha Ingale*, Pratiksha Ingale and Priyanka Shinde

Department of Pharmacognosy, JBVP'S Vidya Niketan College of Pharmacy, Lakhewadi Indapur 413103.

Article Received on
24 August 2024,

Revised on 14 Sept. 2024,
Accepted on 04 Oct. 2024

DOI: 10.20959/wjpr202420-34160

***Corresponding Author**
Manjusha Ingale
Department of Pharmacognosy, JBVP'S Vidya Niketan College of Pharmacy, Lakhewadi Indapur 413103.

ABSTRACT

Curcuma caesia (Black Turmeric), a rare and valuable medicinal plant from the Zingiberaceae family, is native to Southeast Asia and has been traditionally used in various forms of healing for centuries. This study provides a comprehensive evaluation of the plant's pharmacognostic properties, focusing on its macroscopic and microscopic characteristics, powder microscopy, physicochemical parameters, and phytochemical profiles. Key diagnostic features such as major chemical constituents, extractive values, and other important physicochemical properties were documented to establish a standardized framework for its medicinal evaluation. *Curcuma caesia* is known for its wide range of therapeutic activities, including antifungal, anti-inflammatory, antioxidant, antimicrobial, analgesic, anticonvulsant, and muscle relaxant effects. With its unique pharmacological profile, the plant holds significant potential for the development of novel medicinal products for treating various diseases. This review sheds light on its traditional uses, bioactive compounds, and emerging role in modern pharmacology.

KEYWORDS: Curcuma caesia Roxb., kali haldi, pharmacognostic, physicochemical constants, phytochemical profile, microscopy, Pharmacologoical activity.

INTRODUCTION

Curcuma caesia Roxb., sometimes known as Kali haldi, belongs to the Zingiberaceae plant family. In India, it is found in West Bengal, Madhya Pradesh, Orissa, and Chhattisgarh. Uttar

Pradesh states. It grows in moist deciduous environments. Forest areas.[1] Plant rhizomes are used to treat sprains. and bruising and also used in the preparation of cosmetics.[2] The effective application of Curcuma longa Linn. It has long been known as a laxative, anthelmintic, and vulnerary; in addition, it is useful in blood problems. Leukoderma, scabies, smallpox, and sprains. Curcuma Amada Roxb. is beneficial for bronchitis, asthma, sprains, Skin disorders and inflammation caused by injuries. Curcuma Aromatica Salisb. demonstrates wound healing, anti-immunological, antiproliferative, and blood purifier.

Curcuma zedoaria Christm. is believed to have antimutagenic, anticarcinogenic, and anti-inflammatory properties. Curcuma angustifolia has aphrodisiac properties and can help treat Leprosy, asthma, anemia, and leukoderma. The internal component The rhizome is bluish-black in color and possesses a distinctive. It has a pleasant aroma. The "turkomans" (Turks) apply. These roots act as a rubefacient to rub the body after taking in. A Turkish bath. In Bengal, it is utilized in its fresh form—turmeric.[3] The plant is regarded as extremely auspicious and is Traditionally used in India for many magical treatments.

The herb's rhizomes are used by various tribal communities in Mandla, including the Baiga, Sahariya, Agariya, Gond, and Korku. Balaghat, Chhindwara, Anooppur, and Dindori districts. of Madhya Pradesh state for the treatment of pneumonia. Cough and cold in children as well as fever and asthma. in adulthood. Tribal women utilize the powder of herbs. as a face-pack throughout their engagement and marriage. period.[4] Due to its rising demand and overexploitation. Without assuring regrowth, the plant has lately The plant is also considered an endangered species. Having some antifungal protein against drugs Candida albicans is resistant.[5] The preliminary mechanisms Studies have shown its smooth muscle relaxant action on Hydroalcoholic extract.[6]

Plant profile

It is found growing in North-East and Central India, as well as certain regions of South India. The plant typically grows to a height of 0.5 to 1.0 meters. It is separated into an aerial shoot along the rootstock, which is an underground big ovoid tuberous rhizome that is frequently called the foliage. There are deep violet spots on the foliage. The leaves have a rough upper surface, and the leaves are usually found in the 10–20 age range. The flowers that bloom have a ferruginous tint and are green. Petals from flowers could be rich crimson or pink in hue. The rhizome's inside portion is bluish-black in hue and giving forth a recognizable sweet scent, owing to the essential oil's presence. It tastes spicy and bitter and has a strong odor.[7]

The following are its primary components: reducing sugars, proteins, anthraquinones, glycosides, cardiac glycosides, alkaloids, terpenes, amino acids, carbohydrates, tannins, flavones, and steroids. The oil that rhizomes produce is made up of thirty ingredients that nearlycomprise 97.48% oil and other substances such as ar-turmericcrone (28.1%) and camphor.(12.3%), 1,8cineole (5.3%), elemene (4.8%), borbornylacetateand(Z)ocimene (8.2%). There is also curcumene (2.82%), ar-curcumene (6.8%) and 3.3%. which are extremelybeneficial and possess great therapeutic value.[8-13]

Fig.1 black turmeric plant.

Fig.2 rizhomes of Black turmeric.

Fig.3: Flower of Black turmeric.

Table 1: Taxanomical hierarchy of Black turmeric.[14]

Taxanomic Rank	Classification
Kingdom	Plantae
Subkingdom	Viridaeplantae
Phylum	Tracheophyta
Subphylum	Euphyllophytina
Class	Magnoliopsida
Order	Zingiberales
Family	Zingiberaceae
Subfamily	Zingiberoideae
Tribe	Hedychieae
Genus	Curcuma
Species	Curcuma caesia Roxb.

Pharmacognostic study[15]

Macroscopy - The plant is normally erect and ranges in height from 0.5 to 1.0 m. It is comprised of an underground big ovoid tuberous rhizome, known as rootstock, and an erect aerial shoot. with foliage and flowers

(a) Rhizome: The rhizome is tuberous and camphoraceous. fragrant odor, around 2-6 cm in diameter, and the shape Size is a variable. It is solitary, laterally flexible, and covered with

adventitious roots, root scars, and warts.

Furthermore, it demonstrates longitudinal circular wrinkles on the surface with the appearance of nodal and internodal zones. To the rhizome. The surface (cork) of rhizomes is black, dark brown or buff in colour

b) Roots: The plant propagates through rhizomes; therefore, primary roots are not visible. However, yellow-brown long fibrous and tapering adventitious roots can be observed throughout. above the surface of the rhizome

c) Leaves: The leaves are organized in groups of 10-20, each leaf is broad, oblong and glabrous. In the midst. The region of the lamina has a severe farraginous purple color. clouds. The petiole is ivory-colored, ensheathing the A pseudoaxis is formed when petioles wrap one another. The Monocots typically exhibit parallel variation.

d) Inflorescence: It is a 15-20 cm long, thick spike. emerges far before the emergence of the leaf; the bracts are Green, the bracts of coma are rich crimson, and they turn crimson.

e) Flowers: smaller than bracts and pale yellow with a reddish border. The calyx is 10-15 mm long, obtuse, and has three teeth. The corolla is long and tubular, with a pale yellow lip and three lobed semi-sepals. elliptic.

Microscopy

Root

The adventitious root's TS has circular outlines. As seen in [Figures 4 and 5],

1. Epiblema: single-layered consist of thick walls sliced cells. The epiblema in the aged specimen has shriveled. and is swapped out for ten rows of rectangular cork cells
2. Heterogeneous cortex : that is divided into

a) Outer cortex: Parenchymatous tissue makes up this area. Comprising the main and secondary cortex

b) Middle cortex: composed of air cells organized radially chambers divided by a partition wall one cell thick the trabaculae, a hygrophilous plant characteristic.

c) Endodermis: Located in the cortex's deepest layer, The cells have a barrel-shaped and rectangular form.

3. Pericycle: This three-four-tiered structure is made up of rectangular cells

4. Vascular tissue is organized radially. phloem leaf patches and xylem is exarch, and they are organized inversely.
5. Pith: A thick-walled, well-developed parenchymatous structure

Rizhome: the transverse section of rizhome can be described based on structural components observed. [Figure 6 and 7]

1. Epidermis: This is the outermost layer, consisting of a single layer of cells. These cells have very thick walls and are covered with thick cuticle.
2. Cortex: Located beneath the epidermis, the cortex is composed of three to five layers of thick-walled collenchymatous cells that provide structural support.
3. Endodermis: This layer is not well-developed, appearing less distinct compared to other layers.
4. Pericycle: A well-defined layer of radially arranged, compactly placed cells.
5. Pith: The central region of the rhizome, made up of large parenchymatous cells. Many of these cells contain starch grains, or sphaeraphides. Additionally, there are several vascular traces within the pith, which could be leaf traces.
6. Vascular Tissue: The vascular bundles are conjoint and scattered throughout the rhizome. The xylem consists of vessels and xylem parenchyma, while the phloem is made up of sieve tubes and phloem parenchyma.

Leaf: The isobilateral leaf described in your text appears to have specific characteristics, summarized as follows:(figure 8 and 9)

1. Epidermis: Both upper and lower layers are identical, single-layered, covered by cuticle, and have stomata.
2. Mesophyll: Palisade and spongy parenchyma are intermixed, fully chlorophyllous, with well-defined oil cavities.
3. Vascular Bundles: Mixed with oil cavities, each bundle is conjoint and collateral, with sclerenchyma over the xylem.

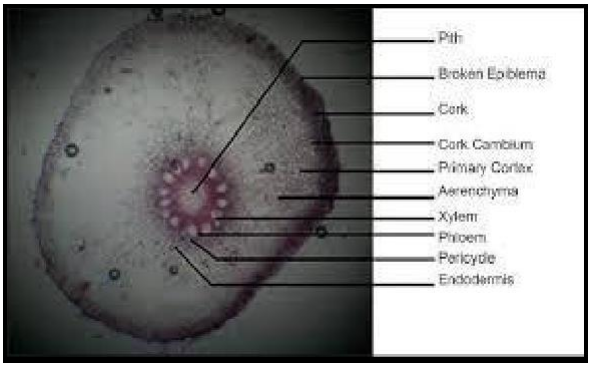


Fig.4 T.S. of adventious root.

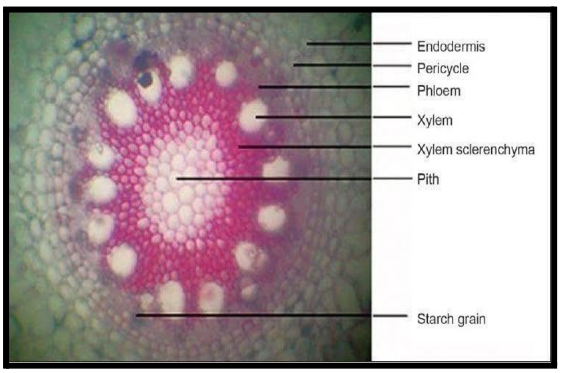


Fig.5.T.S. of root Central part.

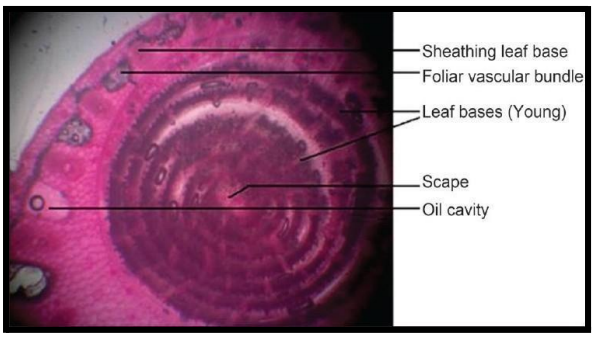


Fig.6. T.S. of rizhome epical part.

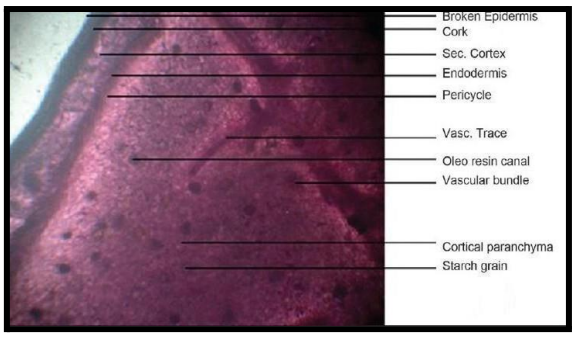


Fig.7.T.S.of curcuma caesia rizhome.

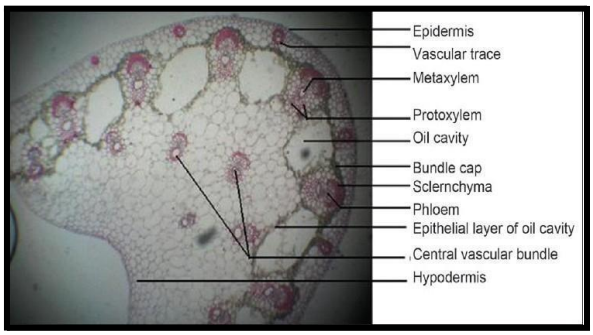


Fig.8. T.S. of central part of leaf.

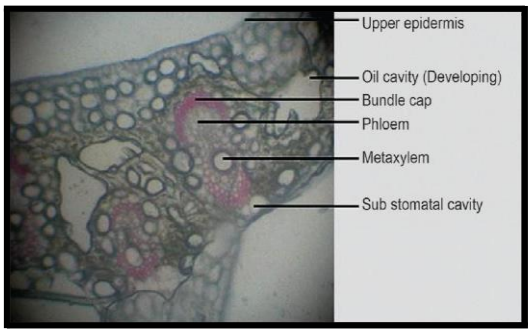


Fig.9. T.S. of leaf lamina.

Powder microscopy: (figure.10 and 11)

Appearance: The powder is brownish-black, with a camphoraceous (strong and fresh) odor and a bitter taste. It includes fiber and small granules.

Parenchyma Cells: These are spherical or angular cells that appear as grains. These grains are clumps of parenchymatous cells filled with starch grains, which turn blue when treated with iodine (indicating the presence of starch).

Oligorasin Crystals: These crystals are originally embedded in the parenchyma cells but become free and scattered when the powder is processed.

Vascular Elements: The powder contains a large number of vessel elements, either whole or in fragments, showing spiral and pitted thickenings. Tracheids, which are specialized cells for water conduction, are present but occur less frequently.

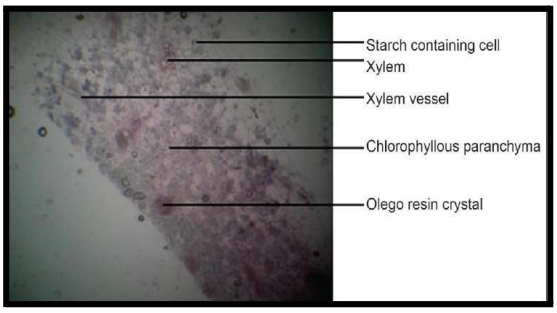


Fig. 10: Powder and allied parts.

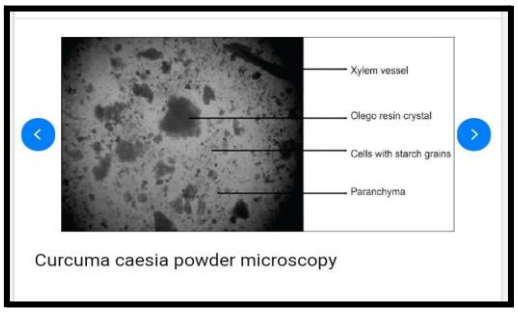


Fig.11: Curcuma Caesia Powder Microscopy.

Physicochemical Standards[16-19]

The physicochemical analysis of the roughly powdered rhizomes of C. caesia typically involves the following parameters, as mentioned:

- Foreign Organic Matter: This is a measure of any external or unwanted organic material present in the sample, such as parts of other plants.

- **Ash Values**

- Total Ash: Indicates the total amount of inorganic residue remaining after incineration, which gives an estimate of mineral content.
- Water-soluble Ash: The part of the total ash that is soluble in water, useful for determining water-soluble minerals.
- Water-insoluble ash: represents the portion of the ash that is insoluble in water, typically indicating siliceous matter or dirt.
- Acid-soluble Ash: The portion of ash soluble in acid, used to evaluate acid-soluble inorganic materials.
- Acid-insoluble ash: represents silica and other acid-insoluble materials, typically from contaminants like soil.
- Sulfurated Ash: The ash value obtained after treating the sample with sulfuric acid, which aids in understanding the inorganic impurities.

- **Extractive Values**

- Alcohol-soluble extractive: measures the components of the sample that are soluble in alcohol, which can be useful for understanding the extractable phytochemicals.
- Water-soluble extractive: represents the part of the material that dissolves in water, showing the water-soluble compounds.

- Moisture Content: The amount of water present in the sample is crucial for determining the sample's stability and shelf life.

These tests are important for the quality control of herbal products. The data for these parameters would be shown in Table 1 of the referenced study.

1. Estimation of foreign organic matter

A section of a freshly cleaned sheet of white paper was sprinkled with 100 grams of early shade-dried organic material from *Curcuma caesia*. The area was spotless. The organic material was visually inspected in daylight, and all abnormal components were manually

removed. After thoroughly sorting the material, the sample was reweighed, and the difference was used to determine the foreign organic matter content using the formula for moisture content shown below:

$$\text{Foreign organic matter :-} \quad \frac{W_A - W_B}{W_A} \times 100\% \text{..... equation(1)}$$

Where,

- WA is the initial weight of the sample before sorting.
- WB is the final weight of the sample after the removal of abnormal components.

2. Estimation of total ash

To estimate the total ash content, 1 g of coarse *Curcuma caesia* powder was placed in a crucible and heated at 100°C for an hour. The sample was then ignited in an electric oven until it reached a constant weight. After incineration, the ash was collected and washed with hot water using filter paper. The filter paper and residue were then burned until the ash turned white. The filtrate was transferred to a china dish, evaporated, and heated to 400°C. The total ash content was determined using the following equation.

$$\text{Total ash:-} \frac{W_A}{W_B} \times 100 \text{ ……equation (2)}$$

Where

- (WA) is the weight of the ash.
- (WB) is the weight of the original sample.

Estimation of Water-Soluble Ash

The complete ash was transferred to a beaker and heated for 5 minutes with 25 cc of distilled water, then filtered with ashless filter paper. The insoluble material was washed with Warm water is dried, placed in a crucible, and then burned at Temperature of 400 degrees for approximately 15 minutes before being weighed. The amount of water-soluble ash was tested. Based on the following formula provided in Equation (3):

$$\text{Water-soluble ash} = \frac{\text{Weight of soluble ash}}{\text{Weight of the total ash where soluble ash = total ash − insoluble ash.}} \times 100 \text{ .....equation (3)}$$

Estimation of Water-insoluble Ash

The complete ash was transferred to a beaker and heated for 5 minutes with 25 cc of distilled water, then filtered with ashless filter paper. The insoluble material was washed with Warm water is dried, placed in a crucible, and then burned at Temperature of 400 degrees for

approximately 15 minutes before being weighed. The amount of water-insoluble ash was tested. Based on the following formula provided in Equation (3):

$$\text{Water-soluble ash} = \frac{\text{Weight of insoluble ash}}{\text{Weight of the total ash}} \times 100 \text{ ..... equation (4)}$$

Estimation of acid-soluble ash

The C. caesia ash was boiled with 10 mL of 2 M hydrochloric acid for 5 minutes, then filtered to remove insoluble particles. was collected on an ash-free filter paper, washed with warm Water was burned and weighed after cooling in a desiccator. The amount of acid-soluble ash was calculated using Equation (5):

$$\text{Acid-soluble ash} = \frac{\text{Weight of soluble ash}}{\text{Weight of total ash}} \times 100 \text{.....equation (5)}$$

Where soluble ash = total ash − insoluble ash.

Estimation of acid-insoluble ash

The C. caesia ash was boiled with 10 mL of 2 M hydrochloric acid for 5 minutes, then filtered to remove insoluble particles. was collected on an ash-free filter paper, washed with warm Water was burned and weighed after cooling in a desiccator. The amount of acid-insoluble ash was calculated using Equation (6):

$$\text{Acid-soluble ash} = \frac{\text{Weight of insoluble ash}}{\text{Weight of total ash}} \times 100 \text{.....equation (6)}$$

Estimation of Sulphates ash

To estimate the sulphated ash, 1 g of coarse C. caesia rhizome powder was placed in a crucible and carefully burned until fully ashed. After letting the residue settle and moisten, 1 ml of concentrated sulfuric acid was added, and the mixture was gently heated until no more white vapors appeared. The crucible was then heated to 500 °C until all black particles were eliminated. Once cooled to room temperature, a few drops of sulfuric acid were added, and the process was repeated with flame heating. This procedure continued until the weights of two consecutive crucibles differed by no more than 0.5 mg.

3. Estimation of extractive value

Estimation of water soluble extractive value

To estimate the water-soluble extractive value, 5 g of shade-dried coarse powder from the

rhizome of C. caesia was mixed with 100 ml of distilled water in a covered flask. This mixture was shaken for six hours and then allowed to sit undisturbed for 18 hours. It was then quickly filtered to prevent loss of solvents. From the filtrate, 25 ml was transferred into a 100-ml flask and heated in a water bath until completely evaporated. The residue was dried in an oven at 100 °C, cooled, and weighed.

$$\text{Water soluble extractive ash} = \frac{\text{weight of residue.}}{\text{weight of sample powder}} \times 100 \quad \text{.....equation (7)}$$

Estimation of alchol soluble

Extractive Value

To estimate the water-soluble extractive value, 5 g of shade-dried coarse powder from the rhizome of C. caesia was mixed with 100 ml of pure ethyl alcohol in a covered flask. This mixture was shaken for six hours and then allowed to sit undisturbed for 18 hours. It was then quickly filtered to prevent loss of solvents. From the filtrate, 25 ml was transferred into a 100-ml flask and heated in a water bath until completely evaporated. The residue was dried in an oven at 100 °C, cooled, and weighed.

$$\text{Alcohol soluble extractive ash} = \frac{\text{weight of residue.}}{\text{weight of sample powder}} \times 100 \quad \text{..... equation (8)}$$

4. Estimation of moisture content

A wet sample of C. caesia was promptly weighted, and the result was listed as the wet weight of the sample. The moist material was dried at a high temperature (100 oC). The sample was left to settle and cool down, and then it was reweighed. once more after 1, 2, and 3 hours, with each subsequent amount being noted as the dried weight of the sample. The Moisture of C. caesia was determined using the following Equation (9).

$$\text{Moisture Content \%} = \frac{W_w - W_D}{W_w} \times 100 \quad \text{..... equation (9)}$$

Where Ww is the wet weight of the sample and WD is the dry weight of the sample

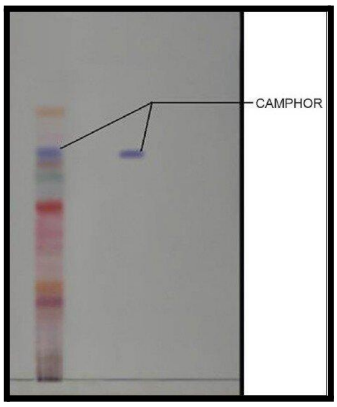
Table 2: Physicochemical analysis of Curcuma caesia rhizome.

S.N.	Physicochemical Composition	Obtained value (mg/g)
1	Foreign organic matter	13.93
2	Moisture content	21.67
3	Total ash	10.76
4	Water soluble ash	6.09
5	Water insoluble ash	4.52
6	Acid soluble ash	8.26
7	Acid insoluble ash	4.98

8	Sulphated ash	2.66
9	Extractive value (water soluble)	15.71
10	Extractive value (acid soluble)	9.94

Thin layer chromatography (15)

Thin Layer Chromatography (TLC) is a method used to separate and identify compounds within a mixture based on their polarity and interaction with the stationary phase (usually silica or alumina) and the mobile phase (a solvent or solvent mixture). The separation occurs due to the different affinities of the compounds to the stationary and mobile phases, resulting in different travel rates up the TLC plate. In the study of Curcuma caesia using thin-layer chromatography (TLC), camphor was identified in the extract. A band corresponding to an Rf value of 0.65 appeared in both the test and standard solutions. This Rf value indicates that camphor traveled 65% of the distance of the solvent front.



Rf value	Color of the band
0.12	Brown
0.23	Brownish red
0.29	Orange
0.48	Red
0.54	Pink
0.58	Light green
0.61	Grey
0.65	Bluish grey (camphor)
0.76	Light pink
0.89	Orange

PHARMACOLOGICAL ACTIVITIES OF CURCUMA CAESIA

The rhizome's bioactive components make it useful for medicinal purposes. Bioactive components such as curcuminoids are responsible for overseeing anti-oxidant and anti-inflammatory Properties, wound healing, hypoglycemia, anticoagulant, Curcuminoids possess free radical scavenging properties.[20] and antioxidant activities.[21] Major bioactive compounds in Curcumin and two similar compounds cause the rhizomes. Demethoxy substances include demethoxycurcumin and Bisde methoxy curcumin. Flavonoids and phenolics chemicals that are widely spread in plantsbeen reported to exert numerous biological effects, includingantioxidant, free radical scavenging properties, anti-Inflammatory, anti-carcinogenic, etc.[22]

a. Antifungal activity

Banerjee and Nigam (1976) identified antifungal properties in the rhizomes of Curcuma

caesia (black turmeric). The essential oil derived from the rhizomes of C. caesia Roxb has been noted for its effectiveness against fungal infections. This discovery underscores the plant's potential for medicinal use in treating fungal conditions.[23]

b. Antiulcer activity

Pranab KR Bordoloi et al. (2012) investigated the anti-ulcer properties of an ethanolic extract from the rhizome of *Curcuma caesia* using animal models. The study involved four groups of albino rats, each weighing between 150-200 g (n=5). After the rats were sacrificed, their stomachs were examined. The results showed that groups III and IV had a significant reduction in ulcer index, pepsin activity, free and total acidity, and gastric juice volume when compared to group II, along with an increase in gastric mucus secretion.[24]

c. Analgesic activity

Satija Saurabha et al. (2011) conducted a study comparing the analgesic and antipyretic effects of various extracts from the rhizomes of Curcuma caesia and Curcuma amada. The researchers evaluated these effects using a chemical model for acute pain and brewer's yeast-induced fever in rats. The study observed writhing and elevated body temperature at doses of 250 mg/kg and 500 mg/kg of the extracts in rats. Both plants demonstrated significant analgesic and antipyretic properties.[25]

d. Anthelmintic activity

Gill Randeep et al. (2011) investigated the anthelmintic properties of two well-known species from the Curcuma genus, Curcuma caesia and Curcuma zedoaria. The study measured the time it took for the extracts to induce paralysis and death in earthworms. All the extracts displayed dose-dependent activity, meaning that higher doses produced stronger effects. Among them, the ethanol extract of Curcuma caesia was the most effective in causing paralysis, highlighting its potential as a potent anthelmintic agent.[26]

e. Anxiolytic and CNS depressant activity

Indrajit Karmakar et al. (2011) investigated the CNS depressant and anxiolytic effects of MECC rhizome. MECC was tested for its hypnotic effects, as well as in the forced swim test (FST) and tail suspension test (TST). Administered intraperitoneally (i.p.) at doses of 50 and 100 mg/kg, MECC significantly reduced the onset time and extended the duration of pentobarbitone-induced sleep in a dose-dependent manner. Additionally, after seven consecutive days of treatment, MECC significantly reduced immobility periods in both the

FST and TST, suggesting notable antidepressant-like activity[27]

f. Antibacterial activity

Angel Gabriel Rajamma et al. (2012) conducted a study on the antioxidant and antibacterial properties of oleoresins extracted from nine different Curcuma species. Using dichloromethane, oleoresins were obtained from the rhizomes of *Curcuma zedoaria* and *Curcuma caesia*, and their antioxidant and antibacterial activities were assessed. The results showed that oleoresins from all species demonstrated strong DPPH radical scavenging activity and ferric reducing power, both of which correlated well with phenolic content. Additionally, the oleoresins were effective in inhibiting both gram-positive and gram-negative bacteria.[28]

g. Anti asthmatic activity

In 2011, Pritesh Paliwal et al. investigated the bronchodilating effects of Curcuma caesia extracts. The study evaluated the extract's ability to counteract bronchospasm induced by histamine aerosol and pre-convulsive dyspnea in guinea pigs. Treatment with a methanolic extract of Curcuma caesia at a dose of 500 mg/kg provided significant protection against histamine-induced bronchospasm. This extract also notably extended the latent period before convulsions occurred following exposure to histamine aerosol at the same dosage, offering greater protection than the standard treatment, chlorpheniramine maleate (2 mg/kg, p.o.). These findings suggest that the extract exhibits H1 receptor antagonistic activity, supporting the plant's potential anti-asthmatic properties.[29]

h. Antioxidant activity

Chirangini et al. (2004) examined the antioxidant activity of rhizome extracts from various medicinal members of the Zingiberales family, which are commonly used in diets and traditional medicine. Curcumin, the orange-yellow pigment found in turmeric rhizomes, is well-known for its antioxidant properties. The study evaluated crude methanol extracts from 11 species, including Curcuma caesia, assessing their antioxidant effects by comparing them to curcumin's reactivity with sulfur free radicals. Curcuma caesia demonstrated a significant level of radioprotection.[30]

CONCLUSION

In conclusion, Curcuma caesia Roxb.is a plant with numerous medicinal properties and significant economic value, Given its versatility, pharmacognostic standardization and

phytochemical analysis are essential to better validate and enhance its medicinal applications.

This investigation has established various standardized parameters, including macroscopic, microscopic, pharmacognostic, and phytochemical screenings, which will assist in the accurate identification and authentication of the plant. The results of this study will also provide valuable reference material for the preparation of a monograph. Its numerous uses in traditional medicine are well-documented, and this research may prove beneficial to both pharmaceutical industries and future researchers seeking to explore the plant's full potential.

REFERENCE

1. Nadkarni KM, Indian Material Medica. Vol.1 Bombay: Popular Prakashan, 1976; 414.
2. Anonymous, The wealth of India. Vol.2 New Delhi: Council of Scientifi c and Industrial Research, 2001; 264.
3. Kirtikar KR, Basu RD. Indian Medicinal Plants. Dehradun: International book distributors, 1987; 2418-26.
4. Vij ay Chourasia, self medication of Baiga tribal's, Aayushman, Oct 2006, 49.
5. Mannangatti K, Narayanasamy M. Anti-fungal protein from Curcuma caesia Roxb. J Biotechnol, 2008; S136-90.
6. Arulmozhi DK, Sridhar N, Veeranjaneyulu A, Arora SK. Preliminary mechanistic studies on the smooth muscle relaxant effect of hydro alcoholic extract of Curcuma caesia. J herb pharmaco nother, 2006; 6: 117-24.
7. Pandey AK, Chowdhury AR. Volatile constituents of the rhizome oil of Curcuma caesia Roxb. from central India. Flavour and Fragrance Journal, 2003; 18: 463-465.
8. Mukunthan K S, Kumar N V, Balaji S and Trupi N P, Analysis of Essential OilConstituents in Rhizomeof Curcuma caesia Roxb. from South India. Journal ofEssential Oil Bearing Plants, 2014; 17: 647-651.
9. Sahu B, Kenwat R and Chandrakar S, Medicinal Value of Curcuma cassia roxb: An Overview, Pharmaceutical and Biosciences Journal, 2016; 4(6): 69-74.
10. Mukunthan K S, Satyan R S and Patel T, Pharmacological evaluation of phytochemicals from South Indian Black Turmeric (Curcuma caesia Roxb.) to target cancer apoptosis. Journal of Ethnopharmacology, 2017; 209: 82-90.
11. Borah A, Paw M, Gogoi R., Loying R, Sarma N, Mundaa S and Lal M 2019 Chemical composition, antioxidant, anti-inflammatory, anti-microbial and in-vitro cytotoxic efficacy of essential oil of Curcuma caesia Roxb. leaves: An endangered medicinal plant

of North East India. Industrial Crops and Products, 2019; 129: 448-454.

12. sharma A, arora P, anti fertility activity of hydro alcoholic extract of trillium govanianum in ethinyl estradiol induced anti fertility model in rats, 2018; 6(2): 62-69.
13. Surbhi Sharma, Amit Sharma, Manoj Kumar Sagar, Amit Kumar. Herbal plants:Source of medicinal value (A Review). International Journal of Pharmacology and Clinical Research, 2019; 1(1): 09-11.
14. Satyendra Singh Baghel, Rajendra Singh Baghel. Pharmacological activities of Curcuma caesia. International Journal of Green Pharmacy, 2013; 7(1): 1-5.
15. Paliwal P, Pancholi SS, Patel RK. Pharmacognostic parameters for evaluation of the rhizomes of Curcuma caesia. J Adv Pharm Tech Res., 2011; 2: 56-61.
16. C. K. Kokate, A. P. Purohit, S. B. Gokhale, A text book of pharmacognosy, 7th Ed., Nirali Prakashan, Pune, India, 2001.
17. N. K. Kashyap, M. Hait, G. Roymahapatra, M. M. Vaishnav, Proximate and elemental analysis of Careya arborea Roxb. plant's root, ES Food & Agroforestry, 2022; 7: 41-47. doi: 10.30919/esfaf620.
18. P. K. Mukherjee, Elsvier, First Edition, Chapter 7 - Bioactive Phytocomponents and Their Analysis, Quality Control and Evaluation of Herbal Drugs, Elsevier, 2019; 237-328, doi: 10.1016/B978-0-12-813374-3.00007-7.
19. B. Ramadurga, R. K. Jat, S. Badami, Pharmacognostic evaluation and antimicrobial activity of root of Careya arborea, Pharmacognosy Journal, 2019; 11: 608-612, doi: 10.5530/pj.2019.11.97.
20. Song E K, Cho H, Kim J S, Kim N Y, An N H, Kim J A Diarylheptanoids with free radical scavenging and hepatoprotective activity in vitro from Curcuma longa. Planta Med., 2001; 67: 876-7.
21. Jayaprakasha G K, Rao L J, Sakariah K K. Antioxidant activities of curcumin, demethoxycurcumin and bisdemethoxy. Food Chem., 2006; 98: 720-724.
22. Miller A L. Antioxidant flavonoids: Structure, function and clinical usage. Alt Med Rev., 1996; 1: 103-111.
23. Banerjee A, Nigam S S. Antifungal activity of the essential oil of Curcuma caesia Roxb. Indian J Med Res., 1976; 64: 1318-21.
24. Das S, Bordoloi P K, Phukan D, Singh S. Study of the anti-ulcerogenic activity of the ethanolic extracts of rhizome of Curcuma caesia against gastric ulcers in experimental animals. Asian J Pharm Clin Res, 2012; 5: 200-3.
25. Kaur R, Satija S, Kalsi V, Mehta M, Gupta P. Comparative study of analgesic and

antipyretic activity of Curcuma amada and Curcuma caesia Roxb. Rhizomes. Inventi Impact: Ethnopharmacology, Vol. 2011. [Last cited on 2013 Feb 20]; Available from: URL: http://www.inventi.in/Article/ep/441/11.aspx.

26. Gill R, Kalsi V, Singh A. Phytochemical investigation and evaluation of anthelmintic activity of Curcuma amada and Curcuma caesia a comparative study. Inventi Impact: Ethnopharmacology vol. 2011. [Last cited on 2013 Feb 20]; Available from: URL: http://www.inventi.in/Article/ep/412/11.aspx.
27. Karmakar I, Dolai N, Bala A, Haldar P K. Anxiolytic and CNS depressant activities of methanol extract of Curcuma caesia rhizomes. Pharmacologyonline, 2011; 2: 738-47.
28. Rajamma A G, Bai V, Nambisan B. Antioxidant and antibacterial activities of oleoresins isolated from nine Curcuma species. Phytopharmacology, 2012; 2: 312-7.
29. Paliwal P, Pancholi S S, Patel R K. Comparative evaluation of some plant extracts on bronchoconstriction in Experimental animals. AJPLS, 2011; 1: 52-7.
30. Chirangini P, Sharma GJ, Sinha S K. Sulfur free radical reactivity with curcumin as reference for evaluating antioxidant properties of medicinal Zingiberales. J EnvironPathol Toxicol Oncol, 2004; 23: 227-36.