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Curcuma Aromatica: A general review

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Abstract
Curcuma aromatic also known as kasturi manjal, vanaharidra in ayurveda belongs to the genus curcuma of zingiberaceae family. There are several types of curcuma which includes Curcuma longa (white turmeric), Curcuma aromatica (wild turmeric), Curcuma amada (mango ginger), Curcuma xanthorrhiza (Javanese turmeric), Curcuma caesia (black turmeric). It is a perennial herb with distinctively fragrant rhizomes that is utilized in numerous traditional medical systems throughout Southeast Asia, including China, India, and other countries [1]. The phytoconstituents present in rhizomes are alkaloids, flavonoids, curcuminoids, tannins and terpenoids, polyphenols, sesquiterpenoids, curcumin, eugenol, zingiberine. According to a thorough review of the literature, the plant possesses anti-tussive, antioxidant, anti-inflammatory, anti-neoplastic, proapoptotic anti-obesity, anti-acne, wound-healing, and anti-cancer qualities. Reviewing Curcuma aromatic's phytochemical and pharmacological characteristics was the goal of the current investigation.

Keywords: Curcuma aromatic, vanaharidra, pharmacological activities, phytoconstituents

Introduction
The word "Curcuma" is derived from the Arabic word "Kurkum" which means yellow colour [2]. Curcuma aeruginosa, Curcuma amada, Curcuma angustifolia, Curcuma caesia, Curcuma elata, Curcuma petiolata, Curcuma rubescens, Curcuma zanthorrhiza, and Curcuma zedoaria are a few of the Curcuma species that produce lovely inflorescences and foliages that are valuable as ornamental crops in the floriculture industry [3]. The Zingiberaceae family includes the wild turmeric plant, *Curcuma aromatica*, which is a medicinal herb with many uses but is in danger of extinction. Ayurveda refers to it as "Vanaharidra." Numerous ancient medical systems, including Ayurveda and Unani, use the therapeutic qualities of this plant. Additionally, it is a common element in herbal treatments. Various phytoconstituents present are responsible to show variety of pharmacological activity. The scientific creation of current medications benefits from knowledge of the plants that have been utilized in traditional medical systems. Pharmacological research has entered a new frontier with the study of bioactive chemicals found in these plants. With numerous scientific studies highlighting this plant's diverse qualities published in the last ten years, its use for a variety of reasons has gained importance.

Geographical Distribution
The genus Curcuma comprises of 70 species, which are distributed widely throughout tropical and subtopical regions of the world [4]. Out of 70 species, about 40 species are found in India [5]. The yellow, aromatic rhizome of Curcuma aromatica has a large number of sessile tubers. The plant is native to Kerala, Karnataka, Orissa and Bihar in India. Leaf lamina is broadly lancolate, acuminate and lower surface has dense pubescent [6]. The plant is an upright, perennial herb that spreads by rhizomes. The plant's aboveground appearance is more akin to that of *C. longa*, but its rhizomes have a distinct camphoraceous odor and are less pigmented. Early spring sees the inflorescence emerge from the dormant underground rhizomes first. The wide, elliptic leaves, which can reach heights of three to four feet, emerge later. Throughout the monsoon season, the plant grows quickly and vigorously. By late October, the foliage ceases to grow, and the rhizomes hibernate through the winter. When the rhizomes reach maturity, they release a distinct scent. Blooms are carried on peduncles with a bract-crowned crown, and have pink and white tones with an orange lip. Typically, it doesn't set seeds. Although over 100 species reportedly exist worldwide, *C. aromatic* is primarily cultivated in China. In South Asia, *C. aromatica* is a common species. It is discovered to be dispersed from China all the way south to Sri Lanka [7].) Micropropagation procedure has been optimized for large-scale production to meet industrial demand for the rhizome and for conservation, as there are several barriers to the plant's commercial cultivation [8]. This plant is most threatened in several South Asian nations because to improper growing methods, habitat damage, deforestation, and the strong demand of the pharmaceutical industry on natural sources [9].

Medicinal uses
Since ancient times, *C. aromatica* has been known for its therapeutic properties. In addition to its antimicrobial and antifungal properties, it is also renowned in India for its cosmetic applications. Rhizome paste is applied to the face to even out skin tone and color while also decreasing acne. Traditionally, wound healing is the best ever property. It is also used as antiseptic, anti-tumor, anti-oxidation, anti-bacterial, anti-fungal anti-parasitic, anti-aging. In recent study it is observed that *C.aromatica* is useful as cardioprotective, angiogenesis, antinociceptive, anti-proliferative, anti- obesity. Additionally, native perfumeries employ it.

Chemical constituents
Camphor, ar-turmerone, curzerenone, 1,8-cineole, and α-turmerone were determined to be the main ingredients of the leaf oil, whereas the main ingredients of the rhizome oil were camphor, curzerenone, α-turmerone, ar-turmerone, and 1, 8-cineole [10]. The volatile oil mainly consists of β-

curcumene, arcurcumene, xanthorrhizol, germacrone, camphor, curzerenone, 7-methanoazulene, 1,8-cineole, β-elemene and linalool and curcumin [11-12] It is also reported that the rhizome extracts contain 1, 2-hexadecanediol, tetramethyl pyrazine, curcumol, neocurdione, and curdione [13]. Rather than curcuminoids, the oil of *C. aromatica* that is derived from the rhizome has a distinct spectrum of components related to sesquiterpenoids [14]. By using flash chromatography on silica gel, the petroleum ether extract of the rhizomes of *C. aromatica* from Vietnam produced three sesquiterpene hydrocarbons, αhumulene, β-selinene, and α-selinene, along with six oxygenated sesquiterpenes, furanodiene, furanodienone, curzerenone, germacrone, curcumenone, and zederone [15]. It stated that the main ingredient in the rhizome of various development stages is curdione [16]. Analysis of the hexane extract revealed the presence of 13 compounds. The major component was germacron (40.46%) followed by avatirenene with 34.73% and androstan-17-one, 3-ethyl-3- hydroxy-(5à) with 13.42% [17]. The primary ingredients found in the Guangxi rhizome were camphor, α-terpineol, eucalyptol, neocurdione, and germacrone [18]. The antibacterial, therapeutic, and scent qualities of aromatic oils are widely established. They serve as antibacterial, analgesic, sedative, anti-inflammatory, and locally anesthetic treatments in addition to being employed in embalmment and food preservation [19]. β-sitosterol-3-O-β-dglucopyranoside reported for the first time from the ethyl acetate extract of rhizomes [20]. *C. aromatica* is never used as a spice but only as an aro-matic for cosmetic purposes and in indigenous medicine for external applications on skin diseases, bruises and sprain [21]. *C. aromatica* is used for preventing and treating coronary heart disease.

Phytoconstituents of Curcuma aromatic

The major constituents in *C. aromatica* rhizome consists of 8,9-dehydro-9- formyl-cycloisolongifolene (2.7-36.8%), germacrone (4.3-16.5%), ar-turmerone (2.5-17.7%), turmerone (2.6–18.4%), curdione (50.6%), camphor (18.8-32.3%), xanthorrhizol (26.3%), ar-curcumene (19.5%), di-epi-α-cedrene (16.5%), curcumol (35.8%), and 1,8-cineole (12.2%) [22]

Pharmacological Action

The Curcuma species' rhizomes are the portion that is most frequently utilized in chemical extractions. Rhizome volatile oils and nonvolatile curcuminoids are the primary active ingredients. The three main curcuminoids are bisdemethoxycurcumin, curcumin, and demethoxycurcumin. These are curcumin's harmless polyphenolic derivatives. Curcuma oil's primary constituents are found to be sesquiterpenoids and monoterpenoids [23].

Anti oxidant activity

Curcumin has the capacity to enhance oxidative stress systemic indicators. The methanol extract of essential oil from the leaves exhibited remarkable superoxide radical-scavenging activities [24]. Acetylcholinesterase (AChE) inhibitory activity was comparatively high in the ethanol extracts of C. aromatica from India, which had a high total polyphenol content and robust radical scavenging capabilities [25]. It has the ability to raise the serum levels of antioxidants like superoxide dismutase. Curcumins have the ability to scavenge various types of free radicals, including reactive oxygen species (ROS) and reactive nitrogen species (RNS) [26, 27]. Like vitamin E, curcumin effectively scavenges peroxyl radicals. As a result, curcumin is also regarded as an antioxidant that breaks chains. Curcumin's unusual conjugated structure, comprising two methoxylated phenols and an enol form of β-diketone, is credited with its antioxidant function [28]. Ethyl acetate and dichloromethane extracts is reported to have high antioxidant activity [29].

Anti Inflammatory activity

Nuclear factor activation, which is elevated by a variety of inflammatory stimuli, is blocked by curcumin. Curcumin effectively prevents the oedema that carragheenin causes in rats and mice. Additionally, curcumins improve H2O2-induced damage in human keratinocytes and fibroblasts as well as wound healing in diabetic rats and mice [30].

Anti carcinogenic activity

Curcumins' ability to induce apoptosis is crucial to their anticarcinogenic properties. Glioma cell proliferation is inhibited by *C. aromatica* germacrone, which triggers apoptosis and cell cycle arrest. In rat aortic smooth muscle cells, it prevents the formation of malignant cells and the advancement of the cell cycle. By strengthening the tumour necrosis factor-related apoptosis-inducing ligand, curcumin can cause apoptosis [31]. Curcumin inhibits the G1 phase of the cell cycle and delays apoptosis in colorectal cancer cell lines. Moreover, curcumin causes nonselective proliferation suppression in a number of leukemia-related nontransformed hematopoietic progenitor cells. Curcumin inhibits cancer cells and human breast cancer via a number of mechanisms [32].

Anti coagulant and Anti platelet activity

As the most potent antiplatelet agent, curcumin extracted from *C. aromatica* prevented platelet aggregation generated by arachidonic acid (AA), collagen, and ADP with IC (50) values of 37.5, 60.9, and 45.7 microM, respectively [33]. In the rat thoracic aorta, curcumin prevents collagen and adrenaline-induced platelet aggregation both *in vitro* and *in vivo* [34].

Antiviral activity

Curcumin dramatically prevented the p300-related acetylation of the HIV Tat protein, which is linked to the invasion and multiplication of HIV-1. Curcumin is a substance that effectively suppresses HIV-1 LTR-directed gene expression without significantly compromising the survival of cells [35]. Curcumin is a versatile and effective antiviral agent due to its inhibitory action on the enzyme known as inosine monophosphate dehydrogenase (IMPDH).

Anti depressant activity

According to a study, rats under chronic moderate stress consume much less sucrose and have higher levels of cortisol, interleukin (IL-6), tumor necrosis factor alpha (TNF-α), corticotropin releasing factor (CRF), and TNF-α. Turmeric's ethanolic extract raises blood levels of TNF-α and IL-6, lowers CRF, and increases sucrose intake to normal control levels [36]. Curcumin demonstrated antidepressant efficacy on behavior in long-term stress rats as opposed to imipramine, which served as the study's control. A study on Alzheimer's disease has demonstrated that curcumin directly reduces amyloid pathology [37].

Anti Protozoal activity

According to reports, the rhizomes' ethanol extract possesses anti-Entamoeba histolytica and anti-Leishmania properties *in vitro*. Numerous artificial curcumin compounds shown anti-L. major, anti-L. falciparum, and anti-L. amazonensis properties [38].

Anthelmentic activity

Four extracts, namely petroleum ether, dichloromethane, ethanol, and aqueous extract, were used to examine the anthelmintic activity of the rhizomes of C. amada and C. caesia at three different concentrations (50 mg/ml, 100 mg/ml, and 150 mg/ml). The findings indicated that the most successful method for paralyzing earthworms was the ethanol extract (150 mg/ml) of C. caesia, but the most effective methods for killing earthworms were the ethanol extract (150 mg/ml) and the dichloromethane extract (150 mg/ml) of both Curcuma species [39].

Anti-asthmatic activity

Pre-contractions generated by carbachol (1 μM) were eased in a concentration-dependent manner by the extract of Curcuma caesia. When methanolic C. caesia extract was applied to histamine aerosol-induced bronchospasm and pre-convulsion dyspnea in guinea pigs, it significantly prevented the bronchospasm from occurring [40].

Anti larvicidal activity

Aedis togoi can be effectively controlled with the rhizome extract. Additionally, the volatile oil exhibits insecticidal properties against sugarcane fields' white termites (Odontotermes obesus Rhamb.). The antimosquito potential of C. aromatica's rhizome extract and volatile oil was observed, along with notably high larvicidal activity against Aedis aegypti larvae in their fourth instar. Culex quinquefasciatus, C. tritaeniorhynchus, and Armigeres subalbatus were all inhibited by the ethanolic extract of C. aromatica. Consequently, the extract can be used as a practical personal defense against mosquito bites [41].

Anti depilatory activity

Hair removal activity of curcumin was tested on the mice by shaving specific area and application of alcoholic extraction. The observation was recorded for 10 days. Length and growth of hair in this area was measured. It was notice that the curcumin exhibit hair inhibitory activity [46].

Antimelanogenic activity

By measuring tyrosinase activity, tyrosinase mRNA levels, and melanin content in human melanoma cells, the antimelanogenic effects of C. aromatica extracts were examined using ultraviolet A (UVA) irradiation. This results in melanogenesis, which is linked to melanoma skin cancer and hyperpigmentation. This study showed that extracts from *C. aromatica* at non-cytotoxic concentrations inhibited UVA-mediated melanin formation [43].

Anti nephrotoxic activity

The effects of *C. aromatica* leaf extract on rats' nephrotoxicity produced by arsenic trioxide were investigated, and the findings showed that the leaf extract may be able to modify the kidney damage brought on by arsenic trioxide [44].

Other properties of Curcuma aromatic

An antitussive activity of *C. aromatica* rhizome ethanolic extract was observed in a sulfur dioxide-induced cough model in mice. In arachidonic acid-induced ear inflammation, the ethanolic extract of *C. aromatica* and its formulations exhibit strong anti-inflammatory and wound-healing properties. Additionally, it significantly impacts the albino mouse excision wound model [45].

C. aromatica's inhibition of hyperlipidemic atherosclerosis was linked to a drop in plasma lipid levels and an elevation in antioxidant skills were documented in a hyperlipidemic rat model caused by Triton X-100 [46].

C. aromatica have been utilized by people as natural colors in textiles, leather goods, cosmetics, and medicine. Historically, curcumin—the only naturally occurring pigment—has been one of the most well-known and vivid yellow dyes obtained from the fresh or dried rhizomes of turmeric. On cotton, the dye exhibits good saturation and rubbing fastness [47].

Because *C. aromatica* toluene extracts were proven to be efficient as antidiabetic both *in vivo* and *in vitro*, they may be utilized as an alternative herbal remedy in the management of diabetes [48].

Arsenic trioxide-induced renal impairment may be modulated by *C. aromatica* leaf extract. It made the elevated serum levels of urea, uric acid, and creatinine in albino rats that had been exposed to arsenic trioxide nephrotoxicity return to normal [49].

When applied at a concentration of 25%, *C. aromatica* extracts demonstrated repellency against Aedes togoi and offered biting protection for 3.5 hours. Additional research on Curcuma extracts has revealed defenses against Culex quinquefasciatus, Culex subalbatus, and Cx. Tritaeniorhynchus [50].

The rhizome extract was efficient against the venom of cobras (Naja kaouthia and Ophiophagus hannah) and vipers (Daboia russelli in particular). The venom of Echis carinatus is both *in vitro* and *in vivo* [51]

Conclusion

The review states that the *C. aromatica* is a significant medicinal plant with multiple lead compounds that have a wide range of bioactivities and other applications. One of the most beneficial herbs which has extremely strong pharmacological effects. People in South East Asian nations like China, India, and others are making advantage of these features. The many characteristics of this plant that have been documented in contemporary scientific publications over the last ten years provide credence to its use in traditional medical systems. Despite the large number of Curcuma species, only a few widely used species have had their chemical composition, bioactivities, and other uses well studied. Additionally, research on the nutritional makeup, dietary value, and health advantages of the edible Curcuma species are poorly documented in the literature. Researchers have vast field of research to be discovered than what exists presently on medicinally important Curcuma species. The species will be more useful in therapeutic alternatives to treat many diseases as well as other ecological remedies.

References

1. Sun W, Wang S, Zhao W, Wu C, Guo S, Gao H, *et al*. Chemical constituents and biological research on plants

in the genus Curcuma. *Crit. Rev. Food Sci. Nutr*,2017:57:1451–1523. 10.1080/10408398.2016.1176554
2. Su X, Jiang B, Wang H, Shen C, Chen H, Zeng Li. Curcumin suppresses intestinal fibrosis by inhibition of PPARγ-mediated epithelial-mesenchymal transition. Evidence-Based Complementary and Alternative Medicine,2017:92:57-66.
3. Maciel N, Criley RA. Morphology, growth and flowering behavior of Curcuma zedoaria. Acta Horticulturae (ISHS),2003:624:111-116.
4. Xia Q, Zhao KZ, Huang ZG, Zhang P, Dong TXX, Li SP, Tsim KWK. Molecular genetic and chemical assessment of Rhizoma Curcumae in China. Journal of agricultural and food chemistry,2005:53(15):6019-6026.
5. Pemba HB, Sharangi AB. Promising curcuma species suitable for Hill regions towards maintaining biodiversity. Journal of Pharmacognosy and Phytochemistry,2017:6(6):726-731
6. Choudhury SN, Ghosh AC, Saika M, Choudhury M, Leclercq PA. Volatile oil constituents of the aerial and underground parts of Curcuma aromatica Salisb. from India. Journal of Essential Oil Research,1996:8:635-638.
7. Ravindran PN, Nirmal Babu K, Sivaraman K. Turmeric: The golden spice of life. In: Turmeric: The genus Curcuma. Boca Raton, FL, USA: CRC Press, 2007, 11.
8. Sharmin SA, Alam MJ, Sheikh MMI, Zaman R, Khalekuzzaman M, Mondal S, *et al*. Micropropagation and antimicrobial activity of Curcuma aromatica Salisb a threatened aromatic medicinal plant. Turk. J. Biol,2013:37:698-708.
9. Kumar V, Sikarwar RLS. Observations on some rare and endangered plants of Chattisgarh state, India. Phytotaxonomy,2002:2:135–142.
10. Bordoloi AK, Sperkova J and Leclercq PA. Essential oils of Curcuma aromatica Salisb. from northeast India. Journal of Essential Oil Research,1999:11:537-540
11. Al-Reza SM, Rahman A, Sattar MA, Rahman MO, Fida HM. Essential oil composition and antioxidant activities of Curcuma aromatica Salisb. Food Chem. Toxicol.,2010:48:1757.
12. Itokawa H, Shi Q, Aklyama T, Morris-Nltschke SL, Lee KH. Recent advances in the investigation of curcuminoids. Chin. Med.,2008:3:11.
13. Huang KX, Tao ZM, Zhang AJ, Peng SL and Ding LS. Studies on chemical constituents of Curcuma aromatica Salisb. Zhongguo Zhong Yao Za Zhi,2000:25:163-165.
14. Jiang Y, Li ZS, Jiang FS, Deng X, Yao CS, Nie G. Effects of different ingredients of zedoary on gene expression of HSC-T6 cells. World. J. Gastroenterol.,2005:11:6780-6786.
15. Giang PM, Son PT. Isolation of sesquiterpenoids from the rhizomes of Vietnamese Curcuma aromatica Salisb. J. Chem.,2000:38:96-99
16. Feng J, Xu MM, Huang XL, Liu HG, Lai MX, Wei MH. GC-MS analysis of essential oil from Curcuma aromatica rhizome of different growth periods. Zhong Yao Cai,2013:36:1926-1929
17. Revathi S, Malathy NS. Antibacterial activity of rhizome of Curcuma aromatica and partial purification of active compounds. Indian J. Pharm. Sci,2013:75:732–735.
18. Ling C, Bu-Ming L, Xiao L, Qi-Xiu L, Mao-Xiang L. Analysis of compositions of the essential oil from Curcuma aromatica by gas chromatography-mass spectrometry. Zhong Yao Cai.,2012:35:1102-1104.
19. Al-Reza SM, Rahman A, Sattar MA, Rahman MO and Fida HM. Essential oil composition and antioxidant activities of Curcuma aromatica Salisb. Food Chem. Toxicol.,2010:48:1757.
20. Neerja P, Himanshu M, Jain DC. Phytochemical investigation of ethyl acetate extract from Curcuma aromatica Salisb. rhizomes. Arab. J. Chem,2013:6:279–283.
21. Phytochemical_investigation_of_ethyl_acetate_extract_from_Curcuma_aromatica_Salisb_rhizomes? (Anon., 1950; Maheshwari and Singh, 1965)
22. Tsai SY, Huang SJ, Chyau CC, Tsai CH, Weng CC, Mau JL. Composition and antioxidant properties of essential oils from Curcuma rhizome. Asian Journal of Applied Sciences,2011:2:57-66.
23. Xiang H, Zhang L, Lu Xi, Yang Y, Wang X, Lei D, *et al*. Phytochemical profiles and bioactivities of essential oils extracted from seven Curcuma herbs, Industrial crops and products 111:298-305
24. Al-Reza SM, Rahman A, Sattar MA, Rahman MO and Fida HM. Essential oil composition and antioxidant activities of Curcuma aromatica Salisb. Food Chem. Toxicol., 48, 2010, 1757.
25. Yeon SJ, Park SJ, Park JH, Kwang-Hwan J, In-Seon L and Seun-Ah Y. Effects of ethanol extracts from Zingiber officinale Rosc., Curcuma longa L., and Curcuma aromatica Salisb. on acetylcholinesterase and antioxidant activities as well as GABA Contents. J. Korean Soc. Food Sci. Nutr., 41, 2012, 1395-140
26. Sahebkar A, Serbanc MC, Ursoniuc S, Banach M. Effect of curcuminoids on oxidative stress: A systematic review and meta-analysis of randomized controlled trials. Journal of Functional Foods,2015:18:898-909
27. Menon VP, Sudheer AR. Antioxidant and anti-inflammatory properties of curcumin. Advances in Experimental Medicine and Biology,2007:595:105-125.
28. Fagodia SK, Singh HP, Batish DR, Kohli RK. Phytotoxicity and cytotoxicity of Citrus aurantiifolia essential oil and its major constituents: Limonene and citral. Industrial Crops and Products,2017:108:708-715.
29. Rachana S and Venugopalan P. Antioxidant and bactericidal activity of wild turmeric extracts. J. Pharmacogn. Phytochem,2014:2:89-94
30. Panahi Y, Alishiri GH, Parvin S, Sahebkar A. Mitigation of systemic oxidative stress by curcuminoids in osteoarthritis: Results of a randomized controlled trial. Journal of Dietary Supplements,2016a:13:209-220.
31. Deeb D, Xu YX, Jiang H, Gao X, Janakiram N, Chapman RA, Gautam SC. Curcumin (diferuloyl-methane) enhances tumor necrosis factor-related apoptosis-inducing ligand-induced apoptosis in LNCaP prostate cancer cells. Molecular Cancer Therapeutics,2003:2:95-103.
32. Li J, Bian WH, Wan J, Zhou J, Lin Y, Wang JR, *et al*. Curdione inhibits proliferation of MCF-7 cells by

inducing apoptosis. Asian Pacific Journal of Cancer Prevention,2014:15:9997-10001
33. Jantan I, Raweh SM, Sirat HM, Jamil S, Mohd Yasin YH, Jalil J. Inhibitory effect of compounds from Zingiberaceae species on human platelet aggregation. Phytomedicine,2008:15(4):306-309.
34. Su X, Jiang B, Wang H, Shen C, Chen H, Zeng L. Curcumin suppresses intestinal fibrosis by inhibition of PPARγ-mediated epithelial-mesenchymal transition. Evid Based Complement Alternat Med,2017:2017:57-66.
35. Balasubramanyam K, Varier RA, Altaf M, Swaminathan V, Siddappa NB, Ranga U, *et al*. Curcumin, a novel p300/CREB-binding protein specific inhibitor of acetyltransferase, represses the acetylation of histone/nonhistone proteins and histone acetyltransferase-dependent chromatin transcription. J Biol Chem,2004:279:51163-51171.
36. Yu ZF, Kong LD, Chen Y. Antidepressant activity of aqueous extracts of Curcuma longa in mice. J Ethnopharmacol,2002:83:161-165.
37. Ringman JM, Frautschy SA, Cole GM, Masterman DL, Cummings JL. A potential role of the curry spice curcumin in Alzheimer's disease. Curr Alzheimer Res,2005:2:131-136.
38. Gomes DC, Alegrio LV, De Lima ME, Leon LL, Araujo CA. Synthetic derivatives of curcumin and their activity against Leishmania amazonensis. Arzneimittelforschung,2002:52:120-124.
39. 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, 2011. Article ID Inventi: ep/412/11.
40. Paliwal P, Pancholi SS, Patel RK. Pharmacognostic parameters for evaluation of the rhizomes of Curcuma caesia. J Adv Pharm Technol Res,2011:2:56-61.
41. Pitasawat B, Choochote W, Tuetum B, Tippawangkosol P, Kanjanapothi D, Jitpakdi A, *et al*. Repellency of aromatic turmeric Curcuma aromatica under laboratory and field conditions. J Vector Ecol,2003:28:234-240.
42. Tahir I, Fatima N. Hair inhibitory effect on integumentary organ by compound isolated from Turmeric. WJPPS,2022.
43. Panich U, Kongtaphan K, Onkoksoong T, Jaemsak K, Phadungrakwittaya R, Thaworn A, *et al*. Modulation of antioxidant defense by Alpinia galanga and Curcuma aromatica extracts correlates with their inhibition of UVA-induced melanogenesis. Cell Biol Toxicol,2010:26(2):103-116.
44. Saxena PN, Anand S, Saxena N, Bajaj P. Effect of arsenic trioxide on renal functions and its modulation by Curcuma aromatica leaf extract in albino rat. J Environ Biol,2009:30(4):527-531.
45. Amith K, Rajiv C, Praveen K, Renu S. Anti-inflammatory and wound healing activity of Curcuma aromatica Salisb. extract and its formulation. J Chem Pharm Res,2009:1:304-310.
46. Rajiv A, Prasanna SS, Ramchandran S, Dhanaraju MD. Evaluation of antioxidant and anti-hyperlipidemic activity of Curcuma aromatica in triton x-100 induced hyperlipidemia rat model. Asian J Phytomed Clin Res,2013:1:116-122.
47. Reazuddin R, Tauhidul IM, Abdullah AM. Ecological risk assessment and health safety speculation during color fastness properties enhancement of natural dyed cotton through metallic mordants. Fashion Textiles,2017:4:1.
48. Srividya AR, Dhanabal P, Bavadia P, Vishnuvarthan VJ, Sathishkumar MN. Antioxidant and antidiabetic activity of Curcuma aromatica Salisb. Int J Res Ayurveda Pharm,2012:3:401-405.
49. Prabhu NS, Shalini A, Nishi S, Priya B. Effect of arsenic trioxide on renal functions and its modulation by Curcuma aromatica leaf extract in albino rat. J Environ Biol,2009:30:527-531.
50. Pitasawat B, Choochote W, Tuetun B, Tippawangkosol P, Kanjanapothi D, Jitpakdi A, *et al*. Repellency of aromatic turmeric Curcuma aromatica under laboratory and field conditions. J Vector Ecol,2003:28(2):234-240.
51. Alam MI. Inhibition of toxic effects of Viper and Cobra venom by Indian medicinal plants. Pharmacol Pharm,2014:5:828-837.