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Review Article

Biological potential of an underutilized medicinal plant Kali Haldi (*Curcuma caesia* Roxb.) - A comprehensive review

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Curcuma caesia also known as black turmeric or Kali Haldi is an important medicinal herb of *Curcuma* genus with wide therapeutic applications. Although the common species of the genus i.e. *Curcuma longa* has been extensively investigated, *Curcuma caesia* remains an underexplored despite being endangered and medicinally important. The rhizomes and leaves of *C. caesia* are rich in various types of bioactive compounds like phenols, terpenoids, flavonoids and alkaloids with diverse array of medicinal properties such as anti-inflammatory, antibacterial, antifungal, analgesic and anticancer. Besides this, *C. caesia* has been found to be contain other bio components such as carbohydrates, amino acids phenols, glycosides, steroids tannins and saponins. The plant has also been used traditionally since ages to treat various ailments like fever, wounds, piles, asthma and other infections related to cough. The plant has also been proved to be effective against various types of cancer like breast cancer, colon cancer and lungs cancer. The present review is an effort to give an overview about the presence of various biologically active compounds, traditional uses and pharmacological potential which can be explored further for understanding the role of *C. caesia* in field of medicine.

Keywords: *anticancer, bioactive compounds, black turmeric, essential oil, pharmacological potential*

Introduction

Medicinal plants have been considered as an important source of various biologically active compounds, which are usually used in home remedies against various illnesses and ailments (Baghel et al., 2013). Plants have been used in the ayurvedic system of medicine and many rituals since ages. Different types of special metabolites are produced by plants which act as a natural defence against various types of diseases and ailments. These metabolites or bioactive compounds hold immense potential to be used in new drug discoveries (Ibrahim et al., 2023). Medicinal plants which have been used traditionally holds a significant role in naturally improving health and also in the development of new therapies with lesser side effects (Houghton,1995). The adaptive nature and compatibility of medicinal plants with the human body, resulting in fewer side effects, shows the significant role of medicinal plants in the field of healthcare (Rehman et al., 2021). The Zingiberaceae family, also known as the ginger family, includes a wide range of plants with various medicinal uses. *Curcuma* is a rhizomatous herb which belongs to the Zingiberaceae family, widely spread all over the world, with more than 70 species, and is cultivated in Western African, Asian, and Australian nations (Kaliyadasa & Samaransinghe, 2019). Most of the species of this genus possess high therapeutic potential that is utilized in treating a variety of diseases, including those of the spleen, stomach ulcers, liver enlargement, hepatic ailments, skin illness, cough, and chest pain. Curcuma genus harbour various bioactive compounds such as flavonoids, terpenes, phenolics, alkaloids and antioxidants that have multiple pharmacological activities (Rahman et al., 2020). *Curcuma caesia,* or Black turmeric, is an important medicinal herb of the genus *Curcuma*. The plant is traditionally used for treating various ailments. In the north-eastern

parts of India, the plant also holds spiritual significance and is valued for ethnomedicinal properties (Khuntia et al., 2023). The plant is an endangered herb which is used in modern and ayurvedic system of medicine and has both commercial and medicinal application (Hait et al., 2019; Benya et al., 2023). North America had the largest regional market for curcuma, while India was one of the top producers of the herb (Kaur et al., 2024). *C. caesia* contains essential oils due to which it possesses a strong aroma. Fresh rhizomes of the plant have camphoraceous odour due to the abundance of camphor compound present in them (Chauhan & Negi, 2023). Black turmeric is rich in various phytocompounds such as phenolics, curcuminoids, flavonoids, and essential amino acids which possess different biological activities like antimicrobial, antidiabetic, anti-inflammatory, anticancer and antioxidant. These bioactive compounds support their therapeutic value as well as their application in flavouring, fragrance and medications (Sharma et al., 2021)**.** Volatile oils of *C. caesia* have been found to contain camphor as a major constituent, accounting for 28.3% of the oil (Pandey & Chaudhary, 2003). Camphor has been considered an important bioactive compound to cure various life-threatening diseases like tuberculosis. The discovery of novel bioactive chemicals with effective anti-tuberculosis characteristics marks a significant step forward in the field of TB medication research. The development of novel ammonium salts generated from (+)-3-Bromocamphor-8-sulfonic acid revealed promising ability to battle drug-resistant strains of *Mycobacterium*, indicating a possible role in anti-tuberculosis treatment (Das et al., 2023). Black Turmeric, holds a unique cultural significance, particularly in regions like West Bengal, where its rhizome is used in the worship of the goddess Kali. This association has led to its popular Hindi name, Kali Haldi, despite the botanical term "*caesia*" suggesting a blue hue. Moreover, in the Mahabharata, Lord Krishna is depicted with blue skin, lending significance to the blue colour. Hence, the Hindi term "Krishna Kedara" also finds its roots in this association, reflecting the blue interior of the rhizome. As a result, the Ministry of Environment forbade the export of these species. The purpose of this regulation is to protect *C. caesia* and other endangered plants in the future (Behar et al., 2014)**.** The species has been considered critically endangered in Central India (Mishra, 2015).

1. Distribution

C. caesia has been found throughout Asia, including China, Nepal, Thailand, Malaysia, Bangladesh, and the north-eastern states of India. The plant has also been found in Bhutan (Orong et al., 2024). In India, it is distributed in north eastern regions and Papi Hills of East and West Godavari in Andhra Pradesh (Chande et al., 2023). It thrives especially in the states like Madhya Pradesh, West Bengal and Uttar Pradesh (Tamang, 2022).

2. Botanical Characteristics

Rhizome: Plant is perennial herb with blue coloured rhizome (Figure 1(D). Rhizome of *C. caesia* has 2 to 6 cm diameter and can be varying size and shape (Sharma et al., 2021). Blue colour of rhizome is variable depending upon the soil nature and age of the rhizome. Rhizome possesses strong smell and comprises nodal and internodal zones (Pathan et al., 2021). Rhizome surface has longitudinal creases (Samarasinghe et al., 2021). There is a strong camphor-like scent in fresh rhizomes, indicating the presence of camphor within the rhizome (Sarma & Deka, 2020).

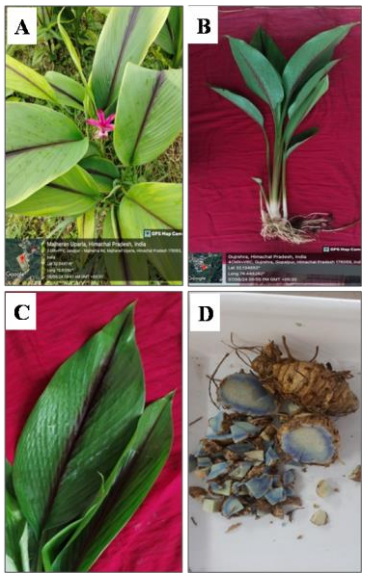

Figure 1. (A) *Curcuma caesia* growing under field condition, (B) Harvested plant (C) Plant leaves (D) Rhizome of the plant

Leaves: The leaves of *C. caesia* have rich violet patches that span the leaf surface and form clusters of 10–20 leaves. These patches are the characteristic features of the species. The veins are ivory in colour and have parallel venation (Borah et al.,2020)**.** The plant has elongated leaves (Kataki & Bhattacharjee, 2020)**.** Leaves have a violet patch along the midrib of the leaves, which is a chief identifying feature of this species (Das et al., 2012) (Figure 1(C).

Inflorescence: The lateral inflorescence measures 25-30 cm in length, with a peduncle spanning 12-18 cm. The spike measures 12-15 × 5 cm, and the coma bracts are large, ranging in colour from pink to violet, with streaks of green present in the lower ones. Flowers measure 4.5-5 cm (Figure 1(A). The calyx is 1 cm in length, truncate, with three lobes at the apex, and split on one side. The corolla tube measures 3-3.3 cm in length (Pathan & Vadnere, 2017).

3. Phytochemistry

The extract and essential oil of *C. caesia* rhizomes contains distinct phytoconstituents. Their distinct chemical compositions and varied functional activities are attributed to these molecules. Many bioactive substances, such as terpenes, amino acids, flavonoids, carbohydrates, alkaloids, tannins, steroids and glycosides are commonly found in rhizome extract. Conversely, volatile molecules including cineole, borneol, ocimene, turmerone, and curcumenone are the major components present in the oil (Das et al.,2012).

3.1 Rhizome extract

The plant extracts are concentrated forms of bioactive compounds found in rhizomes. Rhizomes are storage organs for plants containing nutrients and secondary metabolites. Extracts from rhizomes have been used for centuries in the traditional system of medicine and modern research. *C. caesia* extracts have been known to harbour a variety of bioactive compounds that are considered to possess anti-bacterial, anti-inflammatory and antioxidant properties. *C. caesia* methanolic extract has been proven effective against cancer. It can be used for the inhibition of the negative effects of cyclophosphamide (Devi & Mzumder, 2016). Other bioactive metabolites with varying biological activities are also present in the methanolic extract of *C. caesia*. Some of the prominent compounds such as α-Santalol, Retinal, and Ar-tumerone have been isolated in which α-Santalol emerges as the major constituent in the extract (Pakkirisamy et al., 2017). The ethanolic extracts of *C. caesia* rhizomes have shown their activity against clot dissolution. Maximal thrombolytic activity has been observed when an *in vitro* thrombolytic model was used for the evaluation of clot lysis effect of ethanolic extracts (Fathima et al., 2015). Studies have been conducted where Supercritical Fluid Extraction of rhizome powder under various pressures and temperatures showed that the extraction carried out at 50°C and 15 MPa yields the most effective extract with highest antimycobacterial activity against *Mycobacterium smegmatis* strains (Chaturvedi et al., 2020).

3.2 Volatile composition

Essential oils are valued for their fragrance and medicinal potential and have been used in phytopharmaceutical industries since ages. They have been also utilized in conventional medicine. Due to its therapeutic properties and traditional medicinal usages, the essential oils of *C. caesia* have attracted attention recently. The essential oils obtained from the leaves and rhizome of *C. caesia* possess wide range of bioactive compounds having significant biological properties. Some of the major phytocompounds including β-elemene, 1,8-cineole, camphor, curcumene, eucalyptol, curzerenone, and ar-turmerone present in rhizome have been illustrated (Figure 2) (Pandey & Chowdhary, 2003; Borah et al., 2019). These phytocompounds enhances the antibacterial, anti-inflammatory, and antioxidant activities of essential oils apart from its little genotoxicity (Paw et al., 2020).

The compounds present in essential oil show a wide range of biological activity. The high concentration of Phenols, flavonoids, anthraquinones, tannins, saponins, and carotenoids highlights its important function in preventing cancer and promoting the repair of cell mutations (Dewangan et al., 2014). Mukunthan et al. (2014) reported 35 volatile components including tropolone (15.86% of the oil), ledol, β-elemenone, α-bulnesene, borneol, α-terpineol, eucalyptol and caryophyllene. These compounds have been used in various herbal industries for preparation of medicine and perfumes. The *C. caesia* also contains two main constituents i.e., camphor and 1,8-cineole (also known as Eucalyptol). Another constituent Epicurzerenone present in an amount of 19.62%. The representative chemical structures of some of the major compounds present in *C. caesia* have been depicted (Figure 3).

Among all compounds, camphor imparts aroma and medicinal properties to the essential oil (Paw et al.,2020). *In silico* studies have showed that the volatile oil of *C. caesia* possess antioxidant and antimicrobial activities against *Staphylococcus aureus*. Molecular docking analysis also revealed the interaction potential of essential oil compounds with

the major proteins responsible for the action of bacterial, fungal, and oxidative stress (Khuntia et al., 2023). Kanglom et al. (2024) also reported that the essential oil of rhizomes contains high phenolic content and possesses strong antioxidant and antibacterial activity against *Vibrio cholerae*. These findings reflect *C. caesia* as promising source of natural bioactive compounds for therapeutic applications. Besides rhizomes, the leaves of *C. caesia* also hold aromatic compounds with intense bioactive activities. The leaves oil has been found to be active against three MDR strains, *Escherichia coli, Acinetobacter baumanii* and *Klebsiella pneumoniae*, however, the maximum antibacterial activity against *Acinetobacter baumannii* showed by rhizomes (Tanesib et al., 2023).

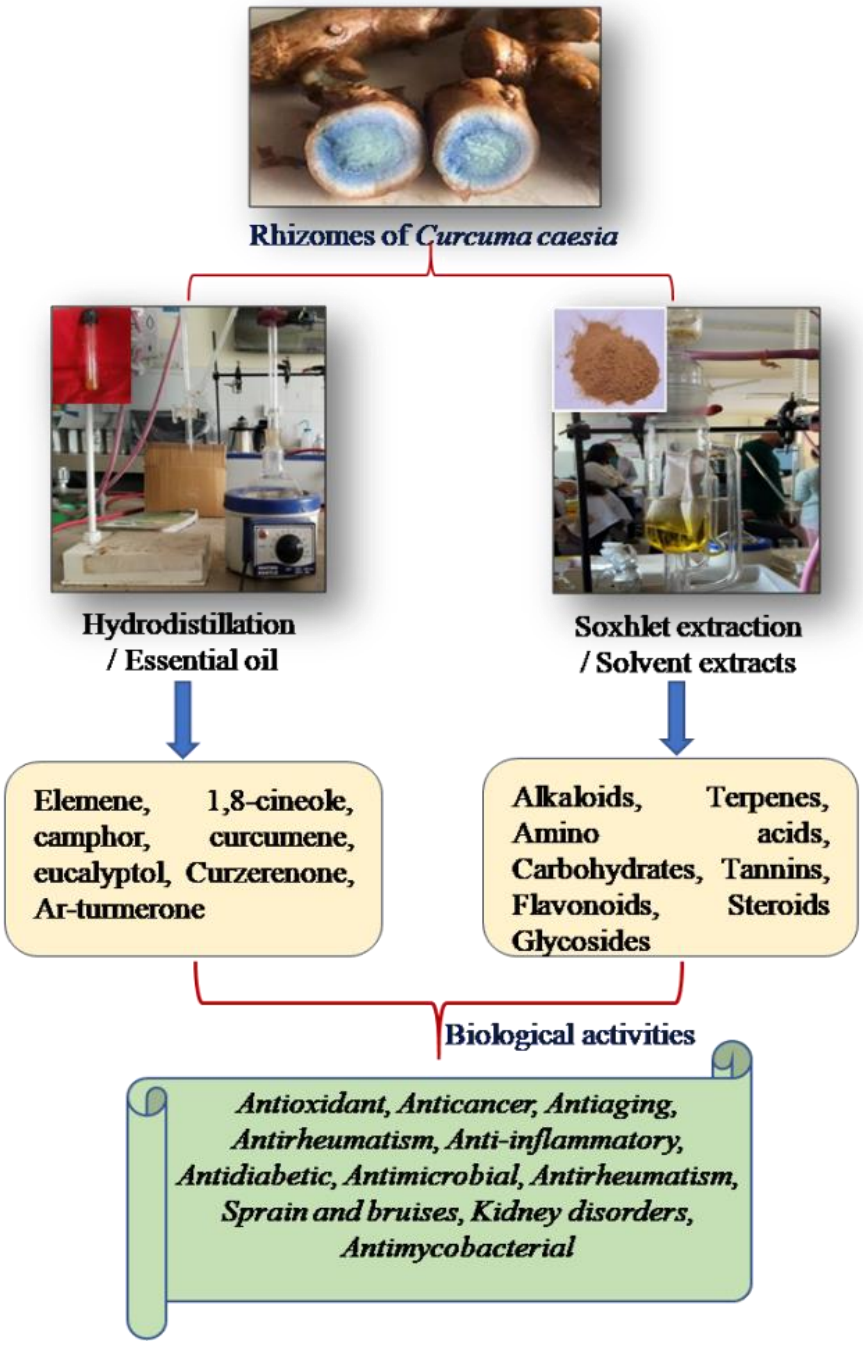

Figure 2. Phytochemicals present in *C.caesia* and their Bioactivities

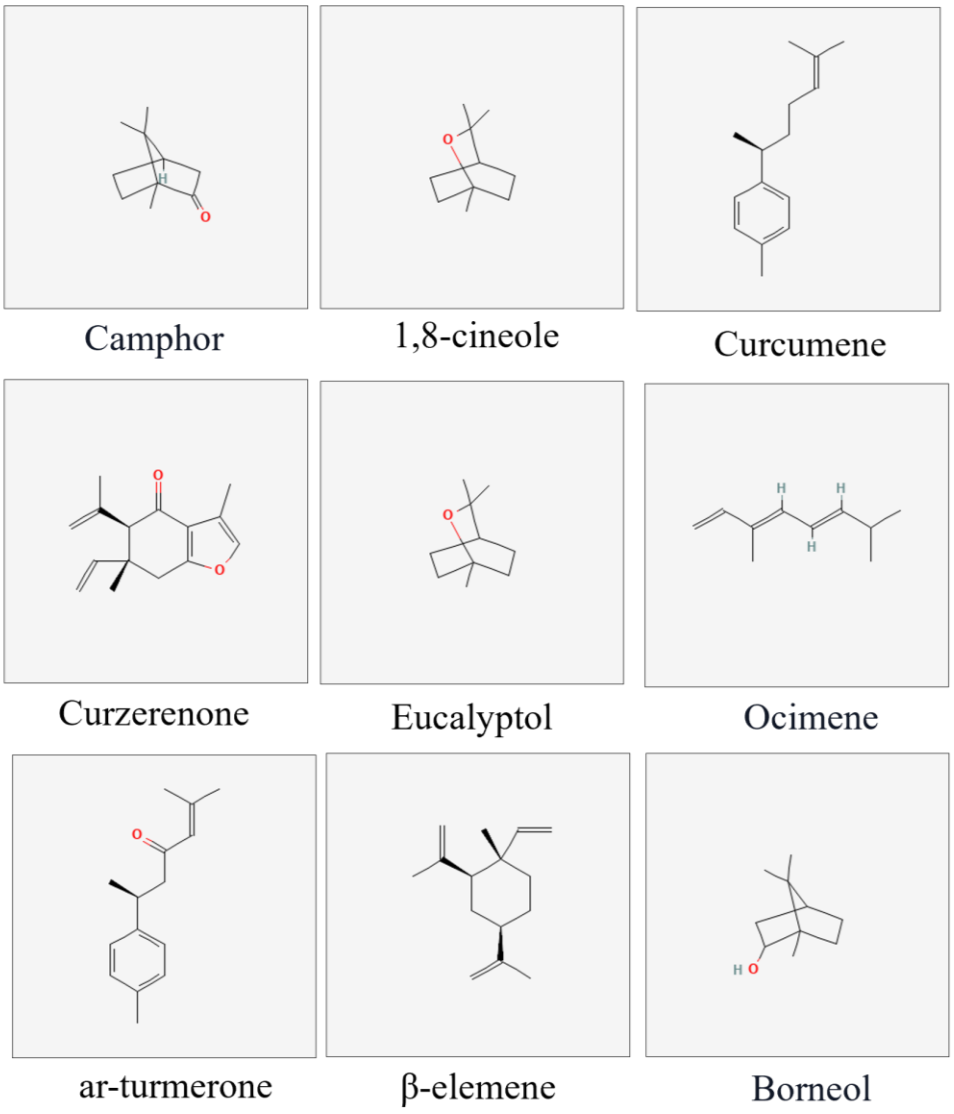

Figure 3. Structures of some major compounds present in rhizome of *C. caesia* (Source: PubChem)

4. Ethnobotanical uses

The versatile medicinal properties of *C. caesia* plays an important role for its potential utility in various therapeutic applications ranging from the treatment of mild skin conditions like acne to the fight against more severe illnesses such as cancer (Figure 4). It has also proven to be hepatoprotective, neuroprotective, nephroprotective and a potential anti-cancerous agent (Elhawary et al.,2024). Different plant extracts are used to treat different illnesses in the traditional medicinal system. The folk remedies utilized in various parts of the world serve as the foundation for the use of medicinal plants as medications (Behar et al., 2014). In the North-Eastern and Central India, the dried rhizome and leaves of *C. caesia* are used to cure many conditions like piles, cancer, leprosy, asthma, allergies, wounds and toothaches. *C.caesia* rhizome have been used for wounds, pox, and tumours in Asia (Venugopal et al.,2017). In north-eastern parts of India, it is used to keep evil spirits away and is also used in tantrik sadhana. Curcuma leaves are also used to stimulate rice seed germination (Mahato & Sharma, 2018). Kali haldi powder is used by various tribal communities in the Indian state of West Bengal's Nadia district for curing a range of ailments, such as jaundice and other diseases of the liver, allergies, diarrhoea, chronic cough, heartburn, wind, and flatulence. It has been used to reduce swelling and inflammation due to sprains, cuts, and bruises (Ghosh et al., 2013). The powdered form is used orally with water for stomach ache and bloating (Dewangan et al., 2014).

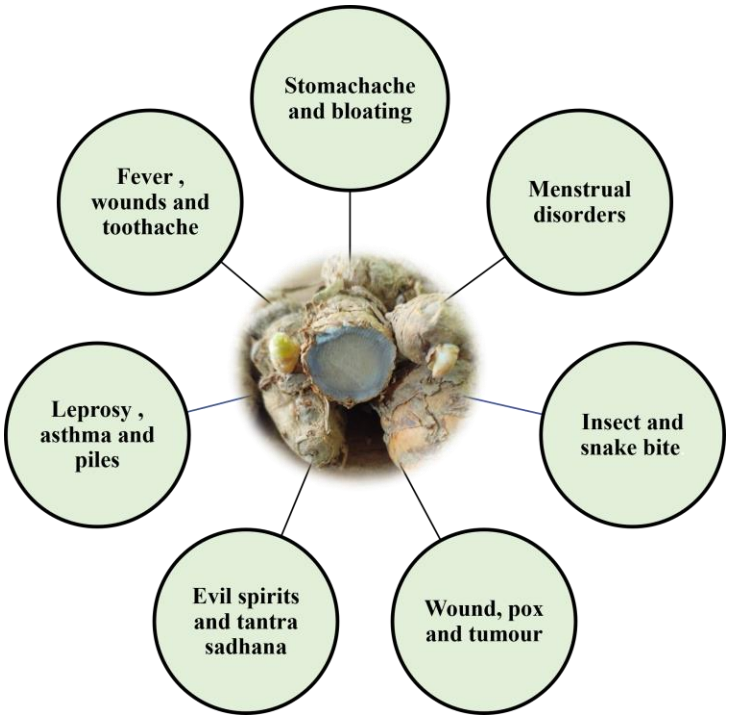

Figure 4. Traditional uses of *C. caesia*

5. Pharmacological Properties

The *C.caesia* contains a variety of natural compounds that are responsible for its significant biological potential (Table 1).

Table 1. Some of the pharmacological properties of *C. caesia*

S.No.	Phytochemical	Chemical type	Pharmacological properties	References
1	Zingiberene	Terpenoid	Antioxidant, Antimicrobial	Venugopal et al., 2017
2	Turmerone	Sesquiterpenoid	Antimicrobial	Venugopal et al., 2017; Tungmunnithum et al., 2018
3	Germacrone	Sesquiterpenoid	Anticancer, Antimicrobial	Munda et al., 2018
4	Phenolic acids	Phenolic compounds	Antioxidant, Anti-inflammatory	Tungumunnitham et al.,2018
5	Curcumin	Curcuminoid	Antioxidant, Anti-inflammatory	Mandal et al., 2020

5.1. Antimicrobial activity

The flavonoids and polyphenolic compounds present in *C. caesia* might interact with bacterial cell walls and inhibit microbial growth, leading to its antibacterial action. Acetone extract of the plant has been found to be most effective against Gram-positive bacteria (Karmakar et al., 2011). It is preventive against different strains of bacteria, as well as the fungal infection caused by various fungi. The methanolic extract has also been found to exhibit bactericidal and fungicidal activity. A study was conducted for the evaluation of antifungal activity of a mixture of the extracts of *Zingiber officinale* and *Curcuma caesia*. The mixture extract at 80% concentration showed significant antifungal activity which revealed that the extract is able to strongly inhibit the growth of fungal pathogens and thus has great potential to be a natural antifungal agent (Juariah et al., 2024). *C. amada* and *C. caesia* extracts mixture has also been found to be inhibitory against Gram-positive and Gram-negative bacteria. Antifungal activity of *C. caesia* ethanol extracts was highest against *Candida albicans*, whereas *C. Caesia* dichloromethane extract was most effective against *Aspergillus fumigatus* (Kaur et al., 2018). Moreover, the essential oils from the *C. caesia* exhibited effectiveness against some microbes e.g. *Salmonella typhi, E.*

coli, Shigella, and Aspergillus niger. The oil has moderate to strong inhibitory activity against different microbes (Garg & Jain, 1998).

5.2. Antihelminthic activity

The extracts of *Curcuma amada and Curcuma caesia* have been found to possess anthelmintic activity against earthworms. Ethanol extracts of both species, particularly *Curcuma caesia*, were highly effective in paralyzing and killing earthworms and can be used as natural anti-helminthics (Randeep et al., 2011). Apart from its reported vermicompost activity, *C. caesia* also possesses vermifuge efficacy. Ethanolic and chloroform extracts of *C. caesia* exhibited vermifuge activity at a faster rate compared to that of the standard drug albendazole, exhibiting high efficacy in inducing earthworm death and paralysis (Chadalavada & Budala, 2017). The ethyl acetate extract of *C. caesia* rhizome possesses potent *in vitro* anthelmintic activity against Indian earthworms (*Pheretima posthuma*). The extract paralysed and killed the worms in a dose-dependent fashion; at 75 mg/ml, the shortest time of paralysis (30.86 min) was observed. Based on these findings, *C. caesia* could possess anthelmintic properties that are promising and comparable to albendazole, the study's reference drug (Karim et al., 2017)

5.3. Analgesic activity

The analgesic properties of methanolic extract of *C.caesia* (MECC) at dosages of 100, 200, and 400 mg/kg body weight were assessed in animal models. The analgesic activity in Swiss albino mice was evaluated by hot plate test and acetic acid-induced writhing model, that reveals positive findings in pain relief. These studies suggest that MECC may be a natural analgesic drug. *C.caesia* have also been employed as an analgesic cream to alleviate pain (Sawant et al., 2014).

5.4. Antiulcerogenic activity

The ethanolic extract of *C. caesia* contains a considerable level of antiulcer activity in rats. The extract exhibits anti-ulcer activity as indicated by the reduction in ulcer index, pepsin activity, acidity content, and gastric juice volume in the extract-treated groups. It was found to release gastric mucus, indicating that it possesses gastroprotective activity (Das et al., 2012).

5.5. Antiplasmodial activity

The ethyl acetate extracts of *C. caesia* showed intense anti-plasmodial activity against malaria strains. β-Selinenol was identified by docking analysis as a potential active compound (Chaturvedi et al., 2020). *C. caesia* has a potential in the development of anti-malarial drugs. Intense parasitaemia inhibition was displayed by ethanolic extracts of *C. caesia* against chloroquine-resistant *P. vivax*, with percentages varying between 5.8% to 75.6%. When the anti-malarial effect of *C. caesia* was also compared to a control chloroquine dose, it showed complete parasitaemia inhibition at both low and control doses of chloroquine (Donipati et al., 2023).

5.6. Antimycobacterial activity

The isolation and identification of new compound, (+)-3-Bromocamphor-8-sulfonic acid ammonium salts from the rhizomes highlights the potential of *C.caesia* to be used against drug-resistant Mycobacterium TB strains. Lipinski's rule of five is satisfied by these compounds, which suggests that they would be good candidates for future therapeutic applications against tuberculosis (Das et al., 2023).

5.7. Antidiabetic activity

C. caesia has been reported to be effective against hyperglycemic conditions. The extracts of *C.caesia* inhibits the α-amylase enzyme that is a major enzyme involved in glucose metabolism. The efficiency of extracts was further enhanced by drying them at various optimised temperatures such as 50°C and 60°C (Junaidi et al.,2024). The ability of *C. caesia* to control diabetic complications such as neuropathy has been studied. Reports are available where the anti-inflammatory properties of the plant prevent nerve inflammation, and its antioxidant activity lowers the oxidative stress, a primary contributor to diabetes-related issues. The methanol extract of *C. caesia* rhizome significantly lowers streptozotocin-induced diabetes in Wistar rats by improving the body's natural antioxidant defence system (Majumder et al.,2017). *C. caesia* also showed the greatest inhibition rate ($97.72 \pm 0.28\%$) in the α-amylase inhibition assay in comparison to the other species (*Curcuma aromatica* and *Curcuma longa*), suggesting strong antidiabetic action (Jain et al., 2017).

5.8. Anti-Rheumatoid Arthritis Activity

Network pharmacology studies showed the potential of phytocompounds present in *C. caesia* for the treatment of Rheumatoid Arthritis. Important target genes that have been identified as key nodes during *in silico* studies include NFKB1, PRKCA, RAC1, STAT3, TLR4, CDC42 and CDK4 (Pati et al., 2025)

5.9. Anti-aging activity

C. caesia rhizome extract has shown a protective role against UVB-induced apoptosis using HaCaT cells. The plant was able to mitigate oxidative stress. Results showed a considerable decrease in mitochondrial superoxide anion levels, suggesting increased cellular resistance to oxidative stress (Burattini et al*.,* 2025)

5.10. Antioxidant activity

The extract and volatile oil of *C. caesia* contain a broad spectrum of phytocompounds possess antioxidant properties. The qualitative analysis through phytochemical screening confirms the presence of active antioxidant compounds in the methanolic and ethanolic extracts. These extracts show free radical scavenging activity suggesting that black turmeric extract could potentially be utilised as a source of natural antioxidants (Adrianta & Wardani, 2022). *C. caesia* alleviates oxidative stress, which is caused by free radicals or reactive oxygen species (ROS). Nag et al. (2021) studied the antioxidant and anti-genotoxic properties of the plant rhizomes *in vitro* against oxidative stress in human peripheral blood lymphocytes caused by methyl methane sulfonate and H_2O_2. The rhizome extracts of *C. caesia* when compared with *C. amada* for their antioxidant activities, showed increased activity which might be due to the presence of higher amounts of phenolics and flavonoids and free hydroxyl substitutions in *C.caesia* (Krishnaraj et al*.,* 2010). Methanolic extract of *C. caesia* also possesses anticancerous and antioxidant activities (Karmakar et al., 2011).

5.11. Anti-cancerous potential of *Curcuma caesia*

Cancer remained a major cause of death worldwide in 2020. Globally, there were 10 million cancer-related fatalities or nearly one death every six. Prostate, colon, lung, breast, and rectal cancers are the most common forms (https://www.who.int/en/news-room/fact-sheets/detail/cancer). Both conventional medicine and complementary approaches acknowledge the importance of traditional medicinal herbs in the cancer management. More than 60% of currently available anticancer medicines are derived from natural sources, highlights the increased use of plant-based compounds in modern cancer treatment (Mukunthan et al., 2017). Strong anti-microbial, anti-mutagenic, anticancer, antioxidant, and antibacterial properties make Kali haldi as an excellent choice for wound and tissue repair (Bohra et al.,2023). In order to combat the cancer globally, the utilization of medicinal plants has been promoted. Earlier studies revealed that the plant derived compounds can help to block or activate the signalling pathways that cause cancer cells to proliferate (Asim et al.,2023). Ethanolic extract of *C. caesia* rhizome and cucurzederone, one of its main constituents, has been observed to be effective against Ehrlich ascites carcinoma and the triple negative breast cancer *in vivo* (Das et al., 2024). Various studies on cancer cell lines have revealed the potential of *C. caesia* as a promising candidate for anticancer therapy (Table 2). Extensive research has been conducted about the anticancer properties of *C.caesia,* demonstrating its potential effectiveness against different type of cancer e.g., Breast cancer, Lung cancer, Colon cancer and Liver cancer. In lung cancer, the protein CFLAR (CASP8 and FADD-like apoptosis regulator) is often overexpressed, however, the compounds such as tau-cadinol and delta-cadinene present in *C.caesia* shows promising results as powerful inhibitors of the disease spread (Tripathy, 2022). The overexpression of the protein CFLAR has been reported to have a strong physiological association with lung cancer.

Cell viability assay studies revealed that the hexane and chloroform fractions of the plant extract have significant effects on human breast cancer cell lines, particularly MCF-7 and MDA-MB-231 cells. In scratch and Transwell migration experiments, cucurzederone significantly inhibited MDA-MB-231 cell migration. These results highlight the potential of curcuzederone as a medicinal drug in breast cancer management (Amin et al., 2021). The molecular mechanism by which *C. caesia* acts against cancer is not yet fully understood. However, studies have suggested several potential mechanisms. One proposed mechanism through which the plant kills cancer cells is the inhibition of cancer cell proliferation and induction of apoptosis (programmed cell death) (Figure 5). These effects may occur through modulation of various molecular pathways involved in cell cycle regulation, apoptosis signalling, and inflammation. The hexane extract of rhizome demonstrated strong anti-cancer action, especially against HepG2 cells. Mechanistic investigations demonstrated that the mitochondrial-mediated intrinsic mechanism of PCD is responsible for HRE-induced G2/M cell cycle arrest and apoptosis. Twenty molecules with significant binding affinities to Tubulin and the Epidermal Growth Factor Receptor (EGFR) were found in HRE by GC-MS analysis. These results offer important insights into the toxicity mechanisms of HRE, directing future efforts in medication discovery targeted at slowing the spread of cancer (Mukunthan et al., 2017).

Table 2. Anti-cancerous activity of *C. caesia with* different solvents

S.No.	Extract used	Cell line /Carcinogen used	Findings	Reference
1	Methanol	EAC cell line	On the EAC cell line, MECC demonstrated direct cytotoxicity (IC50 90.70 8.37 mg/mL). In EAC-treated mice, MECC significantly reduced tumor weight, viable cell count, and percentage while increasing the longevity (57.14 and 88.09%)	Karmakar et al.,2013
2	Methanol	Diethylnitrosamine (DEN)	The delivery of DEN (hepatocellular carcinogen) increased the activities of AST, ALT, ALP, and AChE. The elevated activity of these marker enzymes were diminished by the *Curcuma caesia* extract. In mice treated with CC or AT, the activity of antioxidant enzymes, which had been severely reduced after DEN treatment, were significantly enhanced	Hadem et al.,2015
3	Methanol	Cyclophosphamide	Protective effects against the liver and kidney. By preventing the production of micronuclei, *Curcuma caesia* inhibits the toxicity of cyclophosphosphamide, in bone marrow cells. It also protects the hepatotoxicity and nephrotoxicity	Devi & Mazumder, 2016
4	Hexane Rhizome extract	HepG2	HepG2 cell proliferation was inhibited with a very low IC_{50} value, S and G2/M phase cell cycle arrest and caspase 3-mediated apoptosis	Mukunthan et al.,2017
5	Hexane and Chloroform	MCF-7 and MDA-MB 231	Key bioactive compound i.e. Curcuzederone showed inhibitory effect on the migration of MDA-MB 231	Amin et al.,2021
6	Ethanol	HT-29 Cells	Silver nanoparticles prepared from rhizome extract rescued the viability of HT-29 cells (Human colon cancer cell line)	Jain et al.,2023
7	Hexane and Methanol	HEK293T	Rhizome fractions i.e. 3,4-dihydrocoumarin, exhibited anticancer activity by modulating PI3K/Akt pathway	Parida et al.,2025

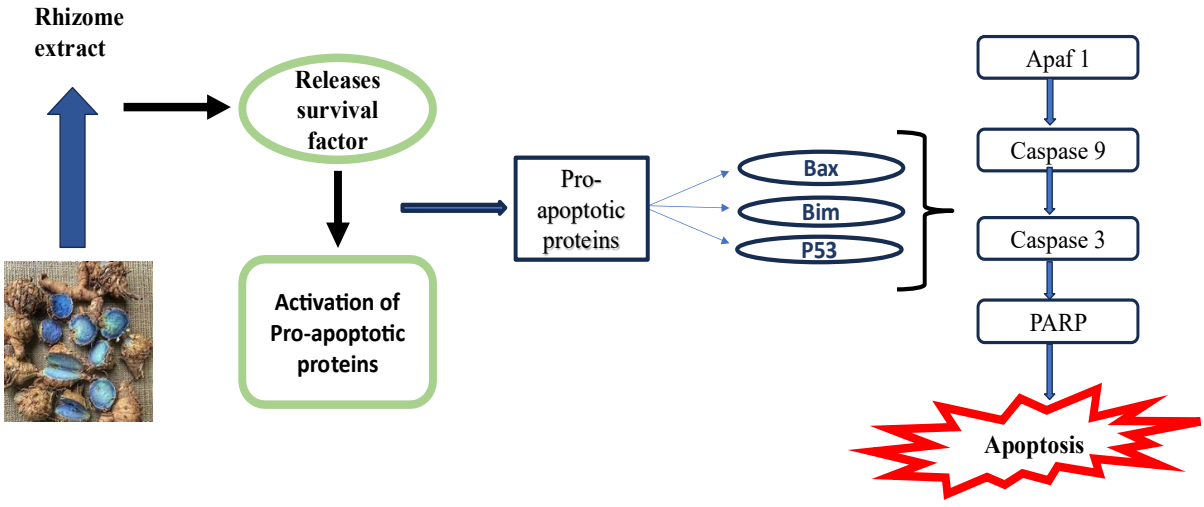

Figure 5. Anti-cancerous effect of *C. caesia*

Conclusion

Medicinal plants are known to have wide medicinal properties used for the treatment of various disorders. *C. caesia* has not been explored fully in comparison to other species of genus Curcuma. Several studies confirm the presence of important bioactive compounds in the rhizome and leaves of *C.caesia* that have therapeutic applications. Owing to the presence of biologically active phytocompounds and health benefits, the *C. caesia* is gaining the importance among the researchers and pharmaceutical industries. The isolation and identification of bioactive phytocompounds in *C. caesia* supports its possible application in the treatment of cancer by inhibiting the cancer cell growth and inducing apoptosis. However, much more research is required to thoroughly understand the extent of its capabilities in the management of different types of cancers. The nutraceutical and medicinal potential of secondary metabolites present in Kali Haldi can be further evaluated using alternative biotechnological approaches which would be helpful for the mankind in the treatment of various ailments.

Author contributions

Munish Sharma suggested the idea and designed the study. Shilpi has collected the information. Shilpi and Deepika B. Prashar were involved in draft preparation for the review. The final editing and supervision was done by Munish Sharma.

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Conflict of interest

The author declares no conflict of interest. The manuscript has not been submitted for publication in other journal.

Ethics approval

Not applicable.

AI tool usage declaration

The authors have not used AI and its related tools to write this manuscript.

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