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Kali Haldi, an ethnomedicinal plant of Jharkhand state- A review

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Curcuma caesia Roxb. is a perennial, erect rhizomatous herb with large leaves, commonly known as *kali haldi.* It belongs to the family Zingiberaceae. It is a multipurpose medicinal plant widely used in the traditional system of medicine, mainly fresh and dried rhizomes, in treating leucoderma, asthma, tumours, piles, bronchitis, bruises, snack bites, etc. The plant is reported to contain camphor, ar-turmerone, (Z)-ocimene, ar-curcumene, 1, 8-cineole, elemene, borneol, bornyl acetate and curcumin as the major constituents. The plant has been scientifically reported to have antifungal, antimicrobial, antioxidant and anti-asthmatic activities. Other medicinal properties are muscle relaxant, analgesic, locomotor depressant, anticonvulsant and anti-inflammatory. It is now considered as one of the potential sources of unique natural products for the development of medicines. In the present review article various established facts related to the plant *Curcuma caesia* have been compiled so that proper scientific methods can be initiated to validate its traditional uses and open the door for a source of potential drugs in near future.

Keywords: *Curcuma caesia*, Ethnomedicinal, Antioxidant, Phytochemistry, Curcumin

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Curcuma caesia Roxb. is a kind of turmeric with bluish-black rhizome, belonging to same family as *Curcuma longa,* i.e., Zingiberaceae (ginger family). In West Bengal, the rhizome of the plant is used in *Kali Puja*, and hence the plant is called *Kali haldi*. By etymology, *Kali* is the feminine form of *Kala*, which means black color and hence the plant is termed as black turmeric in English. This species has been regarded as endangered by the central forest department of India due to biopiracy. It is a perennial herb, grows to a height of 3-5 feet[1] (Fig. 1). It has deep violet patch on the leaf which runs throughout the lamina. Usually, the upper side of the leaf is rough, velvety but this character may vary. Flowering bracts are green with a ferruginous tinge. Flower petals may be deep pink or red in colour. The rhizomes of the plant are aromatic in nature. It has bitter, hot taste with pungent smell. The inner part of the rhizome is bluish-black in colour (Fig. 2) and emits a characteristic sweet smell, due to presence of essential oil[2]. The plant has its origin from India and South-East Asia, thrives well in moist deciduous forest areas in clayey soil. In India it is found in West Bengal, Madhya Pradesh, Orissa, Chhattisgarh, Jharkhand and Uttar Pradesh[3].

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Curcuma caesia (CC) is known by different vernacular names in India, Hindi: *Kali Haldi*; Manipuri: *Yaingang Amuba or Yaimu;* Marathi: *Kala-haldi*; Telugu: *Nalla Pasupu;* Bengali: *Kala haldi*; Mizo: *Aihang* or *Ailaihan*; Assamese: *kala haladhi*; Malayalam: *Kari manjal*; Sanskrit: *Rajani Nishaa* or *Nishi* or *Ratri*[4].

Rhizomes of the plant are used in folk medicine for the treatment of ulcer, leucoderma, asthma, tumours, piles, bronchitis, etc.[5] Pharmacologically it is reported for anticancer, antifungal, antibacterial, antioxidant, antiulcer and neuropharmacological activities. Phytochemically the rhizome extracts contains several alkanes, alkaloids, fatty acids, essential oils, flavonoids, phenolics, saponin and tannins. No doubt the plant is an important medicinal plant used by folk people for various ailments, it is considered very auspicious in Chhattisgarh and Madhya Pradesh, as they believe that, person who posses it will never have shortage of food[6]. Northern tribes use Black Turmeric as a *talisman* to keep the evil spirits away. In some parts of the country it is used in *Tantrik Sadhana*.

The traditional use of *Curcuma caesia* leaves by farmers to stimulate rice seed germination[7]. The dried leaves are also used as a source for fuel.

Fig. 1 — Plant of *Curcuma caesia* Roxb.

Fig. 2 — Tuberous Rhizome (transverse cut) of *Curcuma caesia* Roxb.

Traditional and folk values

It is believed that the drug of natural origin shall play an important role in healthcare particularly in rural areas of India. Medicinal plants typically contain mixtures of different chemical compounds that may act individually, additively, or in synergy to improve health.

Traditionally, the rhizomes of *Curcuma caesia* are used in treating leprosy, cancer, wounds, impotency, fertility, toothache, vomiting, allergies, leucoderma, asthma, tumours, piles, bronchitis, enlargement of the spleen, epileptic, menstrual disorder, smooth muscle relaxant activity, anthelmintic, aphrodisiac, gonorrheal discharges, abnormalities of the uterus after birth, rubefacient[5], etc. The paste is applied on bruises, contusions and rheumatic arthritis pain in Manipur[8]. In Arunachal Pradesh, *Adi* tribes use decoction of fresh rhizome as anti-diarrhoetic[9]. The *Khamti* tribe of Lohit district of Assam applied the paste of fresh rhizome in case of snake and scorpion bite[10]. In Assam fresh rhizome juice mixed with mustard oil is given once daily on empty stomach for 2-3 days in dysentery. It is also applied to gout[11]. The *Chothe* tribe of Manipur uses rhizome of *Curcuma caesia* in wound, pox & tumour[12]. Various tribes of Chhattisgarh using the fresh rhizomes of *Kali Haldi* in skin diseases by grinding the fresh rhizomes and put on affected area. It is also applied by mixed with Neem oil[13]. In road side market of Haridwar, *kali haldi* is sold by herbal healers for the treatment of cough and cold in children[14].

Phytochemistry

Phytochemical screening of n-hexane, petroleum ether (60:80), benzene, chloroform, ethyl acetate, methanol, and water extract of rhizome *Curcuma caesia* revealed the presence of alkaloids, phenols, phytosterols, terpenoids, carbohydrates, tannins, glycosides, saponins, quinones, amino acids, oils and flavonoids[15,16].

Curcuma caesia contains 97.48 % oil, with camphor (28.3 %), ar-tumerone (12.3 %), (Z)-Ocimine (8.2 %), 1-ar-curcumene (6.8 %), 1, 8-cineole (5.3 %), element (4.8 %), borneol (4.4 %), bornyl acetate (3.3 %) and curcumene (2.82 %) as the major constituents. Rastogi *et al*. reported linalool as the major component comprising 20.42 % followed by ocimine (15.66 %), 1- ar-curcumene (14.84 %), zingiberol (12.60), 1, 8-cineole (9.06 %), and borneol (7.4 %) as major constituents[17,18].

Pharmacological profiles

Traditionally, *Curcuma caesia* possesses a wide range of anti-inflammatory activities. Its pharmacological study shows, bioactive components of its rhizomes, such as curcuminoids are responsible for anti-oxidative and anti-inflammatory properties, wound healing, hypoglycemia, anti-coagulant, anti-microbial activities and it also exhibit free radical scavenging property[19-21]. Phytochemicals of *Curcuma caesia* shows potent antitumor properties[22]. Its chemopreventive potential has the potential of protecting endogenous enzymatic and non-enzymatic antioxidant activity[23].

1. Anti-cancer activity

In phytochemical screening of MECC found the steroids, tannins, saponins, volatile oil, proteins alkaloids and flavonoids, which possess potent antitumor properties. This is presumably potentiated by its direct cytotoxic effect and antioxidant property. It was assumed that attenuation of oxidative stress in different tissues in Ehrlich ascites Carcinoma (EAC) bearing mice decreased the viability of EAC cells. Phytochemical findings suggest that the MECC exhibits potential antitumor and antioxidant activities which enlighten a novel source of phytomedicines in free radical and tumour biology[22].

Diethylnitrosamine (DEN) is a well known hepatocarcinogen (HCC) normally used to induce liver cancer in animal models. The chemopreventive potential of CC against DEN induced HCC by enhancing antioxidant status through free radical scavenging mechanism and having potential of protecting endogenous enzymatic and non-enzymatic antioxidant activity[23,24].

2. Antifungal activity

Rhizomes of *Curcuma caesia* possessed antifungal activity. Essential oils extracted from the rhizomes were tested for antifungal activity against several human and plant pathogenic fungi. Dilutions of the oil in ethylene glycol were tested by an agar diffusion procedure on plates seeded with the test isolates. Some antifungal effect was noted[25]. The antimicrobial activity of ethanolic extract of CC was due to the presence of various type of curcumoid like substrate, which is confirmed by the TLC[26]. "(Z)-7-methoxy-1, 5-dihydrobenzo[c] oxepine" is a terpenoid, isolated from CC shows antifungal as well as antibacterial activities against some major plant pathogenic microbes[27].

3. Antibacterial activity

Antibacterial activity was determined against *Bacillus subtilis*, *Staphylococcus aureus* and *E. coli*. The results showed that total phenolic content in the oils ranged from 4 – 83 µg gallic acid equivalents (GAE)/µL oil. Oils from *C. caesia* exhibited maximum antibacterial activity against *B. Subtilis*[28]. The methanol root extracts exhibited significant antibacterial activity against gram positive and chloroform root extracts against gram negative bacterial species except for *P. aeruginosa*. These findings reveal that the plant based antimicrobials have enormous therapeutic potentials and can serve the purpose with lesser side effects that are often associated with synthetic antimicrobials[29]. Most of the *Curcuma* species are used in traditional medicine for their bactericidal and anti-inflammatory properties. Many are underutilized and among them CC have a tremendous scope for utilization of their essential oils as pharmaceutical and food additives[28].

4. Antioxidant activity

An antioxidant is a molecule stable enough to donate an electron to a rampaging free radical and neutralize it, thus reducing its capacity to damage. These antioxidants delay or inhibit cellular damage mainly through their free radical scavenging property[30]. The body can not manufacture these micronutrient antioxidants, so they must be supplied in the diet. When CC was evaluated for their antioxidant properties through sulphur free radical activity with curcumin as reference indicator, it shows significantly decreases the depletion of pure curcumin sample, which indicates that this crude extracts possessed antioxidant properties[31]. The extract showed significant antioxidant activities in a dose dependent manner. The IC_{50} values for scavenging of free radicals were 94.03±0.67 µg/mL, 155.59±3.03 µg/mL, 68.10±1.24 µg/mL, 21.07±1.78 µg/mL, 260.56±12.65 µg/mL and 33.33±0.52 µg/mL for DPPH, nitric oxide, superoxide, hydroxyl, peroxynitrite and hypochlorous acid, respectively. Therefore, it is concluded that the methanol extract of CC rhizome is a potential source of natural antioxidant[32]. Presence of potent antioxidant activity in CC, probably derived from compounds such as flavonoids, phenols and sterols[33].

5. Antiulcer activity

The treatment of rats with ethanolic extract of *Curcuma caesia* produce a significant reduction of ulcer index, gastric acid volume, pepsin, free and total acidity along with increased production of gastric mucus. The LD_{50} value of the ethanolic extract of CC was found to be more than 2000 mg/kg[34]. It shows the ethanolic extract of the plant exhibited anti-ulcer activity.

6. Neuropharmacological activity

The neuropharmacological effect of CC has been examined through experimental demonstration in rodent model. It possessed promising analgesic, locomotor depressant, anticonvulsant and muscle relaxant effects. In rodent model demonstration, the MECC showed significant ($p < 0.001$) inhibition of writhes, at both test doses as compared with control group in a dose dependent manner. The mean writhing score during 30 min observation period in the control group was 59.68 ± 4.63. MECC at the both doses exhibited significant ($p < 0.001$, after 30 and 60 min) increase in reaction time of mice but the effects were not dose dependent. Peak analgesic effect was observed at 60 min indicating maximum increase in reaction times. In locomotor activity study, it was found that MECC significantly ($p < 0.001$) depressed the locomotor activity in mice in a dose dependent fashion. The MECC pre-treatment exhibited significant ($p < 0.001$) and dose dependent protection from PTZ-induced convulsions in mice by delaying the onset of convulsions and recovering the animals

leading to survival. In muscle relaxant study, the MECC significantly ($p < 0.001$) and dose dependently decreased the fall off time in mice demonstrating its muscle relaxant property. This study corroborates the traditional uses of CC rhizome in the management of pain, fever and epilepsy[35].

In sisco study

All the proteins of *Curcuma caesia* showed instability index smaller than 40, which indicates that the proteins are stable. Secondary structure prediction of CC proteins by SOPMA revealed that α – helix, random coil, β – turn and extended strand were more prevalent. In chalcone synthase (CHS2, 1), maturase K, acetyl CoA carboxylase-D α – helix predominates, whereas in RNA polymerase – C, B, ribulose-1,5-bisphosphate carboxylase/oxygenase, Psb K and Psb A random coil region was frequent. In Atp – F, extended strand dominates followed by random coil and α – helix. The secondary structure were predicted by using default parameters (Window width: 17, similarity threshold: 8 and number of states: 4). TMHMM v.2.0 and SOSUI predicted that except Atp –F, all the other 9 proteins were soluble protein. Atp –F found to have transmembrane region of 19 amino acids length. Inter pro tool analysis of proteins of CC revealed its super family, molecular function. The chalcone synthase (CHS2) of CC was subjected to BLASTp analysis to find the other plant species having the same query protein. The results obtained showed that more than 43 plant species belonging to 19 different family have 80 % and above similarity. Expasy's Prot Param tool predicted the physiochemical characters of the proteins. Phylogenetic study revealed the close and distant relationship of chalcone synthase protein of *Curcuma caesia* of Zingiberaceae family with the plants of other family[36].

In vitro regeneration of *Curcuma caesia*

Plantlets of CC can be produced *in vitro* from newly sprouting vegetative buds of tubers. Rhizomes containing sprouted apical buds, junction between the root and the basal portion of the stem were subsequently used as explants for callus induction and plant regeneration via somatic embryogenesis. The explants were inoculated on MS media or Woody Plant Medium (WPM) with different concentrations of 2,4-dichlorophenoxyacetic acid (2,4-D) and benzyl amino-purine (BAP) in the presence of light. The growth medium supplemented with 5 mg/L BAP and 2 mg/L 2,4-D promoted callus induction after 70 days of culture. Sub-culturing on the same medium enhanced the production of friable callus. Culture media containing higher concentrations of agar promoted the development of green somatic embryos from the callus. Respond of somatic embryogenesis was most successful with MS medium in 6.0 g/L agar supplemented with 5 mg/L BAP and 0.2 mg/L 2,4-D whereby the callus developed into green somatic embryos with an efficiency of 53 %. This culture medium also produced the largest number plantlets[3,37].

Conclusion

C. caesia is widely distributed throughout India. The plant appears to have a broad spectrum of activity on several ailments. Rhizomes of the plant have been explored for antifungal activity, smooth muscle relaxant and anti-asthmatic activity, antioxidant activity, analgesic activity, locomotor depressant, anticonvulsant and muscle relaxant effects, anxiolytic and CNS depressant activity, anti-bacterial activity, antiulcer activity, anticancer activity and many other miscellaneous activities. The rhizomes of the plant have enough bioactive properties as shown in the different animal model. The phytoconstituents are also proved to be identified. This data may signify the investigations of different bio-active compounds from the plant *Curcuma caesia* Roxb. and the requisite level of activity. The pharmacological studies reported through various investigations confirm the therapeutic value of *C. caesia*. Its possibility of *in vitro* regeneration through tissue culture and micropropagation will increase its use in pharmaceutical and cosmetic industries.

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