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Review on medicinal and phytochemical properties of different extract of Turmeric's rhizome

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Abstract
Turmeric's rhizome has always been used as a spice and also for its medicinal properties from the ancient time. In the ayurveda, Turmeric has a different place due to its use in treatment of various kind of disease. The purpose of this review is to summarize the pertinent literature of the present era, to provide the knowledge to the people and aware them about the use of turmeric in different kinds of disease's treatment and also providing its phytochemical properties in different kinds of solvents which can provide the knowledge for researchers in future. People of different countries have been using turmeric in different purpose and in different ways. Therefore, the time has come that we make the people aware of the turmeric, because it is a thing which is easily available everywhere. People can stay healthy to make it a part of their daily routine. It can also increase the effect of several drugs, so it can be used with the modern treatment for increasing their effect. So let's see where we can use turmeric.

Keywords: *Curcuma longa*, *Curcuma aromatica* (CA) and *Curcuma aromatica* oil (CAO), reactive oxygen species (ROS)

Introduction
Medicinal plants have provided a reliable source for preparation of new drugs as well as combating diseases, from the dawn of civilization. The extensive survey of the literature revealed that *Curcuma longa* L. or turmeric (from Zinziberaceae family) is highly regarded as a universal panacea in the herbal medicine with a wide spectrum of pharmacological activities. Turmeric is a plant distributed throughout tropical and subtropical regions of the world. It is widely cultivated in Asian countries, mainly in China and India. The plant measures up to 1 m high with a short stem. Turmeric is an essential spice all over the world with a distinguished human use particularly among the Eastern people [1]. Apart from the use as spice, it is used as traditional medicine in Asian countries such as India, Bangladesh and Pakistan because of its beneficial properties [2]. It is called turmeric (Zarchooveh in Iran) and has been in continuous use for its flavoring, and medicinal properties [3]. Current traditional medicine claims its powder against gastrointestinal diseases, especially for biliary and hepatic disorder, diabetic wounds, rheumatism, inflammation, sinusitis, anorexia, coryza and cough etc. The coloring principle of turmeric is called curcumin, which has yellow color and is the essential component of this plant [4]. Recent studies have authenticated turmeric as anticancer, antioxidant, hypolipidemic, anti-inflammatory, anti-fertility, anti-venom, hepatoprotective, nephroprotective, anticoagulant, Etc. The plant has also shown to possess anti HIV activity to combat AIDS [5]. These medicinal properties of turmeric caused it to be considered as a spice with multifunctional medicinal properties.

Medicinal uses of turmeric
In turmeric several therapeutic and pharmacological activities are present. Some of which are as follows:

1. Antioxidant activity
Curcumin, the main active constituent of turmeric, has been shown to be a powerful scavenger of oxygen free radicals. Its antioxidant activity is comparable to vitamins C, E and Beta-Carotene [4]. It can protect lipids or hemoglobin from oxidation. It can significantly inhibit the generation of reactive oxygen species (ROS) such as H_2O_2, superoxide anions and nitrite radical generated by activated macrophages. Its derivatives, bis-demethoxycurcumin and demethoxycurcumin also have antioxidant activities [4]. Curcumin pre-treatment has been shown to decrease ischemia-induced oxidative stress and changes in the heart [6]. An *in vitro* study measuring the effect of curcumin on an inducible stress protein resulted in enhanced

cellular resistance to oxidative damage [7].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 [25].

The chemical composition of hydro-distilled essential oil from leaves of CA was analysed. Twenty-three compounds representing 94.29% of the total oil were identified. The antioxidant activities of the oil and various extracts of C. aromatica were evaluated by using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and superoxide radical-scavenging assays. 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 CA could serve as an important bio-resource of antioxidants for using in the food industries [26].

2. 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.

Turmeric lowers blood glucose level in diabetic rats so the NADPH/ NADP ratio goes up resulting in increased activity of glutathione reductase, which in turn elevates the availability of GSH, the substrate for GPx, so the activity of GPx increases which in turn scavenges H_2O_2. Turmeric or curcumin plays a protective role in Diabetes mellitus (DM) and also decreases complications in DM [8].

3. Inflammatory and edematic disorders

Curcumin is a potent anti-inflammatory agent with specific lipoxygenase- and COX-2- inhibiting properties. *In vitro*, and *in vivo* studies have demonstrated its effects at decreasing both acute and chronic inflammation. Curcumin has inhibited edema at doses between 50 and 200 mg/kg, in mice [5]. A 50% reduction in edema was achieved with a dose of 48 mg/kg body weight, with curcumin nearly as effective as cortisone and phenylbutazone at similar doses. In rats, a lower dose of 20-80 mg/kg decreased paw inflammation and edema. curcumin also inhibited formaldehyde induced arthritis in rats at a dose of 40 mg/kg and demonstrated no acute toxicity at doses up to 2 g/kg/day [9]. In an animal study, rheumatoid arthritis induced by streptococcal cell wall, intraperitoneal injection of turmeric extract containing total curcuminoids 4 mg/kg/ day for four days prior to induction of arthritis, inhibited joint inflammation in both acute (75%) and chronic (68%) phases. To test the efficacy of an oral preparation, a 30-fold higher dose of the curcuminoid preparation, given to rats four days prior to arthritis induction, reduced joint inflammation by 48% [10].

4. Gastrointestinal effects

Turmeric exerts several protective effects on the gastrointestinal tract. Turmeric also inhibits ulcer formation caused by stress, alcohol, Indomethacin, reserpine, pyloric ligation, increasing gastric wall mucus in rats subjected to these gastrointestinal insults. It also inhibits intestinal spasm and increases bicarbonate, gastrin, secretin and pancreatic enzyme secretion. An open, phase II trial performed on 25 patients with endoscopically-diagnosed gastric ulcer, given 600 mg powdered turmeric five times daily, showed completely healing in 48 percent of patients. No adverse reactions or blood abnormalities were recorded [8]. Curcumin reduced mucosal injury in mice with experimentally-induced colitis. Ten days prior to induction of colitis, with 1, 4, 6-trinitrobenzene sulphonic acid, administration of 50 mg/kg curcumin resulted in a significant reduction of diarrhea, neutrophil infiltration and lipid peroxidation in colonic tissue. Also all indicators inflammation were reduced and the symptoms improved [11]. In rat models of experimentally-induced pancreatitis, curcumin was able to decrease inflammation. In cerulean or ethanol induced pancreatitis, curcumin was also able to inhibit the inflammatory mediators, resulted in amelioration in disease severity as measured by histology, pancreatic trypsin, serum amylase, and neutrophil infiltration [12].

5. 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 [9-13].

Antimelanogenic effects of CA extracts were investigated by assessing tyrosinase activity, tyrosinase mRNA levels, and melanin content in human melanoma cells exposed to Ultraviolet A (UVA) irradiation which is said to be the main cause for melanogenesis which in turn is associated with melanoma skin cancer and hyperpigmentation. Protection against melanogenesis were examined by evaluating the inhibitory effects on UVA-induced cellular oxidative stress and modulation of antioxidant defenses including antioxidant enzymes, catalase (CAT) and glutathione peroxidase (GPx), and intracellular glutathione (GSH). Study demonstrated that UVA mediated melanin productions were suppressed by CA extracts at non-cytotoxic concentration. The extract showed protection against UVA- induced cellular oxidant formation and depletion of CAT and GPx activities and GSH content in a dose-dependent manner. This study also suggested that Inhibition of cellular oxidative stress and improving antioxidant defenses might be the mechanisms by which the extracts showed protective effects on UVA-dependent melanogenesis [27].

6. Antimicrobial activity

Curcumin can suppress the growth of a variety of parasite, bacteria and pathogenic fungi. Turmeric has been shown to

inhibit the growth of a variety of bacteria, pathogenic fungi, and parasites. A study of chicks infected with *Eimera maxima* demonstrated that diets supplemented with 1% turmeric resulted in a reduction in intestinal lesion and improved weight gain [12]. In another animal study, topically application of turmeric oil inhibited dermatophytes and pathogenic fungi in guinea pigs at 7 days post-turmeric application [14]. Curcumin has also been found to have moderate activity against *Plasmodium falciparum* and *Leishmania major* organisms [15].

7. Hepatoprotective and renoprotective effects of turmeric

Turmeric has been shown to have renoprotective and hepatoprotective properties similar to silymarin. Animal studies have demonstrated renoprotective and hepatoprotective effects of turmeric from a variety of hepatotoxic insults. The hepatoprotective and renoprotective effects of turmeric are mainly due to its antioxidant properties, as well as its ability to decrease the formation of pro-inflammatory cytokines [3-4, 6]. Turmeric and curcumin have also reversed fatty changes, biliary hyperplasia and necrosis induced by aflatoxin production [3]. Sodium curcuminate, a salt of curcumin, also exerts choleretic effects by increasing biliary excretion of bile salts, cholesterol, and bilirubin, as well as increasing bile solubility, therefore, possibly preventing and treating cholelithiasis [4].

8. 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. Recent reports have suggested the therapeutic potential of curcumin in the pathophysiology of AD, because of its antioxidant, anti-inflammatory, and anti-amloid effects. 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 [16, 17].

9. Photoprotective 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 [8]. Curcumin, in small doses of turmeric has been shown to protect against chromosomal damage caused by gamma radiation [8].

10. Anti-tumour activity

Germacrone is one of the major bioactive components of CA which has been proven to possess anti-tumor properties. In a study on the anti-proliferative effect of germacrone on human glioma cells and the molecular mechanism underlying its cytotoxicity concluded that Germacrone inhibits the proliferation of glioma cells by promoting apoptosis and inducing cell cycle arrest. It also suggested that germacrone may be a novel potent chemo preventive drug for gliomas via regulating the expression of proteins associated with apoptosis and G1 cell cycle arrest [18].

Studies were also conducted on Antitumor effect and pharmacological actions of beta-elemene isolated from the rhizome of CA**.** As a part of study to reveal the inhibitory effects of *Curcuma aromatica* oil (CAO) on cell proliferation of hepatoma in mice, two tumor inhibitory experiments of CAO on hepatoma in mice were conducted. The inhibitory effects of CAO on proliferation of hepatoma in mice were evaluated by DNA image cytometry and immune-histochemical staining of proliferating cell nuclear antigen (PCNA). The resultant tumor inhibitory rates of CAO were 52% and 51% in two experiments, respectively. Compared with those of the saline-treated control groups, both differences were statistically significant ($P < 0.01$). The study concluded that the inhibition of CAO on the growth of hepatoma in mice might be associated with its depression on cellular proliferative activity [19].

11. Repellent activity

Curcuma aromatica was selected for investigation of mosquito repellent activity under laboratory and field conditions**.** In a laboratory study, a 95% ethanol extract of CA extract showed repellency against *Aedes togoi* with ED50 and ED95 values of 0.061 and 1.55 mg/cm2, respectively. It also provided biting protection for 3.5 h when applied at a concentration of 25 g%. The ethanolic extract of CA was therefore chosen for further repellent activity under field conditions, where it had a protective effect against *Armigeres subalbatus*, *Culex quinquefasciatus*, and *Culex tritaeniorhynchus*. The ethanol-extracted CA did not cause dermal irritation when applied to human skin. No adverse effects on human volunteers were observed 2 months after application. Therefore, it concluded that CA extract can be applied as an effective personal protective measure against mosquito bites [20].

In a study on Chemical composition and anti-mosquito potential of rhizome extract and volatile oil derived from *Curcuma aromatica* against *Aedes aegypti* (Diptera: Culicidae), Crude rhizome extracts and volatile oils of *Curcuma aromatica* were evaluated for anti-mosquito potential, including larvicidal, adulticidal, and repellent activities against the *Aedes aegypti* mosquito. Results proved that volatile oil of CA possessed a significantly higher larvicidal activity against the 4th instar larvae of *Aedes aegypti* than that of hexane extracts, with LC50 values of 36.30 and 57.15 ppm, respectively [21].

12. Wound healing activity

The powdered rhizome of CA exhibited wound healing activity in rabbits. Studies also showed significant wound healing activity in excision wound models, conducted to assess the wound healing activity of topical application of CA rhizome extracts and its cream formulations [22].

13. Antitussive activity

There are few studies done to justify the traditional use of *Curcuma aromatica* (CA) for the protection against cough. The ethanolic extract of rhizomes of CA was investigated for its antitussive effect on Sulfur dioxide induced cough model

in mice and the results suggested that the extract exhibited significant antitussive activity in a dose dependent manner [23].

14. Anti-platelet activity

Compounds isolated from CA and other drugs were evaluated for their ability to inhibit arachidonic acid- (AA), collagen- and ADP-induced platelet aggregation in human whole blood. An antiplatelet activity of the compounds was measured *in vitro* by the Chrono Log whole blood aggregometer using an electrical impedance method. Among the compounds tested, curcumin from CA and others showed strong inhibition on platelet aggregation induced by AA with IC (50) values of less than 84 microM. Curcumin from CA was the most effective antiplatelet compound as it inhibited AA-, collagen- and ADP-induced platelet aggregation with IC(50) values of 37.5, 60.9 and 45.7 microM, respectively [24].

Phytochemical Properties of Turmeric in different kinds of solvents

Table 1: Phytochemical properties of curcuma longa in methanolic extract [28]

S. No	Phytochemicals	Methanolic Extract
1	Alkaloids	+
2	Tannins and Phenolic compound	+
3	Terpenoid and Phytosteroids	+
4	Saponins	+
5	Flavonoids	+
6	Glycosides	+
7	Carbohydrates	-
8	Lactones	-
9	Proteins	-
10	Fixed Oil and Fatty Acids	+

Table 2: Phytochemical properties of *Curcuma longa* in aqueous, petroleum ether and benzene extract [29]

S. No	Phytochemicals	Extracts		
		Water	Petroleum ether	Benzene
1	Alkaloids	+	-	-
2	Tannins	+	+	+
3	Phenol	+	+	+
4	Steroids and triterpenoids	-	-	-
5	Glycosides	+	+	+
6	Flavonoids	+	+	+
7	Protein	-	-	-
8	Carbohydrates	+	+	+

Table 3: Phytochemical properties of *Curcuma longa* in ethanolic, chloroform and acetone extract [30]

S. No	Phytochemicals	Extract		
		Ethanol	Chloroform	Acetone
1	Alkaloids	+	-	+
2	Tannins	+	-	+
3	Phenol	-	-	+
4	Phytosterol	-	+	+
5	Saponins	+	+	+
6	Phlobatannin	+	+	+
7	Anthocyanin	+	+	+
8	Amino Acids	-	-	-
9	Emodin	+	+	+
10	Proteins	-	-	-
11	Carbohydrates	+	+	+
12	Cardiac glycoside	+	+	+
13	Chalcones	+	+	+
14	Anthroquinone	+	+	+
15	Leucoanthocyanin	+	+	+
16	Coumarin	-	-	-
17	Flavonoids	-	-	+
18	Steroid	-	+	-

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