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Review Article

Alimentary and Recuperative Prospective of *Curcuma longa* (Turmeric)

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Abstract

Plant based traditional health care is one of the ancient remedies used to prevent and treat different health related disorders. Due to increasing cost of medicine in the modern era, people are now moving towards the utilization of ancient ethno medicinal plants based remedies to prevent and treat diseases as well as to maintain their health. *Curcuma longa*, commonly known as turmeric has been used since ancient times as ethno medicinal plant due to its pharmacological and therapeutic potential. The rhizome of this plant is commonly used to prevent the lifestyle related disorders. Its biologically active components can also be extracted and utilized directly to enhance the efficacy. Purpose of this review is to highlight the importance of turmeric as it contains various biologically active components that are beneficial in prevention and treatment of various health related disorders. Turmeric has been demonstrated to exhibit anti-cancer, immunostimulant, skin protection, ulcer treating, anti-inflammatory, anti-malarial, anti-bacterial, anti-fungal, anti-viral, anti-parasitic, anti-hyperglycemic, anti-oxidant, anti-hyperlipidemic, hepatoprotective, renal protection and hematological parameters maintenance properties. There is no evidence of adverse effects of turmeric in literature. Only the people who are allergic to it can have side effects otherwise it is almost stomach friendly due to which it can be used for treatment of various health related disorders.

Key words: Medicinal plants, *Curcuma longa*, turmeric, therapeutic properties.

INTRODUCTION

The antiquity of plants is as old as the human civilization and based on health care that goes back to the earliest times. Herbs and the plants have been considered as principal base of medication in the old-fashioned healthcare systems round the world, till new in developing countries of the world. On this planet of earth almost 250,000 species of higher plants are predictable. Out of these plant species only 6% of total plants have been isolated for their biological actions and from this only 15% are described to be categorized phytochemically. In comparison to the artificial drugs, universal natural product demand for their benefits is rising exponentially (Verpoorte *et al*., 2006).

Turmeric is an oldest spice that has found to have anti-cancerous, antioxidant, anti-tumor and hypolipidemic characteristics that may be due to its naturally occurring substances which decrease the lipid peroxidation and attenuate the blood cholesterol. For the regulation of hyperlipidemia turmeric is widely used in Unani system of medication. By many pharmacological studies, the lipid lowering effects of turmeric have also been authenticated (Ramırez-Tortosa *et al*., 1999).

Turmeric is one of the spices which are used in curry to improve color and flavor. While one of its chemicals known as curcumin has medicinal properties which are used to reduce the pain and inflammation, like osteoarthritis. Turmeric is good to prevent the oxidation of low-density lipoproteins (LDL) cholesterol which may cause formation of atherosclerosis.

Turmeric

Turmeric (*C. longa*) is composed of rhizomes in the form of large rootstocks. The major biological component of turmeric is Curcumin (diferuloylmethane), and its related compounds that provide a number of different types of physical and pharmacological accomplishments like anti-

inflammatory, anti-cancerous and antioxidant properties. Turmeric also lessens the oxidative stress, and it has observed that it causes the decrease in peroxidation of lipids in human beings as well. The levels of plasma fatty acids and triacyl glycerides of hyperlipidemic rabbits are reported to lower by turmeric extract (Ashraf *et al.,* 2005). The rhizome of *Curcuma longa* is known as turmeric, which is a member of family Zingiberaceae and used as spice, dying material, medicine, ornamental, flavor and food constituent. In pharmaceutical applications, the oil extract of turmeric is heavily used for its antioxidant, counter mutagenic, anti-carcinogenic, anti-fungal and anti-bacterial characteristics (Ling *et al.,* 2012).

The blonde color of turmeric is just because of the presence of curcuminoids that are its bioactive phenolic components. It is a commonly used spice all through the history of South Asian and Middle East countries. Curcumin, desmethoxycurcumin and bisdemethoxycurcumin are most important constituents of curcuminoids having a variety of beneficial pharmacological effects (Panahi *et al*., 2017).

Turmeric is a perennial herbal plant known to have its origin in India. It is also grown in Japan, Korea, Indonesia, Taiwan, and in certain other countries of the world. The word "haldi" is used as name of turmeric in India and has been used as a traditional color for clothes owing to its pale-yellow color. It has also been used in important events and rites, such as marriages, by spread the paste of turmeric on different body parts or by blending rice with turmeric powder towards the groom and bride. Ointments made from turmeric have been used to treat chicken pox, leprosy and skin ulcer. "Ayurveda", the first Indian medical publication, claimed the turmeric as an anti-inflammatory agent. Increasing the nutritive value, delaying freshness and preserving the quality, preference and reliability of shape are some other important functions of turmeric (Kim *et al*., 2016).

It is perennial plant with 1meterheight primarily used as a dye but later used as a medicine and it is a major part of Ayurveda. Turmeric is a key ingredient in many Asian dishes gives mustard color, pungent smell and slightly bitter flavor. Turmeric is not only used in savory dishes it is also used in some sweet dishes like Sfouf (almond-semolina cake). Due to curcumin, turmeric gives golden yellow color which makes poor fabric dye. It is also used as food additive to protect food products from sunlight, coded as E100. While turmeric paper used in chemical analysis as indicator of acidity and alkalinity.

Composition of turmeric

Generally, the turmeric rhizomes contain 4-15% of such polyphenolic compounds with curcumin as the primary compound. Curcumin is an orange- yellow chemical having molecular weight of about 368.38. It is immiscible in water, but it is solubilized easily in almost all types of organic solvents like ethanol, methanol and acetone etc. Commercially available "curcumin" is a combination of three types of curcuminoids. Chemical this commercial curcumin is composed of about 71.6% curcumin (curcumin 1), 19.3% demethoxycurcumin (curcumin 2) plus 9.10% bisdemethoxycurcumin (curcumin 3). Some other species of Curcuma also possess these curcuminoids, but they are present in certain other concentrations. For example, cyclocurcumin have cyclization of the seven-carbon unit as a pyrone ring, only found in C. longa (Li *et al., 2011).*

Overall chemical composition of vital oil is different in various parts of turmeric plant. For example, oil of turmeric flowers contains about 60 constituents, 48% of oil is composed by just 25 components. In the same way rhizome oil constitute about 47 components out of which 24 compounds contribute the 70% of oil. Turmerone (10%), ar-turmerone (31.2%), curlone (10.5%) and ar-curcumin (6.30%) are present in rhizome oil (Leela *et al.,* 2002).

The major component of turmeric is volatile oil, which consist of turmerone and other coloring agents which known as curcuminoids. Turmerone, arturmerone, and zingiberene are the components which are responsible for pleasant aroma of turmeric. It is a rich source of essential fatty acids like α-linolenic acid and ω-3 fatty acid. These essential fatty acids are responsible for formation of cell membranes, retina and central nervous system.

Traditional uses of turmeric

Ayurvedic system has been using *Curcuma longa* as an ethno medicine, dietary spice and coloring agent since ancient times. In English *Curcuma longa* is called turmeric and ukon in Japanese. It is called haldi in Hindi, and called pasupu in Telugu, Aarishina in Canada and nalud in Bengal. Turmeric is used as a dyeing agent to tint silk, cotton, wool and other clothing of daily use. In Indian medication system, it is used to treat acidity, stomach pain, wound healing and as an anti-inflammatory, carminative and blood purifying agent (Luthra *et al.,* 2001).

Curcumin has found as a strong curing agent against a number of health-related disorders including anemia, cancer, diabetes mellitus, digestive issues, food intoxication, gallstones, indigestion, IBS, parasitic attack, poor circulation, staph infections and poor wounds healing. Further the phlegm in the gullet, liberations like leucorrhea and other fluids of the eyes, ears or wounds can be treated with turmeric. In Unani medicine, turmeric has also been used in illnesses including liver obstruction, jaundice and applied topically to treat ulcerative and inflammatory problems (Debjit *et al.,* 2009).

The actions of turmeric against several sicknesses particularly oxidation stress induced ones like oncogenesis, diabetes and inflammatory syndromes are authenticated by recent studies. Some other significant contributions that insure the normal functioning of liver, kidneys, steady blood flow and to combat with HIV and AIDS were also achieved by using turmeric. Moreover turmeric has very low toxic level. Due to reduced use of traditional medicine in modern era the production of turmeric based innovative medication must be encouraged to resist the occurrence of different infections (Nasri *et al.*, 2014).

Turmeric used in many therapeutic preparations all over the world. It has many medicinal properties like strengthening the energy of the body, improving digestion, regulating menstruation, dissolving gallstones, and relieving arthritis. Turmeric (Haldi) has traditional use in wedding ceremony. In Hinduism, people applied turmeric to bride and groom before their wedding because they think turmeric color keep the evil eye away from newlywed couple. It also gives extra glow to bride and groom and it's a symbol of blessing.

Anti-hyperlipidemic perspective

Hyperlipidemia is increased amount of circulating fats in the blood. These fats involve high levels of triglyceride, cholesterol, or lipoproteins. Hyperlipidemia is generally common after consumption of food but it should be diminished within 12 hours of consumption. But such type of lipidemia is taken normal. Mildly elevated cholesterol may occur in animals on high-fat diets. However, the persistent hyperlipidemia is abnormal, and it may be primary or secondary. The main reasons behind the global prevalence of hyperlipidemia are poor eating practices, overweight and sedentary lifestyles (Verma, 2013). The condition of familial hypercholesterolemia (FH) is caused by increased concentration of LDL in blood circulation that causes the unwanted accumulation of cholesterol in the muscles ultimately leads to the atherosclerosis and improves the risks of coronary heart diseases. Poor degradation and improper hepatic uptake of LDL causes the FH (Soutar & Naoumova, 2007).

Turmeric helps to lower down the concentration of lipids especially low-density lipoproteins (LDL) in blood. So, by the use of turmeric we may prevent the cardiovascular diseases which are endemic. Curcumin is an active ingredient of turmeric which may protect the patients at high risk of cardiovascular diseases through improving serum lipid level.

To determine the cardio protective effects and biological safety of turmeric by lowering blood lipids in patients at risk of CVD's this human based study was performed. This analysis included 649 patients. Serum LDL and TG levels were significantly reduced by turmeric and curcumin in treatment group but it remained same in the control group. These treatments found beneficial to reduce the level of serum TC in patients having metabolic disorders and a greater effect can achieve possibly by using turmeric extract however certain improvements in level of serum HDL were not observed there. Regarding the biosafety aspect of curcumin and turmeric, no harmful effect was seen in any included subject of study that cleared that both treatments are quite safe. It means curcumin and turmeric have potential to reduce the risks of CVD's in different patients by showing improvement in blood lipids status through improving serum lipid levels (Qin *et al*., 2017).

Associated complication of diabetes mellitus may include hyperlipidemia. A study was conducted to examine the effects of tetrahydro curcumin (THC), an active component of curcumin on lipid profile in mice suffering from diabetes induced by the administration of streptozotocin. Oral administration of THC in amount of 80 mg per kg B.W was insured in diabetic mice for the period of 45 days, the results showed a significant decline in level of blood glucose and growth in plasma insulin, which explored the antidiabetic potentials of THC supplementation. The levels of hepatic and serum cholesterol, triacylglycerides, extra fatty acids, activity of HMG CoA reductase, low density lipoproteins and high-density lipoproteins showed significant improvements after the THC consumption. After this treatment decreased serum high density lipoproteins of diabetic mice showed reversal towards the normal levels. Histopathological examination of liver was done to supplement these biochemical observations. It was proved by results that THC showed hypolipidemic achievements both in control and experimental groups of diabetic rats. As compared to same dose of curcumin the hypolipidemic and antidiabetic effects of THC are more compelling (Pari & Murugan, 2007).

Nicotine is one of major lethal constituents of cigarette that plays a pivotal role in initiation and progression of pulmonary cancer and cardiovascular diseases. In this study the creation of an analogue of curcumin and bio monitoring of its impact over chemical biomarker enzymes and lipids profile of rats induced with nicotine-toxicity was done. A renowned antioxidant and hypolipidemic compound called curcumin was used as a standard to compare the end results of given treatments. To induce the toxicity nicotine was administered hypodermically at the rate of 2.5 mg per kg of body weight, and intragastric intubation of curcumin (80 mg per kg) was introduced concurrently along with nicotine for the period of 22 weeks. During this research the activities of different chemical biomarker enzymes including aspartate transaminase, alanine transaminase, alkaline phosphatase, lactate dehydrogenase and of plasma lipid profiles were tested to determine the lipid regulating

capacity of curcuminoids. The rats treated with nicotine showed the increased levels of plasma marker enzymes and lipid profiles in their collected blood samples. Whereas the feeding of curcumin and its analogues to nicotine treated rats induced a significant reduction in the actions of marker enzymes and plasma lipid concentrations. Thus, it is suggested by our study that curcumin and its analogue supplied the diversified impacts on the regulation of lipids levels in nicotine induced toxic rats and for the treatment of hyperlipidemia and atherosclerosis it may be a promising agent (Kalpana *et al.*, 2005).

Curcumin also attenuated the oxidative stress and vascular structural variations induced by the hypertension. These effects were caused by the elevated plasma nitrate/nitrite level, up regulated NOS expressions, down regulated p47phoxNADPH oxidase and decreased superoxide level in the vascular tissues. The overall conclusion of this study suggested the mechanism behind the antihypertensive actions of curcumin in 2K-1C hypertension induced endothelial dysfunctioning and vascular remodeling (Boonla *et al.*, 2014).

Results of studies from literature revealed that turmeric possesses anti-hyperlipidemic properties due to presence of one of its active ingredient curcumin. Curcumin is responsible for improving endothelial dysfunction and vascular remodeling thus improving the cardiovascular health.

Anti-diabetic activity of turmeric

Curcumin adopt different ways to maintain the blood sugar concentration such as by reducing the production of sugar in liver, suppress the hyperglycemia induced inflammatory responses, stimulate the uptake of glucose by up-regulation of GLUT4, GLUT2 and GLUT3 genes efficiency, stimulation of AMP kinase, encouraging the PPAR ligand-binding action, enhancing the production of insulin in pancreatic tissues, improvements in pancreatic cell performance, and decrease in insulin resistance. It means curcumin carries both the hypoglycemic and insulin sensitizing potentials (Ghorbani *et al.*, 2014).

Anti-inflammatory and anti-diabetic characteristics of curcumin have been documented by numerous studies. In its mechanism of action the reduction of inflammatory cytokines such as MCP and TNF-a and the production of AMPK by decreasing the activity of MAPK plays a central role (Kazazis *et al.*, 2014).

Spent turmeric oleoresin (STO) was studied in present research trial to evaluate its anti-oxidant and anti-diabetic capabilities. The inhibition assays of enzymes like α-amylases and α-glucosidases were used to assess the above mentioned aspects of STO. Modern technology including DPPH, ABTS, superoxide radical scavenging and metal chelating activity techniques were used to quantify its free radicals scavenging potentials. The STO was found to show an excellent anti-diabetic performance by the inhibition of α-glucosidase and α-amylase that are key enzymes linked with diabetes. The superoxide free radical scavenging activity of STO was effective and it also expresses a reasonable iron chelating character. So, it was concluded that the STO is totally a waste product that should be used in nutraceutical and food industries to manage diabetes and oxidative stress, where it can prevent several metabolic disorders (Nampoothiri *et al.*, 2012).

The protecting effects of turmeric against most commonly occurring metabolic disorders such as diabetes, hypertension and oxidative stress were evaluated here. The ethyl acetate extract of turmeric was found more effective against the activation of α-Glucosidase and α-amylase activity as compared to that of the drugs used in routine treatment. The inhibitory effect of ethyl acetate extract against the glycation of proteins was about 800 times better than that of ascorbic acid. It was also revealed that the ability of ethyl acetates extracts to minimize the oxidation of fats, scavenging free radicals and to alleviate the oxidative stress is much higher. The direct relationship between the anti-glycation and free radical scavenging capacities of this extract further confirmed the part of antioxidants to control glycation responses. This ethyl acetate extract has also been seen to inhibit the angiotensin converting enzymes found effective in reducing hypertension (Lekshmi *et al.*, 2014).

Literature revealed that there are several mechanisms that are responsible for anti-diabetic activity of curcumin present in turmeric. Curcumin present in turmeric is responsible to fight against diabetes, glycation of proteins and cellular oxidation.

Effect on cancer

More than eight hundred reports about the anti-cancer potential of curcumin have been published. Various studies investigated that cancer cells and their growth could be inhibited by curcumin in various organs cancer such as blood, GIT, prostate, pancreas, brain, skin, breast and ovary. In the advance stage of colon cancer, curcumin at all doses was observed well tolerated and there was no observation of limiting toxicity (Annapurna *et al.*, 2011).

Curcumin at all dosages showed no toxicity at different stages of cancer. Cancer cells are not totally removed by the application of curcumin, basically cancer cells growth is inhibited. Curcumin inhibits the growth of many sorts of cancer cell.

The anti-cancerous properties of turmeric, tulasi, neem and ginger on HeLa cells were analyzed in

this study. The products of these plants were used in encapsulated form and their aqueous and alcoholic extracts were collected by using the method of sox let extraction. MTT assay was performed to check the efficacy of these drugs that determines the percentage of viability and cytotoxicity. IC50 values of aqueous and alcoholic extracts of above mentioned plant products were compared. The final results of this study led to declare that the mentioned natural plants are powerful anti-cancerous compounds and they have capability to inhibit the development of immortal cells by apoptosis (Sharma *et al.*, 2004).

In another study the anti-cancerous potential of turmeric rhizome was explored by using both ex-vivo and in-vivo methods of experiments. Ex-vivo method involved the tissue culture technique and in-vivo involved the lymphoma cell's growth in rat model. The results showed that the 0.4 mg per ml supplementation of turmeric extract retarded the ovarian cell growth but this concentration was found toxic for normal body cells blood cells and Dalton's lymphomas. This toxicology was seen within 30 min of administration at ambient temperature. The active chemical ingredient behind this action was actually the curcumin that exhibited the cytotoxicity even using at the rate of 4 µg per ml. (Kuttan *et al.*, 1985).

Indian and south East Asian people have been used turmeric to treat different ailments like inflammations, skin injuries and swellings since the ancient times. Curcumins had showed a wide range of malignancy chemo protective potential in pre-clinical animal's model. The extraction of Iraqi curcumins was done by using 95% solvent solution of ethanol, followed by the isolation of extracted materials by using the technique of column chromatography. After isolation characterization of curcumins was performed by the methods of UV visible, FTIR and proton NMR spectroscopy. The research of anti-cancerous capacities of the curcumins and its alcoholic extract was determined by applying ex-vivo on rats and in-vivo on cell lining. The alcoholic extract exhibited a significant anti-cancerous potential against the cell lining of human hepatic cellular carcinomas (Naama *et al.*, 2010).

Overall the results explained that the curcumins are major biological ingredients of turmeric extract which have potential to restrict the growth of tumors in animals well as human tissues.

Effect on hepatotoxicity and liver diseases

Curcumin has imposed beneficial impact in the clinical taken trials of the patients with hepatotoxicity (Roy *et al.*, 2011). Curcumin attenuated hepatic injury by preventing hepatomegaly without causing any reduction of body weight. Curcumin also prevent lipid oxidation referred as lipid per oxidation, changes in liver enzymes level, liver enzymes activity and total proteins activity. This is because; curcumin scavenges free radicals and protects the liver antioxidant enzymes, CAT, SOD and GST (Messarah *et al.*, 2013). In human and other animals liver function is regulated by detoxifying enzymes. Curcumin regulate these enzymes system by increasing their antioxidants capacity. Curcumin also directly prevent lipid peroxidation.

The positive effects of turmeric on lead acetate induced liver toxicity were investigated in present model of research. Swiss albino rats were arranged equally into 5 groups, the group one was fed with basal diet and it was considered control group, the group two was fed with lead acetate supplemented basal diet and this group was considered positive control and the remaining three groups were fed with lead acetate supplemented basal diet including 5% turmeric and only 1% myrrh powder respectively. Consequently, the value GSH in all of the treated groups was reduced significantly when compared with negative control group. At the same time it was also observed that the actions of GSH S-transferases were considerably lessened in positive control group as compared to others. But the combined use of the above mentioned plants caused a remarkable improvement in the action potential of GST in comparison to both negative and positive control groups. And the positively controlled group showed a significant increased lipid peroxidation, whereas the combined treatment of both plants caused reduction in the peroxidation of lipids at the rate of 31% in 1% and 49% in 5% treatment groups of rats respectively. So, it was revealed that myrrh and turmeric are valuable herbal medications to control the oxidative injuries and genotoxicities produced by lead acetate intoxications (El-Ashmawy *et al.*, 2006).

Epidemiological literature clearly indicated that there is an association among arsenic exposure and the liver diseases, such as hepatic cirrhosis, hepatic fibrosis, hepatocephaly and hepatomegaly (Li *et al.*, 2008). The mechanism through which arsenic induces hepatotoxicity is not yet clear. However, recent evidences cleared that its role in increasing oxidative stress causes inflammation which ultimately damage the tissues and organs (Fouad *et al.*, 2012). It causes the oxidation of liver mitochondria that changes the permeability and transition of hepatic cells (Hosseini *et al.*, 2013). Arsenic is reported to induce apoptosis, disrupt electron transport chain and induces necrosis in the stellate cells of liver that leads to liver steatosis and hepatic fibrosis (Pan *et al.*, 2011). There are clear evidences that arsenic possess ability to induce toxicity in liver, kidneys and brain. Arsenic toxicity alternates proper functioning of brain, liver and kidneys, through disrupting different biochemical reactions such as electron transport chain.

Curcumin has imposed beneficial impact on the clinically taken trials of the patients with arsenic generated hepatic toxicity (Roy *et al.*, 2011). Against the in vitro induced arsenic genotoxicity in animal

models and rodents, curcumin showed protective effects (Tiwari & Rao, 2010). Rats treated with sodium arsenate and curcumin in dosage of 15mg/kg demonstrated that curcumin attenuated arsenic provoked hepatic injury by preventing the hepatomegaly. Curcumin also prevents the lipid oxidation referred as lipid peroxidation. Along with the GHS, curcumin also prevents the changes in liver enzymes level, liver enzymes activity and total proteins activity. Because, curcumin scavenges free radicals and protects the liver antioxidant enzymes CAT, SOD and GST (Messarah *et al.*, 2013).

Vitamin C is natural antioxidant which checked out oxidation process. Exposure of nicotine caused the deficiency of vitamin C and increased the oxidation. While different studies have declared the efficiency status of curcumin against oxidants by improving antioxidants level.

Effect on wound healing

Curcumin, isolated from turmeric, carries a number of different pharmaceutical possessions. The incorporation of curcumins in keratinocytes of human using a dose of 10 µg per mL provided substantial defensive effects against hydrogen peroxide. Similarly, the dose of exposure of 2.5 µg per mL in skin fibroblasts of human provided remarkable shielding effects against the hydrogen peroxide. However, the defensive effects of curcumins on both fibroblasts and keratinocytes against the hypoxanthine xanthine oxidases induced damages were absent in this study. The results indicated that curcumins possess very strong inhibitory potentials against hydrogen peroxide induced damages in human keratinocytes and fibroblasts (Phan *et al.*, 2001).

This study was planned to evaluate the wound healing potentials of curcumins, after topical application. It included the wounds of burns in rat models. The male albino rats were classified into three random experimental groups containing twelve rats, each group contained further subgroups. Wounds were created by burning the backsides of rats and topical application of curcumins was done. On the completion of this protocol, the biochemical and histopathological changes of the wound tissues were analyzed after the scarification of all experimental animals. The skin tissues of curcumins group showed a remarkable improvement in the level of hydroxyproline. It was ensured by the activity of different biomarkers that the healing of wounds that were treated with curcumins was comparatively very fast. The collected facts also showed that the curcumins treated rats of the burn group had an improvement in the proliferation of cellular and nuclear antigen of affected skin tissues. So, the beneficial effects of topical application of curcumins in the acceleration of wound healing was very clear in the results (Kulac *et al.*, 2013).

Medical health professionals paid a keen attention to the healing process of irradiated wounds because radiations disrupt the normal responses to injured cells and ultimately lead to a prolonged recovery period. So finding an efficient agent to heal the irradiated wounds is an important task in the field of medical management. Considering these aspects, this study was designed to examine the effects of curcumins on the healing of wounds in rats caused by exposure to γ-radiations. A full thickness wound was created on the dorsal sides of whole body irradiated rats. The progressions in wound contractions were checked occasionally by taking video images of the wounds. The histological profiles along with collagen, hexosamine, DNA and nitric oxide were assessed at different post irradiation days in rats with and without the treatments of curcumins before their contact to 0 or 6 Gy. Irradiation initiated a substantial decrease in above mentioned parameters. The rate of wound contraction was significantly enhanced by curcumin treatment. At the same time positive improvements in all histopathological aspects were also observed (Jagetia & Rajanikant, 2004).

The end results demonstrated that curcumin pre-treatment posed favorable effects on the wounds caused by radiations and it could be a considerable therapeutic approach to initiate and support the repairing of tissues damaged in irradiated wounds.

Effect on Rheumatoid Arthritis

The inflammatory, macroscopic and radiological changes in animals that were affected with collagen-induced arthritis were used to investigate the prophylactic potentials of CL extract. Six groups of male Sprague Dawley rats were used and each group had equal number of rates. From six groups one group served as control group and the remaining groups were immunized by subdermal intrusion of 150 micro grams collagen type II on day first. All the rats that were suffering from Collagen-induced arthritis, were given oral treatment of betamethasone (0.5 mg per kg of body weight) and different amounts of CL extract (30, 60 and 110 mg per kg of body weight and for four weeks use olive oil as a vehicle on daily basis. The name of tests that were performed is Arthritic scorings (AS) of the paw, estimation of erythrocytes sedimentation rate (ESR) and paw's thickness and radiological scorings. The treatment of rats by using 110 mg per kg CL gave ESD remarkable mean difference, in radiological scores on days 28 and compare with other groups that were treated with vehicle. ESR, AS and radiological scores of highest CL dose groups were showing an insignificant mean difference as compare to other group that treated with the betamethasone. From this study it was conclude that the Curcuma longa (CL) or turmeric cause deteriorating changes in the bones and joints of collagen induced arthritis rats (Zahidah *et al.*, 2012).

The distilled water extracts of ginger and turmeric were compared to examine their effects against the rheumatoid arthritis. During this study arthritis was induced into the palmar surface of rats. The given treatments included indomethacin, ginger and turmeric with distilled water. From this study it was conclude that GTaq was more effective than indomethacin more over alleviating the reduction in weight gain of body, the histopathological variations detected in ankle joints such as blood leukocytosis and thrombocytosis, iron deficiency anemia, serum hypoalbuminemia and globulinemia, the weakening of renal functioning, and the threats for cardiovascular disease in arthritic rat were reduces by using GTaq. Gingerandturmeric rhizome combination was found more potent to treat the severity of RA (Ramadan & El-Menshawy, 2013).

Some scientists conducted a study to observe the changes in the joints of arthritis effected experimental rats which were treated with turmeric. Twenty four male Sprague-Dawley (approximately 7 weeks-old) mice were arranged into four groups with different number of mice in every group. From these four groups three groups were immunized by using 150 µg of collagen and remaining one group kept as control. For two weeks all the mice having CIA and arthritis scoring greater than 1, were given an oral treatment of betamethasone and curcumin. By this study they concluded that treatment showed significant mean differences with curcumin in the average white blood cell (WBC) count (Kamarudin *et al.,* 2012).

Essential oils derived from the turmeric strongly inhibit the joint's inflammations and destruction of peri-articular joints in a specific dosage. Ex-vitro treatments showed the prevention of initiation and progression of NF-KB involving chemokine, cyclo-oxygenase 2, and RANKL- regulated inflammation and destruction of genes mediating joints. Consistent with these findings, turmeric extract treatment inhibits the influx of inflammatory cells, levels of prostaglandin E2 in the joints and particularly the synthesis of osteoclasts (Funk *et al.,* 2006).

Scientist treated female rates with turmeric essential oil TEO to induce changes in the arthritis that were induced with streptococcal cell wall (SCW). The anti-arthritis effects of TEO were convoyed by a remarkable mortality and morbidity. Twenty times higher dosages of TEO were found non-toxic and they showed 20% inhibition of joint swelling. From this experiment they found that TEO reduced the swelling of joints and showed many safety concerns in vertebrates exposed to TEO (Funk *et al.,* 2009).

Author performed a research work to associate the anti-inflammatory potentials of both curcuminoids and gingerols by applying the treatment of rat adjuvant induced arthritis. Dose of these plants decrease the intensity of arthritis by modifying the rate of inflammatory responses and initiating the anti-oxidant defense mechanism. Turmeric has greater anti-arthritic potential than that of indomethacin and ginger, particularly during the treatment of affected rats from the day first of induction. Recovery of disorder with turmeric was 4.5–8.4% and 10.3% greater in turmeric as compared to that of ginger and indomethacin. The results of this study declared that the free radicals scavenging potential of turmeric was quite higher than indomethacin and ginger, which may provide defensive properties against the rheumatoid arthritis in AIA rat model (Ramadan *et al.,* 2011).

Author evaluated the safeties of curcumin alone and with the combination of diclofenac sodium for active rheumatoid arthritis. In this study three groups of forty five patients effected by RA were used and treated with curcumin alone and then combined with diclofanic sodium. After treatment all patients from three groups showed a significant change in DAS score. Improvements in overall DAS and ACR score were high in groups that were treated with curcumin alone than other groups treated with diclofanic sodium. More over curcumin treatment could not produce any other harmful effect. Consequently, this study concluded that curcumin alone had more safe and protective effects than diclofanic sodium in the treatment of rheumatoid arthritis (Chandran & Goel, 2012).

Scientist treated the RA affected female Lewis rats with turmeric to observe the anti-arthritic activity of turmeric extract. Arthritis Induced through streptococcal cell wall to female Lewis rats. A turmeric extract containing curcuminoid was isolated intraperitoneally to female Lewis rats. Efficacy of turmeric against the prevention of joint's swellings was observed clinically, histopathologically and even by measuring the bone mass density. A turmeric extract profoundly inhibited the inflammation and destruction of joints. Particularly turmeric extract treatment inhibited the formation of osteoclast (Mewar & Wilson, 2006).

Scientist used 18 patients of rheumatoid arthritis to study the comparison of protective effects of curumin and phenylbutazone. After two weeks of curcumin treatment, the patients whose medication included the corticosteroid prior to the experiment displayed remarkable improvement in joint swelling and walking time. It was also studied that curcumin inhibits the production of cyclooxygenase-2 enzyme that causes inflammation. By inhibiting this enzyme curcumin reduced the joints swelling (Amodio *et al.,* 2018).

An animal study was conducted by Shpitz *et al.* (2006) in which the rheumatoid arthritis was induced by streptococcal cell wall, and then it was treated with turmeric by intraperitoneal injection of turmeric extract

for four days from first day of induction. Result was concluded that turmeric extract inhibit acute joint inflammation (75%) and chronic (68%). A 30-fold higher dose of curcumanoid was given to arthritic rats for four days to test the efficacy on oral preparation. Then find the result that it inhibited 48% joint inflammation.

Curcumin is an anti-inflammatory agent with specific inhibitory properties. Both vivo and vitro researches had confirmed that curcumin decreases the acute and chronic inflammation by inhibiting the lipoxygenase- and COX-2 enzymes which cause inflammation and joint swelling.

CONCLUSION

Medicinal plants have been used since centuries for the prevention and treatment of life style related disorders. Curcuma longa has been used since centuries as a therapeutic rhizome due to presence of its most abundant active ingredient curcumin. Curcumin has multiple health benefits including anticancer, antihyperlipidemic, antidiabetic, antioxidant and neuro protective potential. Due to these multiple health benefits it should be included in daily diet.

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