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A review on pharmacological and cosmeceutical properties of *Curcuma longa*

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Abstract
Curcuma longa is extensively used as an aromatic medicinal cosmetic in Indian subcontinent. The plant has been in traditional use and in Unani literature it is mentioned as a remedy for various diseases related to skin, cardiovascular and respiratory system. For the last few decades, research works have been done to establish the pharmacological potential of *Curcuma longa* and its extracts. Some of them include anti-inflammatory, wound healing, anti-melanogenic, antioxidant and free radical scavenging activity, anti-tumor, anti-cancer, anti-repellent, antitussive, anti-platelet activity and antinephrotoxic activity. This review gives an update mainly on the pharmacological and cosmeceutical activities of *Curcuma longa*. and its extracts with plausible medicinal applications.

Keywords: *curcuma longa*, pharmacological, cosmeceutical, anti-inflammatoty, skin disease

1. Introduction
Curcuma longa or turmeric is the rhizome or underground stem of ginger like plant. The plant is an herbaceous perrineal, 60-90 cm high with a short stem tufted leaf. Its flowers are yellow, between 10-15 cm in length and they group together in dense spikes, which appear from the end of spring until the middle session. No fruits are known for this plant. The whole turmeric rhizome, with a rough, segmented skin. The rhizome is yellowish-brown with a dull orange interior that looks bright yellow when powdered. Rhizome measures 2.5-7.0 cm (in length), and 2.5 cm (in diameter) with small tuber branching off. Turmeric held a place of honour in Indian traditional ayurvedic medicine. In ayurvedic it was prescribed for the treatment of many medical problems ranging from constipation to skin diseases. It was used as digestive aid and treatment for fever, inflammation, wounds, infections, dysentery, arthritis, injuries, trauma, jaundice and other liver problems. In Unani turmeric is considered to be sefest herb of choice for all blood disorders since it purifies, stimulates and builds blood. To most people in India, from housewives to Himalayan hermits, turmeric affectionately called the 'KITCHEN QUEEN', the main spice of kitchen. Long term use in turmeric, tulsi and trifala can be likened to a short term Pancha Karma treatment. Turmeric is relatively broad spectrum antifungal. Turmeric exhibits antioxidant activity and protect from free radical damage. Curcumas also exhibits anti-tumor activities and prevent cancer. It inhibits the topoisomerase enzyme, which is required for cancer.

Marco polo (1280 AD) refers to turmeric as Indian saffron used for dying cloths. As far as documented evidence, it is used daily in India for at least 6000 years as medicine, beauty aids, cooking spice and a dye. Obstensibly it was used to worship the Sun during the solar period of India, a time when Lord Ram Chandra walked the Earth. It was mentioned in the Artharveda of India. Buddhist monks have used turmeric as a dye for their robes for at least 2000 years. It was listed in an Assyrian herbal circa 600 BC and was mentioned by Discorides in the herbal that was the western herbal rediscovered it 700 years ago via Marco Polo and it is used in traditional lethal poison of pit vipers. In China it was mentioned in the Pent-Sao of the 7th century. For at least 1000 years Chinese are used turmeric as medicine especially for the spleen, stomach and liver medicines. They use it to stimulate and purify and as an anti-biotic, anti-viral and an analgesic. As such it is used to stimulate and strengthen the blood and decrease blood pressure, to clean abdominal pain and stagnation in men, woman and children. They consider it one of the better herbals for woman because it stimulates the uterus and clears menstrual stagnation. In the 1870's, chemists discovered turmeric orange yellow root powder turned reddish brown when exposed to alkaline chemicals. This discovery led to the development of turmeric paper to test for alkalinity. European and American herbalists up until the rate 20th century had little interest in turmeric. In one western herbal from the early 20th century, Maude Greve's book A Modern Herbal, in which she gives a botanical description and the constituents of the herb as if the herb was of some importance, but then under medicinal actions and uses she says; "Turmeric is a wild aromatic stimulant seldom used in medicine except as a colouring. It was once a cure for jaundice. Its chief use is in the manufacture except as a colouring. It was once a cure for jaundice. Its chief use is in the manufacture of curry powder. It is used as an adulteration of mustard and a substitute for it and forms once of the ingredients of cattle condiments. Turmeric paper is used as a test for alkaloids and boronic acid". Daniel B. Mowrey tells the story. "Serious research on turmeric began in Germany, in the early 1920's. Sesqueterpenes in the essential oil of turmeric were isolated in 1926 and to them was ascribed the therapeutic activity (Lal 2012) [29].

Fig: Plant of *Curcuma longa* (Turmeric)

2. Ethanobotany

The genus *Curcuma longa* (Zingiberaceace) contains many taxa of economic, medicinal, ornamental and cultural importance. Throughout the world India stands as largest producer of turmeric (93.3% of the total world production) and its cultivation is done in 150000 hectares in India. (Satishkumar B, 2005) [47]. Turmeric covers 6% of the total area under the spices in the country, which are mainly used for domestic purpose as condiment and occupies. Only 8% of the total production is exported annually and the rest is consumed in the domestic market. Maximum area under turmeric is in Andhra Pradesh followed by Maharashtra, Tamil Nadu, Orissa, Karnataka and Kerala. The genus *Curcuma L*. (Zingiberaceace) contains many taxa which are economically important as food, condiment and as coloring, medicinal and ornamental materials (Skorniekova J, *et al.* 2004) [48]. It is found throughout the South and South East Asia with a few species extending to China, Australia and South Pacific. The highest diversity is concentrated in India and Thailand, with atleast 40 species in each area, followed by Myanmar, Bangladesh, Indonesia and Vietnam. Due to lack of a comprehensive taxonomic revision, still there is little consensus on the number of species that should be recognized. Recent species may vary from 503 to 80 species. (Larsen K. *et al*. 1998) [30]. Their number will probably reach 120 in the near future due to ongoing detailed botanical exploration of India and South East Asia. The genus exhibit wide variations at intra and inter-specific levels. Turmeric having anti-inflammatory, hypocholestraemic, choleratic, anti-microbial, insect repellent, anti-rheumatic, anti-fibrotic, anti-venomous, anti-diabetic, anti-viral, anti-hepatotoxic as well as anti-cancerous properties in day to day domestic use as a folk lore medicine from time immemorial. With curcumin, oleoresin oil and other complex compounds it is lately gaining importance as potential source of drugs for various ailments.

Turmeric oil is used as aromatherapy and in perfume industry apart from religious, cultural uses. (Sopher DE, 1964) [49]. It is being as an inseparable part of Ayurvedic system of medicine in India and China. Many authors are attempting to collect the information to provide a comprehensive ethanobotanic treatment on turmeric in India with special reference to its use in medication based on the information available in literatures along with those collected by the authors. The first evidences of the use of turmeric, known as *Haridra*, are found in *Atharvaveda* (a collection of Vedas and mantras) and it was considered a curative drug for skin disease, graying of hair, and for charming away jaundice. In Tibetan medicine also, the term "Haridra" is given for turmeric. Turmeric is bitter in taste and its action is "pungent-like" after digestion and metabolism. Being hot, light, acrid, and irritant, it is able to reduce corpulence; stimulate all functions, and clear channels. The use of turmeric as a spice, a dye, or a cosmetic is well known the world over. Turmeric has got a wide range of activities, properties, and uses as per the ancient traditional medicine texts, some of which are as aromatic, stimulant, tonic, carminative, and anthelmintic. It is effective in treating liver obstruction and dropsy, is externally used for ulcers and inflammation, cures flatulence, dyspepsia, anorexia, intermittent fevers, prurigo, eczema, sprain, bruises, wounds, inflammatory troubles of joints, small pox, chicken pox, catarrhal and purulent ophthalmia, conjunctivitis, cough, ring worm and other parasitic skin diseases, piles, common cold, catarrh, coryza, hysterical fits, relieves pain in scorpion sting, chronic otorrhoea, reduces indolent swellings, and is used in the treatment of urinary diseases, leucoderma, diseases of blood, bad taste in mouth, elephantiasis, diarrhea, bronchitis, vertigo, and gonorrhea, (Nadkarni 1976; Kritikar and Basu 1984) [34, 37, 19]. It is intellect-promoting (*Sayana*), antidote for snake venom (*Kausika Sutra)*, in cardiac complaints and jaundice (*Atharvaveda samhita*). has made an exhaustive list of the known and reported uses of turmeric in the treatment of illnesses.

Turmeric is indicated against a variety of health problems and pathological conditions and used traditionally by a large number of ethnic communities in a variety of conditions. Some of the properties are well documented and validated by pharmacological and clinical trials, while many remain to be validated. (Duke JA. 2003) [10] It was compiled that 114 biological properties of turmeric from the USDA database. (Jager P de, 1997) [17] In Chinese medicine, turmeric rhizomes and tubers (root tubers) are used for different purposes. Turmeric rhizome is said to be a "blood" and *Qi* (vital energy) stimulant, with analgesic properties. It is used to treat chest and abdominal pain and distention, jaundice, frozen shoulder, amenorrhea due to blood stasis, and postpartum abdominal pain due to stasis. It is also used for injuries (Chang and But, 1987) [7]. The "tuber" has properties more or less similar, but is used in hot conditions as it is more cooling and has been used to treat viral hepatitis (Bensky and Gamble, 1986) [4].

3. Vernacular names

Arabic	:	Kurkum
Bengali	:	Halud
Marathi	:	Halad
Nepali	:	Haldi
Chinese	:	Wat gam
Punjabi	:	Haldi
English	:	Turmeric
Russian	:	Kurkumy
Farsi	:	Zardchubeh
Sanskrit	:	Ameshta
French	:	Safran des Indes
German	:	Indischer safran
Swedish	:	Gurkmeja
Greek	:	Kourkoumi

Tamil	:	Manjal
Gujrati	:	Halad
Telugu	:	Haridra
Hindi	:	Haldi

4. Scientific classification

Kingdom	:	Plantae
Subkingdom	:	Tracheobionta
Superdivision	:	Spermatophyta
Division	:	Magnoliophyta
Subclass	:	Zingiberidae
Order	:	Zingiberales
Family	:	Zingiberaceae
Genus	:	Curcuma
Species	:	Longa
Scientific name	:	*Curcuma longa*

5. Unani description

Unani name	:	Zardchub
Botanical name	:	*Curcuma longa*
Synonyms	:	Kurkum, Halud, Halad, Haldi, Zardchubeh, Wat gam
Temparament	:	Mizaj 3rd Order Warm and Dry
Maza	:	Bitter taste.
Boo	:	Aromatic odor.
Muzir	:	In high dosage bad effect of CVS (for persons with hot temperament)
Mukhrij	:	Expels Balgham (Phlegm)
Nafa-e-Khas	:	Bronchitis, respiratory disorder, cough, cold, in gastric disorder.

6. Important formulations

Important Unani and Ayurvedic formulations containing *Curcuma longa* are as follows:

- Sarbat Musaffi
- Morham Nasur
- Morham Neem
- Sufoof Tehal
- Ashagandharista
- Saribaddarista
- Mongistashob
- Dashomularista
- Lokkhonarista (B.N.U.F and B.N.A.F 2010) [3]

7. Chemical composition of *Curcuma longa*

Turmeric contains protein (6.3%), fat (5.1%), minerals (3.5%), carbohydrates (69.4%) and moisture (13.1%). The essential oil (5.8%) obtained by steam distillation of rhizomes has *a*-phellandrene (1%), sabinene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpines (53%)5. Curcumin (diferuloylmethane) (3–4%) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%) (Ruby *et al*; 1995) [42]. Demethoxy and bisdemethoxy derivatives of curcumin have also been isolated (Vopel *et al*; 1990) [57] (Figure 1). Curcumin was first isolated (Vogel and Pelletier 1815) [58] in 1815 and its chemical structure was determined (Roughley *et al*; 1973) [43] in 1973. It has a melting point at 176–177 °C; forms a reddish-brown salt with alkali and is soluble in ethanol, alkali, ketone, acetic acid and chloroform.

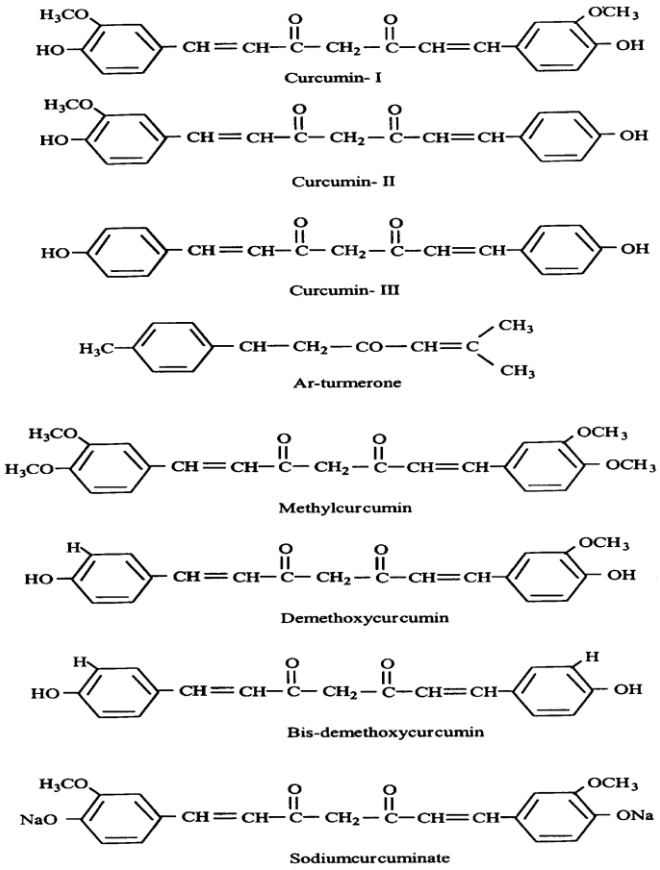

Fig 1: Structure of natural curcuminoids.

8. Cosmeceutical properties of *Curcuma longa* Linn. (Turmeric): The paste of turmeric powder has been used as antiseptic and for skin nourishment since centuries. Curcumin, the active compound of turmeric, is a polyphenol used in skin care preparations. Its hydrogenated form, tetrahydrocurcumin, an off-white coloured compound, is preferred over curcumin because curcumin is a yellow colouring substance. It has dual function of being an antioxidant and to protect the lipids in moisturizers from becoming rancid. Curcumin also has anti-inflammatory activity by inhibiting leukotriene formation, inhibiting platelet aggregation and stabilizing neutrophilic lysosomal membranes (Mortellini *et al*; 2000) [31].

9. Food safety

Turmeric is an approved food additive for humans. Several animal studies conducted in a wide variety of models confirmed a lack of significant toxicity. Doses of curcumin administered in some studies were as high as 3.5 to 5.0g/kg body weight or as high as 50 000-ppm turmeric oleoresin in the diet and lasted several months in duration (Sharma *et al*; 2004) [50]. Likewise, clinical data indicate that curcumin elicited no significant adverse effects at oral doses of up to 8 g/d for several months (Hatcher *et al*; 2008, Chainini 2003, Joshi *et al*; 2003) [14, 8, 18]. Minor GI events reported include diarrhea and temporary nausea (Sharma *et al*; 2007) [51]. There is one recent report that consumption of supplemental doses of turmeric for 4 weeks resulted in a significant elevation of urinary oxalate levels and likely increased risk of kidney stone development in susceptible individuals (Tang *et al*; 2008) [55]. Curcumin consumed (300mg/d) for 6 days also was reported to reduce the bioavailability of talinolol, a drug used in the treatment of

hypertension and coronary heart failure (He *et al*; 2008). In mice, curcumin attenuated cyclophosphamide-induced breast tumor regression and in cell culture studies has shown to have adverse effects on DNA.1 Thus, possible curcumin-drug interactions should not be overlooked. It should be emphasized that as curcumin analogs are identified with substantially enhanced bioavailability, these issues of safety and toxicity will need to be more fully revisited.

10. Nutritional value of *Curcuma longa* or Turmeric

It is very rich source of many essential vitamins such as pyridoxine (vitamin B6), choline, niacin, and riboflavin, etc (Table No.1). Fresh root contains very good levels of vitamin-C. Turmeric also contains very good amounts of minerals like calcium, iron, potassium, manganese, copper, zinc, and magnesium (Eigner 1996) [13].

Table 1: Nutritional value of Turmeric

Sr.no	Energy	354 Kcal	Folates	39 µg
1	Carbohydrates	64.9 g	Niacin	5.140 mg
2	Protein	7.83g	Pyridoxine	1.80 mg
3	Riboflavin	0.233 mg	Vitamin A	0 IU
4	Dietary Fiber	21 g	Vitamin C	25.9 mg
5	Iron	41.42 mg	Vitamin E	3.10 mg
6	Magnesium	193 mg	Vitamin K	13.4 µ g
7	Calcium	183 mg	Phosphorus	268 mg
8	Copper	603 µ g	Zinc	4.35 mg

11. Pharmacological properties

Several medicinal properties have been attributed to *Curcuma longa* Linn. Rhizome of turmaric is known to possess therapeutic activities and has been used by medical practitioners as an anti-diabetic, hypolipidemic, anti-inflammatory, anti-diarrhoeal, hepatoprotective, anti-asthmatic and anti-cancerous drug. Turmaric is widely used in cosmetology. The following section discusses its various therapeutic uses in medicine.

11.1 Anti- Inflammatory activity

Aqueous and alcoholic extracts showed anti –inflammatory activity in mice. The ethanol extracts and formulations exhibited significant anti- inflammatory activity in arachidonic acid –induced ear inflammations. The resulting anti - inflammatory activity was suggested to be due to effects on several mediators and arachidonic acid metabolism involving cyclo-oxygenase pathway (Kumar *et al*; 2009) [20]. A study was also done on Antiinflammatory effect of the volatile oil from *Curcuma longa*.

11.2 Healing property, skin care

Oil of turmeric and its ether and chloroform extracts have proved to be antifungal, anti-protozoan, antiviral, and antibacterial. In a screening for antibiotic property, turmeric showed broad-spectrum antibacterial activity (Omoloso and Vagi, 2001) [38]. Turmeric oil obtained as a by-product from curcumin manufacture was subjected to antibacterial study and found effective against *Bacillus cereus, Bacillus coagulans, Bacillus subtilis, Staphylococcus aureus, Escherichia coli,* and *Pseudomonas aeruginosa*. (Negi *et al.* 1999) [35].

11.3 Antioxidant activity

Water and fat-soluble extracts of turmeric and its curcumin component exhibit strong antioxidant activity, comparable to vitamins C and E. A study of ischemia demonstrated that curcumin pretreatment decreased ischemia-induced changes in the heart (Dikshit *et al*; 1995) [11]. An *in virtro* study measuring the effect of curcumin on endothelial heme oxygenase-1, an inducible stress protein, was conducted utilizing bovine aortic endothelial cells. Incubation with curcumin resulted in enhanced cellular resistance to oxidative damage.

11.4 Cardiovascular and anti-diabetic effects

Turmeric exerts cardio-protective effects mainly by antioxidant activity, lowering lipid peroxidation, anti-diabetic activity and inhibiting platelet aggregation. A study of 18 atherosclerotic rabbits given 1.6-3.2 mg/kg/day of turmeric extract demonstrated decreased susceptibility of LDL to lipid peroxidation, in addition to lower plasma cholesterol and triglyceride levels. Turmeric effect on cholesterol levels may be due to decreased cholesterol uptake in the intestines and increased conversion of cholesterol to bile acids in the liver. Inhibition of platelet aggregation by turmeric constituents is thought to be via potentiation of prostacyclins synthesis and inhibition of thromboxane synthesis. Both turmeric decreases blood glucose level in diabetic rats. Turmeric also decreases complications in diabetes mellitus. Further clinical studies need to be performed in this area to discover optimal dosages for cardiovascular protection and lipid or glucose lowering activities (Khajehdehi 2012) [21].

11.5 Photo-protector activity

This action is due to its antioxidant activity. A large part of the lipids of the surface of the skin is unsaturated. Therefore, they are easily attacked by free radicals. The ultraviolet rays of the sun penetrate the skin and accelerate the damage caused by these radicals. Prolonged exposure to these radiations may degrade the lipids thus causing deterioration in the texture of the skin. In laboratory studies, extract of turmeric was shown to be effective in suppressing inflammation and protecting the epidermal cells from the damages caused by ultraviolet B radiation (7). Curcumin, in small doses of turmeric has been shown to protect against chromosomal damage caused by gamma radiation.

11.6 Alzheimer and turmeric

Epidemiological studies have suggested reduced risk of in Alzheimer's disease (AD) in patients with long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs) which may show the role of brain inflammation in Alzheimer's disease. It also has been shown with increased cytokines and activated microglia. It has been shown that curcumin has NSAID like activity and reduces oxidative damage. To evaluate whether it could affect Alzheimer-like pathology, the effect of 160 ppm and 5000 ppm doses of dietary curcumin on inflammation, oxidative damage, and plaque pathology were tested. Both doses significantly lowered oxidized proteins and IL-1, a proinflammatory cytokine usually elevated in the brains of these mice. In view of its efficacy and apparent low toxicity, this spice has promise for the prevention of Alzheimer's disease (Rabiei *et al*; 2014) [44].

11.7 Hepatoprotective activity

The powder of the rhizome mixed with amla juice is used in jaundice (Pandey 2002) [39]. Corriliyum (Anjana) with Haridra, Red ochre (Gairika), and Amalaki (*Emblica officinalis*) cures

jaundice (Tripathi 2009) [56]. Curcumin, the most common antioxidant constituent of *Curcuma longa* rhizome extract, was reported to enhance apoptosis of damaged hepatocytes which might be the protective mechanism whereby curcumin down-regulated inflammatory effects and fibrogenesis of the liver. The ethanolic extract of *Curcuma Longa* rhizomes showed a significant hepatoprotective effect when orally administrated in doses of 250 mg/kg and 500 mg/kg, and the protective effect was dosedependent. The main constituents of *Curcuma longa* rhizome ethanolic extract are the flavonoid curcumin and various volatile oils, including tumerone, atlantone, and zingiberene. The hepatoprotective effects of turmeric and curcumin might be due to direct antioxidant and free radical scavenging mechanisms, as well as the ability to indirectly augment glutathione levels, thereby aiding in hepatic detoxification. The volatile oils and curcumin of Curcuma longa exhibit potent antiinflammatory effects (Salama *et al*; 2013) [52].

11.8 Cardioprotective activity

Curcumin decreases the severity of pathological changes and thus protects from damage caused by myocardial infarction (Nirmala *et al*; 1996) [36]. Curcumin improves Ca2+-transport and its slippage from the cardiac muscle sarcoplasmic reticulum, thereby raising the possibility of pharmacological interventions to correct the defective Ca2+ homeostasis in the cardiac muscle (Sumbilla *et al*; 2002) [53]. Curcumin has significant hypocholesteremic effect in hypercholesteremic rats (Patil *et al*; 1971) [40].

11.9 Gastrointestinal activity

Constituents of *Curcuma longa* exert several protective effects on the gastrointestinal tract. Sodium curcuminate inhibited intestinal spasm and p-tolymethylcarbinol, a turmeric component, Increased gastrin, secretin, bicarbonate, and pancreatic enzyme secretion. Turmeric has also been shown to inhibit ulcer formation caused by stress, alcohol, indomethacin, pyloric ligation, and reserpine, significantly increasing gastric wall mucus in rats subjected to these gastrointestinal insults (Akram *et al*; 2010) [32].

11.10 Antibacterial activity

Curcumin act as an antibacterial agent as it effectively targets *Staphylococcus aureus*, *Salmonella paratyphi*, *Trichophytongypseum*, and *Mycobacterium tuberculosis* (Benson 2012) [5]. It exhibits a wide range of activities in eukaryotic cells including its antiviral effect against herpes simplex virus by a mechanism independent of p300/CBP histone acetyltransferase activity (Kutluay *et al*; 2008) [22].

11.11 Turmeric in urinary disorders

Some recent experimental studies suggested that the administration of Curcumin is a promising approach in the treatment of renal disorders. In Brunes (Darussalam), turmeric rhizome is used to cure urinary infection, as a traditional method. Vangasena (an ancient Ayurvedic expert, who had written his own treatise) that turmeric is good for calculus. (Kolammal, 1979) [23]. Curcumin and curcumioids as oral drug to prevent the formation of urinary calculi. The nephroprotective effect of curcumin was analyzed in rats. They studied the effect of curcumin on Adriamycin (ADR)-induced nephrosis in rats and found that the injury was prevented by curcumin treatment. Curcumin protected ADR induced proteinuria, albuminuria, hypoalbuminaemia, hyperlipemia, and urinary excretion. Curcumin restored renal function.

11.12 Free radical scavenging with antioxidant activity

In a study, methanol aqueous extracts of 100 plants were screened for anti-oxidative activity using Fenton's reagent/ethyl linoleate system and for free radical scavenging activity using the 1,1-diphenyl-2-picryl hydrazyl free radical generating system. The results suggest that *Curcuma aromatica* may be potential sources of anti-oxidants (Kim *et al*; 1997) [24]. The chemical composition of hydro-distilled essential oil from leaves of *Curcuma aromatica* was analysed. Twenty-three compounds representing 94.29% of the total oil was identified. The antioxidant activities of the oil and various extracts of *Curcuma aromatica* were evaluated by using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and superoxide radical-scavengingassays. The oil and methanol extract showed potent DPPH radical-scavenging activities, which were higher than butylated hydroxyanisole. The extracts also exhibited remarkable superoxide radical-scavenging activities and the activity in the methanol extract was superior to all other extracts. The results indicate that the oil and extracts of *Curcuma aromatica* could serve as an important bio-resource of antioxidants for using in the food industries (Al-Reza *et al*; 2010) [1].

11.13 Anti-cancer effect

Numerous animal studies have explored turmeric influence on the carcinogenesis. Several studies have demonstrated that curcumin is able to inhibit carcinogenesis at three stages: angiogenesis, tumor promotion, and tumor growth. In two studies of colon and prostate cancer, curcumin was shown to inhibit cell proliferation and tumor growth. Turmeric and curcumin are also able to suppress the activity of several common mutagens and carcinogens. The anticarcinogenic effects of turmeric and curcumin have been related to direct antioxidant and free-radical scavenging effects, as well as their ability to indirectly increase glutathione levels, thereby aiding in hepatic detoxification of mutagens and carcinogens, and inhibiting nitrosamine formation. Curcumin has also been shown to inhibit the mutagenic induction effect of UV rays (Kwon *et al*; 2009) [25].

11.14 Antidepressant activity

The curcumin loaded solid lipid nanoparticles at a dose of (1, 2.5, 5 and 10 mg/kg, p.o.) exhibited 47.42%, 67.39%, 31.67% and 36.2% reduction in immobility time after administration of the dose in mice using swim model respectively. However, conventional curcumin did not result in a significant reduction, except at 2.5 mg/kg, which could produce a reduction of only 21.7% (Kakkar and Kaur 2012) [26].

11.15 Anti-nephrotoxic activity

The protective effects of *Curcuma aromatica* leaf extract were studied on nephrotoxicity induced by arsenic trioxide in rats and the results revealed that *Curcuma aromatica* leaf extract has a potential to modulate the renal dysfunction caused by arsenic trioxide (Saxena *et al*; 2009) [54].

11.16 Antitussive activity

Ethanolic extract of rhizomes of *Curcuma aromatica* was investigated for its antitussive effect on Sulfur dioxide induced

cough model in mice. The results suggested that the extract exhibited significant antitussive activity in a dose dependent manner (Marina *et al*; 2008) [33].

11.17 Anti-protozoal activity

The first work to relate the activity of curcumin and some semi-synthetic derivatives in the literature against tripanosomatids was studied in promastigotes (extracellular) and amastigotes (intracellular) forms of *Leishmania amazonensis*. The authors showed that curcumin (a phenolic curcuminoid) in experiments *in virtro* has an excellent activity (LD_{50} = 24 μM or 9 mg/ml) and the semi-synthetic derivative, methylcurcumin (a non-phenolic curcuminoid), has the best action with a LD_{50} < 5 μg/ml and LD_{90} = 35 μM against promastigotes forms. This derivative was tested *in vivo* in mice and showed a good activity with 65.5% of inhibition of the lesion size of the footpad of the animals, when compared with the group inoculated with the parasites alone (Araújo *et al*.1999) [2]. Another interesting point mentioned by the authors is that they did not observe any inflammatory reaction in the area where the drugs were injected, perhaps because curcuminoids are potent inhibitors of inflammation. Rasmussen *et al*. (2000) [45] reported the efficacy of an ethanolic extract from *Curcuma longa* against *Plasmodium falciparum* and *L. major*, which was able to inhibit the *in virtro* growth of these parasites.

11.18 Nematocidal activity

Curcuma oil was studied on *Paramecium caudatum* in different concentrations, varying from 1 in 2,000 to 1 in 5,000. The ciliates became sluggish and ultimately died (Chopra *et al*. 1941) [9]. Kiuchi *et al*. (1993) [27] demonstrated the activity of fractions (methanolic and chloroformic) of turmeric against *Toxocara canis*. In this work they isolated a new curcuminoid, the cyclocurcumin. All the substances did not show activity when applied independently, but the activity was observed when they were mixed, suggesting a synergistic action between them.

11.19 Analgesic action

The powdered rhizome is effective in the treatment of sprain and inflammation (Khare, 2000) [28] Turmeric paste mixed with a little lime and saltpeter and applied hot is a popular application to sprains (Nadkarni, 1976) [34, 37].

11.20 Antidermatophytic activity

Fresh juice of rhizome of Haridra is used as antiparastic in many skin affections (Dhiman 2004). Its rhizome powder mixed with cow's urine is taken internally in itching and dermatitis (Paranjpe 2001) [41]. *Curcuma longa L.* leaves have good promise as an antifungal agent that could be used as a therapeutic remedy against human pathogenic fungi on account of its various *in virtro* and *in vivo* antifungal properties, *viz.*, strong fungicidal action, long shelf-life, its tolerability of heavy inoculum density, thermo stability, broad range of antidermatophytic activity and absence of any adverse effects. Curcumin obtained from the turmeric rhizome (*Curcuma longa*) have shown to possess the ability to protect the skin from harmful UV-induced effects by displaying antimutagen, antioxidant, free radical scavenging, anti-inflammatory and anti-carcinogenic properties (Binic *et al*; 2013) [6].

12. Curcumin prevents drug resistance

The Curcumin is a potent drug resistance preventer. It exhibits novel ability to prevent the upregulation of P-glycoprotein and its mRNA induced by adriamycin (ADM). The prevention capacity is also functionally associated with the elevated intracellular drug accumulation and parallel enhanced ADM cytotoxicity (Xu *et al*; 2011) [59].

13. Dosage of *Curcuma longa*

Adults: By mouth

- For high cholesterol: 1.4 grams of turmeric extract in two divided doses daily for 3 months has been used.
- For itching (pruritus): 1500 mg of turmeric in three divided doses daily for 8 weeks has been used. Also, a specific product containing turmeric extract (C3 Complex, Sami Labs LTD) plus black pepper or long pepper has been used daily for 4 weeks.
- For osteoarthritis: 500 mg of a non-commercial turmeric product four times daily for 4-6 weeks has been used. 500 mg of a specific turmeric extract (Turmacin, Natural Remedies Pvt. Ltd.) has been used twice daily for 6 weeks (89721). 500 mg of a specific turmeric extract (Meriva, Indena) containing turmeric and phosphatidylcholine has been used twice daily for 2-3 months. Other combination products have also been used.

Children: By mouth

- For high cholesterol: 1.4 grams of turmeric extract in two divided doses daily for 3 months has been used in children at least 15 years-old.

14. Side effects of *Curcuma longa*

Turmeric is likely safe when taken by mouth or applied to the skin appropriately for up to 8 months. Turmeric is possibly safe when it is used as an enema or a mouthwash in the short-term. Turmeric usually does not cause significant side effects; however, some people can experience stomach upset, nausea, dizziness, or diarrhea. In one report, a person who took very high amounts of turmeric, over 1500 mg twice daily, experienced a dangerous abnormal heart rhythm. However, it is unclear if turmeric was the actual cause of this side effect. Until more is known, avoid taking excessively large doses of turmeric.

15. Drug-botanical interactions

Medications that slow blood clotting (Anticoagulant / Antiplatelet drugs) interacts with turmeric**.** Turmeric might slow blood clotting. Taking turmeric along with medications that also slow clotting might increase the chances of bruising and bleeding. Some medications that slow blood clotting include aspirin, clopidogrel (Plavix), diclofenac (Voltaren, Cataflam, others), ibuprofen (Advil, Motrin, others), naproxen (Anaprox, Naprosyn, others), dalteparin (Fragmin), enoxaparin (Lovenox), heparin, warfarin (Coumadin), and others.

16. Pregnancy and Lactation:

Although there is no evidence that dietary consumption of turmeric as a spice adversely affects pregnancy or lactation, the safety of curcumin supplements in pregnancy and lactation has not been established.

17. Future prospects

Turmeric has been used in unani and ayurvedic medicine since ancient times, with various biological applications. Although some work has been done on the possible medicinal applications, no studies for drug-development have been carried out as yet. Although the crude extract has numerous medicinal applications, clinical applications can be made only after extensive research on its bioactivity, mechanism of action, pharmacotherapeutics and toxicity studies. However, as curcumin is now available in pure form, which shows a wide spectrum of biological activities, it would be easier to develop new drugs from this compound after extensive studies on its mechanism of action and pharmacological effects. Recent years have seen an increased enthusiasm in treating various diseases with natural products. Curcumin is a non-toxic, highly promising natural antioxidant compound having a wide spectrum of biological functions. It is expected that curcumin may find application as a novel drug in the near future to control various diseases, including inflammatory disorders, carcinogenesis and oxidative stress-induced pathogenesis.

18. Conclusion

Turmeric has a broad spectrum actions with certain effects and is beneficial for long term and daily usage.Turmeric is the household spice for diverse cuisines in all parts of India since many centuries. Generally the rhizome powder of Turmeric is used as a spice all over India but only a few people are aware of its therapeutic properties. Turmeric is regarded as one of the best drug in many diseases like Diabetes, Skin diseases etc, which is in use since ages owing to its multiple pharmacological activities. Turmeric is enriched with many useful phytoconstituents which are responsible for its efficacy. Curcumin is one such phytoconstituent, a nutraceutical substance with numerous pharmacological activities proven experimentally and clinically. It has been established beneficial in treating Anti-inflammatory, Anti-allergic, Anti-oxidant, Anti hyperglycaemic and Anti- cancer properties. Till date many researches have been carried out on the medicinal effects of Turmeric, this review will give a new impetus to utilize turmeric in various disorders.

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