Indian Journal of Agriculture and Allied Sciences
A Refereed Research Journal

ISSN 2395-1109
e-ISSN 2455-9709
Volume: 3, No.: 1, Year: 2017

www.mrfsw.org

Received: 13.12.2016, Accepted: 28.12.2016

TURMERIC (*CURCUMA LONGA*) AN ADAPTABLE DRUG IN AYURVEDA: A REVIEW

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Abstract: *Recently, it is seen that a great interest is given to the studies of herbal drugs and traditional remedies through worldwide and there has been an upsurge in the scientific investigations in area. Although turmeric (Curcuma longa) has been described in Ayurveda, especially for the treatment of inflammatory diseases but it has a broad range utility among common people. It is referred by different names in different cultures according to its use and adoptability active principle called curcumin or diferuloylmethane, a yellow pigment present in turmeric (curry powder) has been shown to exhibit numerous activities. Extensive research over last fifty years has revealed several important functions of curcumin. The present paper is aimed to review the ethanobotanical properties, pharmacognostic, phytochemical and pharmacological properties of turmeric plant. Root part (Rhizome) of the plant are widely used by different tribal communities as turmeric have been shown to have wide spectrum of biological actions, which include anti-inflammatory, anti-cancerous, anti-diabetic, analgesic, antibacterial, anti-fungal, anti-protozoal, anti-ulcer, hypocholesteremic activities and many more medicinal values.*
Keywords: *Curcuma longa, Kasthuri turmeric, Haridra, Phytochemistry.*

Introduction: Kasthuri turmeric (Curcuma aromatica Salisb.) is an aromatic plant of Zingiberaceae family which has great medicinal values and multiple uses. Turmeric is known as the "golden spice" as well as the "spice of life." Turmeric has strong associations with the socio-cultural life of the people of the Indian subcontinent. This "earthy herb of the Sun" with the orange-yellow rhizome was regarded as the "herb of the Sun" by the people of the Vedic period. No wonder the ancients regarded turmeric as the *Aushadhi*, the healing herb, the most outstanding herb, the one herb above all others [1]. Turmeric has at least 6000 years of documented history of its use as medicine and in many socio-religious practices. Turmeric is probably a native of South East Asia, where many related species of curcuma occur wildly, though turmeric itself is not known to occur in the wild. Turmeric is cultivated most extensively in India, followed by Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, and Philippines. On a small scale, it is also grown in most tropical regions in Africa, America, and Pacific Ocean Islands. Several commercially produced cosmetics and *Ayurvedic* preparations contain turmeric. Skin care is the major domain of application of this aromatic plant. Rhizome of *Curcuma aromatica* is also used in medicines as a stomachic, carminative and emmenogogue for skin diseases and recently as a health food in Japan [2]. Considering the world demand for organic food, the improvement of soil health and productivity and the availability of local resources, the organic farming practice can be encouraged. Our farmers can take advantage of this opportunity presently available in the international market by offering organically produced spice, aromatic and medicinal products. Use of bio-fertilizers for crop production is gaining momentum as they are environmentally safe when compared to chemical fertilizers. Declining availability and huge cost of bulky chemical manures demands the need for reducing their quantity through appropriate substitutes. As a cost effective supplement to chemical fertilizers and as a renewable energy source, microbial inoculants can economize the high investment needed for fertilizer usage of N and P [3].

Ethanobotany: 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 [4]. Turmeric covers 6% of the total area under the spices in the country, which are mainly used for domestic purpose. 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, as coloring, medicinal and ornamental materials [5]. It is intellect-promoting (Sayana), antidote for snake venom (Kausika Sutra), in cardiac complaints and jaundice (Atharvaveda samhita). 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 [6]. It was compiled that 114 biological properties of turmeric from the USDA database [1]. 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 and [7].

Phytochemistry: The major constituents, curcumin (diferulolmethane) is in the most important faction (60%) of *Curcuma longa*, which melts at 176 ^{0}C to 177 ^{0}C and forms red-brown salts with alkalis. Curcumin is soluble in ethanol, alkalis, ketone, acetic acid and chloroform; and insoluble in water. In the molecule of curcumin, main chain is aliphatic chain, unsaturated and aryl group can be substituted or not. The essential oil (5.8%) obtained by steam distillation of rhizomes has a-phelladrene (1%), sabinene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpines (53%) [8, 9]. Curcumin (diferuloylmethane) (3-4%) is responsible for yellow color and comprises of curcumin I (94%), curcumin II (6%) and curcumin III (0.3%). Demethoxy and bis-demethoxy derivatives of curcumin have also been isolated [10].

Adoptogenic Therapeutic Properties of Turmeric

Analgesic Action: The powdered rhizome is effective in the treatment of sprain and inflammation [11]. Turmeric paste mixed with a little lime and saltpeter and applied hot is a popular application to sprains [12].

Anti-inflammatory Action: Inflammatory changes of joints are often associated with rheumatic complaints. Turmeric is attributed with hot potency and antiinflammatory action. It cures the etiological factors and pathological changes of inflammation [13]. A clinical trial in eight patients with definite rheumatoid arthritis showed significant improvement in morning stiffness and joint swelling after two week therapy [14].

Healing Property, Skin Care: In *Ayurveda* Turmeric powder is extensively described for its wound healing effect and to brighten the gleam and tone of the skin. Oil of turmeric and its ether and chloroform extracts have proved to be antifungal, anti-protozoan, antiviral, and antibacterial [14]. Turmeric is said as Vranahara (ulcer healing),Varnya (improve complexion), Tvakdoshahara (cure skin diseases), and Kandoohara (cure itching). Till recently, before the onslaught of synthetic and herbal skin care products in the market, womenfolk were dependent more on turmeric, and they used to smear their bodies with a mixture of turmeric–sandal paste for gaining a golden glow to their skin, [15]. Turmeric helps to remove hairs and impart colour and improve complexion of skin. Several Sanskrit synonyms of turmeric indicate its color-improving property (such as: varna-datri—one who gives color, indicates its use as enhancer of body complexion; hemaragi and hemaragini—both indicate golden color, meaning that it is used by womenfolk to get a golden complexion; yoshti priya, meaning favorite of young women, indicating its use for enhancing beauty; hridayavilasini, meaning giving delight to heart, charming; etc.). It is considered as an effective wound-healing medicine and is strongly related to the social customs of India. If a wound occurs as a part of a ritual, only turmeric powder is used for healing. The fresh juice of turmeric is believed to have anti-parasitic property in many skin afflictions. Turmeric powder with cow's urine is given internally also in prurigo and eczema. Turmeric mixed with gingili oil is applied over the body to prevent skin eruptions. A coating of turmeric powder or a thin paste is applied on small pox and chicken pox patients to facilitate the process of scabbing [12]. Experimental studies proved that

curcumin enhances cutaneous wound healing in rats and guinea pigs by increasing the formation of granulation tissue and biosynthesis of extra cellular matrix proteins. Systemic treatment with curcumin in local muscle injury led to faster restoration [16].

Antidiabetic Property: From the Samhita period itself (ca. 4000 yrs), turmeric was famous for its antidiabetic property. Experimental study reports also prove the efficacy of turmeric in diabetes [17]. Experimental study on the efficacy of turmeric on blood sugar and polyol pathway in albino rats and found that both turmeric and curcumin decreased blood sugar level in alloxan-induced diabetes. Curcumin was found to be capable of decreasing the complications in diabetes mellitus [18]. The report suggests that the antidiabetic action of turmeric may be mainly through the vitalization of pancreatic cells and by stimulation of insulin production. The ethanolic extract of turmeric was found to lower blood glucose level when given as injection to experimental rats. The lowering effect was 37.2% after 3 hours and 59.5% after 6 hours.

Anthelmintic Property: Alcoholic extract of rhizomes was found to have anti-protozoal activity against Entamoeba histolytica [19]. Curcumin has anti-leishmania activity [20]. Turmeric is said to be Krimihara (anthelmintic) and Krimighna (destroyer of worms) in Ayurvedic lexicons. The juice of turmeric has anti-helminthic property on internal use. In the rural areas of Nepal, turmeric powder or paste boiled in water with a little common salt is taken as an anti-helminthic [12].

Turmeric in Respiratory Diseases: Turmeric is well accepted as a Kaphahara drug (phlegmatic conditions are termed as "Kapha" and that which cures it is Kaphahara). Turmeric is anti-inflammatory and anti-purulent in nature. It is reported that volatile oil of turmeric as oral drug in a clinical trial was found very effective in the treatment of bronchial asthma [21]. Fresh rhizome proved effective against whooping cough and other coughs and in dyspnea [11]. In catarrh and coryza, the inhalation of burning turmeric fumes causes copious mucous discharge and gives instant relief [12]. The root, parched and powdered, is given in bronchitis [22]. A report of clinical trials in respiratory diseases such as bronchial asthma, bronchitis, bronchiectasis, and tropical eosinophilia revealed that turmeric could play a vital role as an adjuvant in improving the airway resistance. Anti-asthmatic property of Curcumin had been tested in guinea pig model [23].

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 [24]. 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.

Turmeric in Liver Diseases: For curing jaundice, turmeric paste was applied over the body of the patient, and the sorcerer carried out magical expulsion of the disease. After that, the turmeric was washed off and the people believed that the disease also got washed off together with the turmeric [15]. Turmeric is considered good for afflictions of the liver [25, 22]. Turmeric is effective in treating jaundice and is recommended in the diet of patients suffering from jaundice or even infective hepatitis. Clinical trial with turmeric and Phyllanthus fraternus for treating infective hepatitis has proved very effective, without any side effects. In Japan, crude turmeric rhizomes were tested in experimental animals against CC14-induced hepatotoxicity. The curcuminoids showed significant anti-hepatotoxic action. Ethanolic extract of turmeric showed significant hepatoprotective effect. Curcumin in combination with Eclipta alba and P. fraternus was a promising combination against liver injuries, which normalized the level of lipid accumulated in the liver and brought down the level of serum bilirubin in CC14-induced hepatotoxicity in experimental rats. The level of serum triglycerides, pre-β- lipoproteins and cholesterol improved and that of glycogen normalized after treatment [26].

Turmeric in Digestive System: Turmeric is a traditionally used spice and has formed an essential ingredient in Indian recipes from time immemorial. In the digestive system, turmeric acts as a carminative and protective against intestinal gas formation. The hot potency of turmeric (as per Ayurveda) enables it as a

digestive and stimulant. Turmeric is an important constituent of the group of drugs indicated for diarrhea, in Ashtanga hridaya and Susruta samhita, two of the most respected lexicons in Ayurveda. Turmeric is anti-flatulent, digestive, and stimulant due to its hot potency. It is reported to have antispasmodic activity, inhibiting excessive peristaltic movements of the intestine [25-26]. Anti-flatulent activity of turmeric/curcumin in experimental animals [27]. Curcumin enhanced intestinal lipase, sucrase, and maltase activity [28]. Turmeric powder increased mucin secretion in rabbits and thus acted as a protecting agent against irritants [29]. In experimental studies, curcumin showed protective effects from ulcerogenic effects of phenylbutazone [30-31]. But 0.5% curcumin failed to protect, and at higher doses of 50 mg or 100 mg/kg it produced ulcers (Gupta et al. 1980). Curcumin blocked indomethacin; ethanol and stress-induced gastric ulcers in experimental rats [14].

Turmeric in Ophthalmic Care: Turmeric is indicated in traditional medicine in catarrahal and purulent ophthalmia, conjunctivitis, etc. Central Food Technological Research Institute, Mysore, isolated a water-soluble peptide (0.1% of dry weight) from turmeric, having antioxidant activity. It inhibited deoxyribonucleic acid (DNA) damage, especially produced by wood smoke, and reported that it can reduce the opacity on eye lens, produced by smoke condensate and thereby prevent loss of vision [26]. Efficacy of curcumin in the management of chronic anterior uveitis (CAU) was investigated clinically [32]. Curcumin was administered orally to patients suffering from CAU at a dose of 375 mg tds for 12 weeks and found that the efficacy of curcumin in curing CAU, and the recurrences following treatment were comparable to that of corticosteroid therapy. The lack of side effects with curcumin forms the greatest advantage, compared to corticosteroids. Screening of some indigenous plants for their lens aldose reductase (LAR) - inhibiting potential. Turmeric and three other indigenous plants were found effective in inhibiting LAR activity [33].

Antitumor/ Anticancerous Activity: Dietary turmeric could be effectively used as a chemopreventive agent in benzo- (alpha)-pyrene-induced forestomach tumors in Swiss mice. An ethanolic extract of turmeric, as well as an ointment containing curcumin, is reported to produce remarkable symptomatic relief in patients with external cancerous lesions [26]. It is now proved that the antioxidants present in turmeric neutralize carcinogenic free radicals. Curcuminoids possess anti-carcinogenic property due to their oxygen radicalscavenging property [34-35]. In a comparative study of curcuminoids for their free radical-scavenging activity. It is found turmeric to be the most potent free radical scavenger, followed by dimethoxycurcumin and bis-demethoxy curcumin. Acetyl curcumin was found inactive [36]. Reports showed the use of turmeric preparations in the treatment of cancer. Curcumin has showed a suppressive effect on human breast carcinoma cells [37-38]. In the course of a search for antitumor agents, the extract of turmeric was found to be effective in inducing apoptosis or programmed cell death (PCD) in human myeloid leukaemia cells (HL—60) [39]. Curcuminoids protect the normal human keratinocytes from hypoxanthine/xanthine oxidase injury. Further, they proposed that since curcuminoids synergistically inhibited nitrobluetetrazolium reduction, a decrease in superoxide radical formation, leading to lower levels of cytotoxic hydrogen peroxide, might explain the protective effect [40]. The chemopreventive effect of curcumin was assayed during the promotion/progression stages of colon cancer. The inhibition of adenocarcinomas of the colon was reported as dose dependent. Curcumin treatment during the initiation and postinitiation stages as well as throughout the promotion/progression stage increased apoptosis in colon tumors, compared with groups receiving azoxymethane (AOM) and the control diet [41]. It is revealed that the antitumor activity of curcumin is mediated through the induction of apoptosis in AK -5 tumor cells [42]. Reports showed that turmeric inhibited tumor necrosis factor (TNF)-α-induced expression of adhesion molecules on human umbilical vein endothelial cells. Curcumin was the most potent among the three compounds tested, as inhibiting TNF-α induced expression of intercellular adhesion molecule-1(ICAM-1), vascular cell adhesion molecule-1 (VCAM-1), and E-selectin by human umbilical vein endothelial cells [43]. Curcumin-I, II, and III from turmeric were assayed by for their cytotoxicity and antioxidant, and anti-inflammatory activities. These compounds were reported to have potent activity against leukemia and colon, central nervous system (CNS), melanoma, renal, and breast cancer cell lines [44]. Evaluation of the anticancer potential of curcumin was performed. Human clinical trials indicated no doselimiting toxicity when

administered at doses up to 10 g/d. The available evidences indicate that turmeric and curcumin can inhibit cancer at the initiation, promotion, and progression stages of TPA (12-O-tetradecanoylphorbol-13-acetate)- induced tumor promotion in mouse skin [45]. All the studies thus suggest that curcumin has enormous potential in the prevention and therapy of cancer.

Anticholesterol Action: Turmeric, as well as curcumin, is reported to reduce the uptake of cholesterol from the gut and increase the high-density lipids (HDL) cholesterol and decrease low-density lipids (LDL) type. It can also inhibit the peroxidation of serum LDL, which can lead to atherosclerotic lesions. Thus, turmeric can prevent coronary problems and heart diseases [26]. Investigation showed the possible hypolipidemic effect of curcumin in rats fed on a high cholesterol diet (HCD). He found an obvious hypocholesterolemic effect that is supposed to be due to an effect on cholesterol absorption, degradation, or elimination, but not due to an antioxidant mechanism. The report suggests that the ingestion of curcumin-containing spices in diet, especially rich in fat, could have a lipid-lowering effect [46].

Antifertility: Turmeric is reported to possess anti-fertility activity, as observed in experimental animals. Petroleum ether and aqueous extracts produced 100% anti-implantation effects in rats at a dose of 200 mg/kg body weight fed orally on the first to seventh day of pregnancy [47]. Studies showed the effect of curcumin as a potential vaginal contraceptive and found that it inhibited human sperm motility and had the potential for the development of novel intravaginal contraceptive. The test results indicated that curcumin had a selective sperm-immobilizing effect in addition to a previously studied antihuman immunodeficiency virus (HIV) property. Investigation showed the contraceptive effect of turmeric in male albino rats and observed a reduction in sperm motility and density in treated group. Turmeric is supposed to have affected the androgen synthesis, either by inhibiting the Ley dig cell function or hypothalamus pituitary axis, thereby inhibiting the spermatogenesis [48].

Biomedical Applications of Turmeric: If systemic bioavailability of curcumin can be improved to allow bioactive concentrations of curcumin and piperine in vivo, then this combination may serve as an effective cancer preventive intervention to limit stem cell self-renewal, since these cells, and deregulation of self-renewal pathways, may be involved in carcinogenesis. Strategies aimed at reducing stem cell number and inhibiting their self-renewal could be an effective approach in cancer prevention. If this is the case, then assays such as atmosphere formation and ALDH expression may serve as biomarkers for cancer prevention studies in clinical trials. Curcumin, even at large doses, has been demonstrated to be non-toxic in clinical trials. Piperine has been shown in a small, phase I clinical trial to enhance the systemic bioavailability of curcumin. However, a more systematic phase I trial with pharmacokinetic, pharmacodynamic and toxicity endpoints of repeated dosing of these agents in combination is still needed. If proven safe and efficacious, dietary polyphenols could be an acceptable non-toxic long-term cancer risk reduction strategy [49].

Table 1: Important Components of turmeric and their medicinal Properly

Component Name	Medicinal Property
Curcumin	Anti-HIV, anti-EBV, antioxidant, antiadenoma carcinogenic, antiaflatoxin
Bis- desmethoxycurcumin	Antiangiogenic, anti-flammatory, cytotoxic, anticancer
Desmethoxy Curcumin	Antiangiogenic, anti-nflammatory, anticancer
Tetrahydro Curcumin	Antioxidant and anti-inflammatory
Alpha Curcumene	Antitumor and anti-inflammatory
Ar- turmerone	Anti-inflammatory, antitumor, cox-2 inhibitor
Curcumol	Anticancer, antitumor (cervix) and anti-sarcomic
Curdione	Anti-leukopenic, antisarcomic, antitumour
Dehydro Curdione	Analgesic, anti-inflammatory antipyretic and calcium channel blocker
Zingiberene	Antirhinoviral, antiulcer and carminative

Conclusion: Turmeric is one of the most precious and powerful plant on earth and is being used as a natural wonder by the ancient people of India. Turmeric is proving beneficial in the treatment of many different health conditions from cancer to Alzheimer's disease. Studies at Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore, India shown that turmeric may play a vital role in fighting HIV/AIDS. Consequently, agents that can modulate multiple cellular targets are now attractive objects of research. As this review has shown curcumin is one such agent and has potential to treat various diseases. More extensively well controlled

clinical trials are now needed to fully investigate its potential. Regardless of all these curcumin has established as a foodstuff and also a natural medicine because of its low cost, proven chemopreventive and therapeutic potential and potent pharmacological activities of turmeric at in-vivo and in-vitro which made it a nature's precious drug. Curcumin is rapidly moving from kitchen shelf toward the clinic.

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