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Turmeric: A spice with multifunctional medicinal properties

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ABSTRACT

Curcuma longa (Turmeric), belonging to Zingiberaceae family is one of the most useful herbal medicinal plants. Extensive researches have proven that most of the turmeric activities of the turmeric are due to curcumin. It has various useful properties with antioxidant activities and is useful in conditions such as inflammation, ulcer and cancer. It also has antifungal, antimicrobial renal and hepatoprotective activities. Therefore, it has the potential against various cancer, diabetes, allergies, arthritis, Alzheimer's disease and other chronic and hard curable diseases. The purpose of this review was to provide a brief summary of the new and current knowledge of the effects of curcumin. The recently published papers in international cites such as PubMed/ Medline, Science Citation Index and Google Scholar about turmeric were searched. Recent studies have authenticated the use of turmeric for various diseases especially oxidative stress induced ones such as cancer, diabetes mellitus and inflammatory disorders. It also is used as hepatoprotective, nephroprotective, anticoagulant and anti-HIV to combat AIDS. Curcumin, as a spice, exhibits great promise as a therapeutic agent. It has very low toxicity, too. As the global scenario is now changing towards the use of non-toxic plant products having traditional medicinal use, development of modern drugs from turmeric should be emphasized for the control of various diseases. Further evaluation needs to be carried out on turmeric in order to explore the concealed areas and their practical clinical applications, which can be used for the welfare of mankind.

Implication for health policy/practice/research/medical education:
Curcuma longa has the potential against various cancer, diabetes, allergies, arthritis, Alzheimer's disease and other chronic and hard curable diseases. Curcumin, as a spice, exhibits great promise as a therapeutic agent. As the global scenario is now changing towards the use of non-toxic plant products, development of modern drugs from turmeric should be emphasized for the control of various diseases.

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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 Zingiberaceae 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 uses 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,

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sinusitis, anorexia, coryza and cough (4). 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, anti-diabetic, antioxidant, hypolipidemic, anti-inflammatory, antimicrobial, anti-fertility, anti-venom, hepatoprotective, nephroprotective, anticoagulant, etc. The plant has also shown to possess anti HIV activity to combat AIDS. These medicinal properties of turmeric caused it to be considered as a spice with multifunctional medicinal properties.

Phytocomponents of turmeric

Turmeric contains 69.4% carbohydrates, 6.3% protein, 5.1% fat, 3.5% minerals, and 13.1%. moisture. The essential oil (5.8%) obtained by steam distillation possesses Sesquiterpenes (53%), zingiberene (25%), *a*-phellandrene (1%), sabinene (0.6%), cineol (1%), and borneol (0.5%). Curcumin (3–4%) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%) (Figure 1) (5). Demethoxy and bisdemethoxy derivatives of curcumin have also been isolated from turmeric. Curcumin has a melting point at 176–177 °C; forms a reddish- brown salt with alkali and is soluble in acetic acid, ethanol, alkali, ketone and chloroform (2).

Presence of tumerone a, tumerone b, curzerenone, curdione, mono- and di-demethoxycurcumin have been reported in the rhizomes. The essential oils of leaves of *C. longa* have been analyzed by Gas Liquid Chromatography and reported to contain linalool, caryophyllene, geraniol, α-pinene, β-pinene, sabinene, myrcene, α-phellandrene, 1,8-cineole, *p*-cymene, C8-aldehyde, and methyl heptanone (6).

A novel sesquiterpene, (6S)-2-methyl-6-(4- hydroxyphenyl-3-methyl)-2-hepten-4-one, two new bisabolane sesquiterpenes, (6S)-2-methyl-6- (4-hydroxyphenyl)-2-hepten-4-one, (6S)-2- methyl-6- (4-formylphenyl)-2-hepten-4-one, and two calebin derivatives, 4"-(4"'-hydroxyphenyl-3"'-methoxy)- 2"-oxo-3"-butenyl-3-(4'-hydroxyphenyl)-propenoate and 4"-(4"'-hydroxyphenyl)- 2"-oxo-3"-butenyl-3-(4'-hydroxyphenyl- 3'-methoxy)-propenoate were isolated along with five known bisabolane sesquiterpenes from turmeric (7).

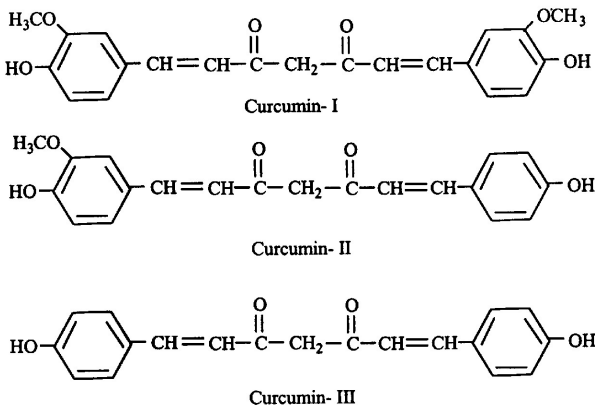

Figure 1. Various curcumins

Phytopharmacology of turmeric

Turmeric has several therapeutic and pharmacologic activities. The following is the most important phytopharmacology and therapeutic properties of turmeric.

Antioxidant activity

Curcumin has been shown be a powerful scavenger of oxygen free radicals. Its antioxidant activity is comparable to vitamins C and E (4). It can protect lipids or hemoglobin from oxidation. It can significantly inhibit the generation of reactive oxygen species (ROS) such as H2O2, superoxide anions and nitrite radical generation 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 (5). An *in vitro* study measuring the effect of curcumin on an inducible stress protein, resulted in enhanced cellular resistance to oxidative damage (6).

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 (7).

Inflammatory and edematic disorders

Curcumin is a potent anti-inflammatory 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. 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 (8). In an animal study, rheumatoid arthritis induced by streptococcal cell wall, intraperitoneal injection of turmeric extract containing 4 mg total curcuminoids/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% (9).

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 healed in 48 percent of patients. No adverse reactions or blood abnormalities were recorded (7). 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 (10). 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 (11).

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 (8-12).

Antimicrobial activity

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 (11). In another animal study, topically application of turmeric oil inhibited dermatophytes and pathogenic fungi in guinea pigs at 7 days post-turmeric application (13). Curcumin has also been found to have moderate activity against *Plasmodium falciparum* and *Leishmania major* organisms (14).

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 (3-5). 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).

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 (15,16).

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 (7).

Conclusion

Turmeric is the unique source of various types of chemical compounds, which are responsible for a variety of activities. Although, a lot of experiments have been done on turmeric, however, more investigations are needed to exploit other therapeutic utility to combat diseases. A drug development programme should be undertaken to develop modern drugs. Although crude extracts from leaves or rhizomes of the plant have medicinal applications, modern drugs can be developed after extensive investigation of its pharmacotherapeutics, bioactivity, mechanism of action, and toxicities, after proper standardization and clinical trials. As the global scenario is now changing towards the use of non-toxic plant products having traditional medicinal use, development of modern drugs from *C. longa* should be emphasized for the control of various diseases. Further evaluation needs to be carried out on *C. longa* in order to explore the concealed areas and their practical clinical applications, which can be used for the welfare of mankind.

Authors' contributions

Authors contributed equally.

Conflict of interests

The authors declared no competing interests.

Ethical considerations

Ethical issues (including plagiarism, misconduct, data fabrication, falsification, double publication or submission, redundancy) have been completely observed by the authors.

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