The Pharmaceutical and Chemical Journal, 2018, 5(4):115-120

Available online www.tpcj.org

Review Article

ISSN: 2349-7092
CODEN(USA): PCJHBA

Pharmacological and Medicinal Properties of Turmeric

Tari Marcella Joshua*[1], Ibiene Sarah Kalio[2]

[1]Department of Medical Laboratory Science, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria
[2]School of Medical Laboratory Science, Rivers State College of Health Science and Technology, Rumueme, PMB 5039, Port Harcourt, Rivers State, Nigeria

Abstract The increase of certain neurological, metabolical and multigenetical diseases such as those found in arthritis, diabetes mellitus, cardiovascular diseases, cancers as well as the high cost in providing medical healthcare has made scientists to look into phytomedicine as an alternative way for providing modalities in treatment. A natural root herb of high interest in phytomedicine used for alleviating the aforementioned diseases is the rhizome of turmeric plant (*Curcuma longa Linn*.). The phytochemicals of the turmeric rhizomes include curcuminoids, alkaloids, flavonoids and saponins. Curcuminoids have been found to be in high abundance with its three forms commercially available as Curcumin. These three forms are diferulorylmethane, demethoxycurcumin and bisdemethoxycurcumin. Curcumin is the active agent of *Curcuma longa Linn.* Curcumin functions in modulating signaling pathways in targeted cells which helps it to act as an antioxidant, anti-inflammatory, anticancer, antibacterial, wound healing agent.

Keyword: Turmeric, curcumin, *Curcuma longa*, curcuminoid

Introduction

Turmeric is a root plant cultivated in India, Asia and some parts of Africa, in Nigeria it's planted in Southern Kaduna State. The rhizome of the turmeric plant has been reported to have a great deal of Curcumin which is the main active agent of the Curcuminoids of the exudates of this rhizome. *Curcuma longa* Linn. is the generic name of the rhizome of turmeric which also belongs to the family Zingiberaceae same as the ginger plant and for its numerous medicinal value, it has been called the 'golden spice' by the Indians [1]. *Curcuma longa* Linn. can be bought from the local market of Asansol in West Bengul of India, it has been known to the Indian native as a therapeutic agent that fights against several ailments such as various chronic complications of diabetes, nephritis, inflammatory bowel diseases, cardiovascular problems as well as certain neurodegenerative diseases like the Parkinson's and Alzheimer's [2]. *Curcuma longa* Linn. has also been reported to have certain photochemical like curcuminoids, flavonoids, alkaloids. However, curcuminoids have been reported to have certain polyphenols of whose pharmacological properties are found in abundance as an antioxidant, anti-cancer, anti-rheumatodal, anti-suppressive when compared to other photochemical. Among the Curcuminoids extracted, Curcumin has exhibited the greatest of these anti-oxidative properties in animals, known for its overt function as a scavenger for free radicals that damages cellular membranes [3].

Curcumin a Phytochemical from the Rhizomes of Turmeric (*Curcuma longa* Linn.)

The rhizome of the turmeric plant (*Curcuma longa* Linn.) is the root part planted on the horizontal side underneath the ground, it is orange-yellowish in color that is responsible for the yellowing coloration of curry used as spice in soups and its phytochemical contents includes Curcumin otherwise known as diferulorylmethane (~77%), demethoxycurcumin (~18%) and bisdemethoxycurcumin (~5%) [4].

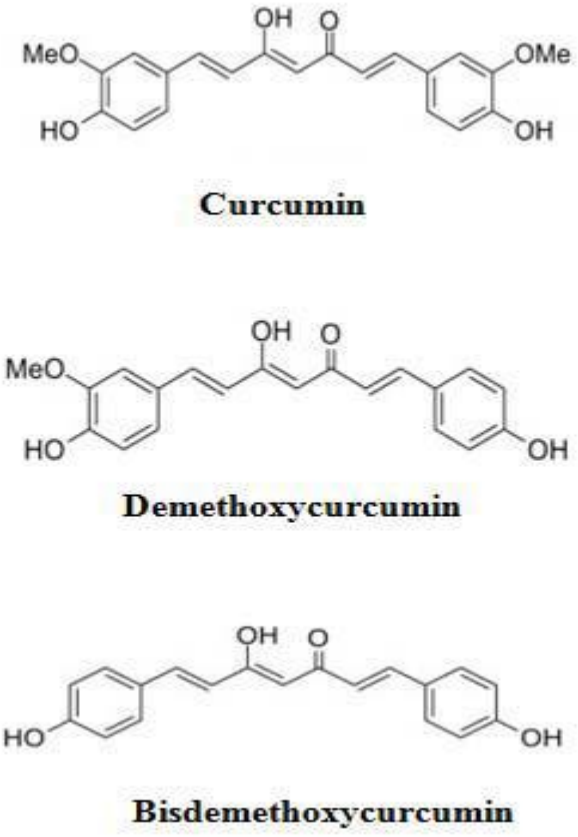

Figure 1: Structure of Curcumin, Demethoxycurcumin and Bisdemethoxycurcumin [5]

Curcumin otherwise known as diferulorylmethane is the most abundant of the turmeric analogue from the Curcuminoids, as well as its main active agent and known by the Indians for its medicinal value in alleviating diseases such as arthritis, diabetes mellitus, cardiovascular diseases, cancers [6]. Due to its low water solubility, Curcumin binds to an adjuvant like piperine (black pepper) to increase its bioavailability as well as its rate of absorption in the gastrointestinal tract down to the blood stream [7].

Structure of Curcumin's Analogue

Curcumin has a very distinctive structure, a proportioned beta- diketone which is embedded with many functional groups. It also has phenolic groups that contain aromatic rings which are binded together by two alpha, beta-unsaturated carbonyl groups. The carbonyl groups are known to create a diketone which is embedded in keto-and-enol-tautomeric shapes where aggressively more stabilized enol shapes exists in the solid phase as well as in acidic solutions [8].

Some researchers [9] described the phototherapeutic and photodegradation analogue of Curcumin especially when Curcumin is found in ground state as' Reketonized', that is when Curcumin interacts with a particular solvent such as acetone or methanol, its hydroxyl and methoxy groups tend to influence the molecular charge distribution as well as its intra-molecular proton transfer state which places it in a very unpredictive excited state.

Curcumin can be made to dissociate when in a slightly alkaline state to produce an enolate moiety, such dissociations have been perceived to be responsible for the multidynamic actions that Curcumin provides. Although as suggested by some researchers [10], this mode of action can be blocked through Knoevenagel condensation of the active methylenic group in curcumin.

Extraction of Curcumin from the rhizome (*Curcuma longa* Linn.)

The rhizomes are cut into pieces and dried in the sun for 7 days. The outer peel of the rhizome is peeled off to obtain freshly fine rhizomes. It can further be oven dried to about 50 degree Celsius after which its being taken to a universal mill to be grounded into fine powder.The powdered extract will further be dried to be ready for the extraction process. About 6g of the powdered rhizome is taken by measurement in a little thimble and placed in a soxhlet extractor [5]. The solvents to be used in this extracting appartus with regards to their boiling points include the followings (Ethyl acetate (B.P= 77 degree celsius), Chloroform (B.P = 61 degree celsius), Methanol (B.P=65 degree celsius) and Acetone (B.P= 56.33 degree celsius). The process is observed as completion when a dark brown exract after subjected to coolness is seen.The purified Curcumin usinga rotary evaporator gives a crude dried extract which is black orange in colour.The rotary evaporator produces a refluxed residue when cooled,filtered and washed with 100 ml of acetone,the diluted sample of the extract with that of the standard of Curcumin (95% HPLC purified, Charak) forms the solution that would be measured spectrophometrically at 420nm.Curcumin is thus calculated in percentages as:

$$\text{Curcumin}(\%) = \frac{\text{Absorbanceof the sample x dilution factor}}{\text{Factor derived from standard x weight of sampl}}$$ [11].

Pharmacological Properties of *Curcuma longa* Linn. (Turmeric rhizome) in Disease Conditions

Curcumin from *Curcuma longa* L. has been reported to show certain ameliorative functions in disease conditions such as in the following ways:

Anti-Inflammatory Properties of Curcuminin Arthritis

Arthritis has been categorized as inflammatory due to certain irregularity in functions of some group of proinflammatory cytokines such as interleukin-6, interleukin- 1 Beta, alpha-Tumour Necrotic Factor as well certain proinflammatory enzymes such as lipoxygenases and cyclooxygenases [12]. The remedial function Curcumin exhibits as being an anti-inflammatory agent is that it inhibits the inflammatory actions of these cylooxygenases which are prostaglandins (unpolysaturated fatty acids) that produce free radicals that are responsible for the action of inflammation responses with an increasing outcome of redness, pains and swollen joints often referred to as 'Arthritis'[1]'.

A researcher [13] showed the anti-inflammatory property of curcumin when 0.5 g of Curcumin in addition with diclofenac sodium was administered to 45 patients suffering from rheumatoid arthritis. After two weeks, these patients were observed to show a decrease in concentration of C-reactive protein as a result of anti-inflammatory property Curcumin exhibits. The patients however showed faster walking time, decrease in redness of joints and decrease in muscle stiffness.

Cardio-Protective Property of Curcumin in Cardiovascular Diseases

Another protective property Curcumin exhibits is that of ameriorating cardiovascular diseases particularly that of atherosclerosis whichis described as the stacking of fatty streaks in the arterial linings of the walls of the arteries causing stiffness as well as cutting short the supply of oxygen rich blood to the heart [14]. Curcumin has been reported to show some cardioprotective property in inhibiting the supply of free radicals that steal electrons from lipid membranes causing damages to the arteries and vascular system that brings about lipid peroxidation hence cardiovascular diseases as found also in angina that presents as tightness and heaviness of the chest when the heart muscle does not get enough oxygen rich blood as it should. This was reported in the work done by a researcher [15] who evaluated ten volunteers with high serum cholesterol concentration, they assigned them under the Curcumin

monitoring giving them 0.5 g orally for a period of 7 days, they observed a dramatic reduction in serum lipids such as in total cholesterol, low density lipoproteins and an increase in high density lipoprotein. For this reason Curcumin is known as a chemo-preventive agent against atherosclerosis.

Anti-Oxidative Property of Curcumin in Diabetes Mellitus

Diabetes mellitus is a metabolic disorder with characteristic features of chronic hyperglycemia, with an increase risk of micro and macro vascular diseases [16]. It also presents with glycosuria and polyuria.

Curcumin acts as an antioxidant as it scavenges free radicals and reactive oxygen species like those of superoxide anions and hydroxyl anions that steal electrons from the cell which causes damages to the beta cells of the Islet of Largenhans which is responsible for easy permeability of glucose into cell membranes. This antioxidative nature of Curcumin was observed in the work carried out by a researcher [17] who administered orally about 5 g of turmeric powder with insulin therapy to a 65 year old man suffering from type two diabetes mellitus for 16 years. It was observed after a period of two weeks that his fasting blood sugar decreased from 140mg/dl to 70mg/dl.

Anti-Cancerous Property of Curcumin in Breast, Colorectal and Prostrate Cancers

A multi dynamensional pathway which involves certain irregularities or alteration of more than 500 genes results in cancer which could be in form of breast, colon or prostate depending on where the virus is in the cell its signaling [18]. There are certain drugs tagged as being monotargetted that can suppress the effect of replication of cancerous cells but these drugs have been observed to have adverse effects and are seen as costly.

The expensive nature of these monotargeted drugs in cell signaling and modulation of cancerous cells has brought about a shift in certain nutraceuticals for which curcumin extract has been encapsulated into in form of nanoparticles in current undergoing human clinical assays [19]. The nanoparticles measures about 20-200nm in diameter, encapsulated in it is the Curcumin extract which is reported to inhibit the actions of angiogenesis and modulation. The nanoparticle is one which has two signaling states categorized as the cathode and anode. The process is well programmed and monitored in a way that its cationic ion releases the drug into the bloodstream making to ensure its solubility and absorption while the anionicstate will avoid the overcrowding in drug capacity, this it does in ensuring that the drug is delivered to its actual site of action and avoiding it being accumulated in other portions of the body. This process of drug monitoring is undergoing trials for therapeutic measures that will curb cancer replication in the breast, colon and prostate.

Neuroprotective Properties of Curcumin in Alzheimer's Disease

Alzheimer's disease is a neuron- dysfunctional disease that falls under the classification of dementia, it has been identified as a major concern now to the modern world in area of health care provision [20] due to the formation and some accumulation of amyloid plaques which are deposited into the brain with increasing memory loss mostly in older people of 65 years and above [21]. Curcumin in a study carried out by a researcher [22] showed the neuroprotective effect it has in inhibiting the effect of amyloids which have been reported to cause the loss of cholinergic neurons that are responsible for memory loss by randomly recruiting a total of 33 patients in their study, some of the patients with Alzheimer's disease were placed in a placebo group and others 'the test patients' were assigned to take Curcumin, with a variation of some in a high dose (4g/day) range and others in low dosage (2 g/day). It was reported after 24 weeks that the tested patients were made to be consistent in their Curcumin dosage therapy while those in the placebo were administered with one of the two dosages of Curcumin. The pharmacokinetics of this trial was well appreciated although the observations of this effect is still ongoing [22] however the study still showed some efficacy in the admissibility of curcumin as a novel marker in the assessment of patients with Alzheimer's.

In conclusion, The rhizomes of Turmeric (*Curcuma longa* Linn.) has been known for its pharmacological as well as its medicinal properties in the alleviation of certain neurological, metabolical as well as multigenetical diseases such as found in arthritis, diabetes mellitus, cardiovascular diseases as well as in cancers. The clinical trials carried out with the use of Curcumin has provided a lot of insight through its underlying mechanisms therein and its efficacy in

the alleviation of the aforementioned diseases places it as the 'spice of life' as its becoming globally known for its magical wonders.

References

1. Gupta, S.C., Patchva, S., Koh, W. & Aggarwal, B.A. (2012). Discovery of Curcumin, a Component of Golden Spice and its Miraculous Biological Activities. *Clinical Experimental and Pharmacological Physiology*, 39(3), 283-299.
2. Pari, L., Terras, D. & Eckel, J. (2008). Role of Curcumin in and Disease Health. *Archives of Physiology and Biochemistry*, 114, 127-149.
3. Maizura, M., Aminah, A. & Wan-Aida, W.M. (2011). Total Phenolic Content and Antioxidant Activity of Kesum (*Polygonum minus*), Ginger (*Zingiber officiale*) and Turmeric (*Curcuma longa)* Extract. *Journal of International Food Resources*, 18, 529-534.
4. Murali, M.Y., Meena, J. & Subhash, C.C. (2013). Curcumin Nanomedicine: A Road to Cancer Therapeutics, *Current Pharmaceutical Design*, 19(11), 1-34.
5. Kulkarni, S.J, Maske, K.N, Budre, M.P. & Mahajan, R.P. (2012). Extraction and Purification of Curcuminoids from Turmeric (*Curcuma longa* L.). *International Journal of Pharmacology and Pharmaceutical Technology*, 1(2), 81-83.
6. Hamerski, L., Rezende, M.J.C. & Silva, B.V. (2013). Using Nature's Colours for Meat Consumer Wishes: Natural Substances Such as Dyes in Industry and Foods. *Revelations of Virtual Quim*, 5(3), 394-420.
7. Sasaki, H., Sunagawa, Y., Takahashi, K., Imaizumi, A., Fukada, H. B. & Hashimoto, T. (2011). Innovative Preparation of Curcumin for Improved Oral Bioavailability. *Biological and Pharmaceutical Bulletin*, 34(5), 660-665.
8. Zambre, A.P., Kulkarni, V.M., Padhye, S., Sandur, S.K. & Aggarwal, B.B. (2006). Novel Curcumin Analogues Targeting TNF Induced NFKappa B activation and Proliferation in Human Leukemic KBM-5 cells. *Journal of Bioorganisms and Medical Chemistry*, 14, 7196-7204.
9. Luca, N., Alessandra, A., Maria, B., Masson, M. & Tonnesen, H.H. (2009). Studies on Curcumin and Curcuminoids. XXX1V. Photophysical Properties of a Symmetrical, Non-Substituted Curcumin Analogue. *Journal of Photochemistry and Photobiology*, 97 (2), 72-86.
10. Padhye, S., Chavan, D., Pandey, S., Deshpande, J., Swamy, K.V. & Sarkar, F.H, (2010). Perspectives on Chemopreventive and Therapeutic Potential of Curcumin Analogues in Medicinal Chemistry. *Mini Reviews in Medicinal Chemistry*, 10(5), 372-387.
11. American Spice Trade Association (1997). *Astas Analytical Methods Manual*, Method. In. 1.09, 5th Edn. Englewood Cliffs, New Jersey, American Spice Trade Association.
12. Anand, P., Kunnumakkara, A.B., Newman, R.A. & Aggarwal, B.B, (2007). Bioavailability of Curcumin: Problems and Promises. *Molecular Pharmacology*, 4(6), 807-818.
13. Chandran, B. Sethi, R. & Srimal, R.C.(2012). A Randomized Pilot Study to Assess the Efficacy and Safety of Curcumin in Patients with Active Rheumatoid Arthritis. *Journal of Phytothermal Resources*, 26(11), 1719-1725.
14. Kinouchi, M., Aihara, F., Fujinaka, Y., Yoshida, S., Ooguro, Y., Kurahashi, K., Kondo, T., Aki, N., Kuroda, D., Endo, I., Matsushisa, M. & Matsumoto, T. (2014). Diabetic Conditions Differentially Affect the Endothelial Function, Arterial Stiffness and Carotid Atherosclerosis. *Journal of Atherosclerosis Thrombosis*, 21*(*5), 486-500.
15. Soni, K.B. & Kuttan, R. (1992). Effect of Curcumin Administration on Serum Peroxides and Cholesterol Levels in Human Volunteers. *Indian Journal of Physiology and Pharmacology*, 36, (4), 273-275.
16. Chinenye, S. & Young, E. (2011). Diabetes Care in Nigeria. *Nigerian Health Journal*, 11(4), 101-106.
17. Chuengsamarn, S., Rattanamaongkolgul, S., Luechapudiporn, R., Phisalaphong, C. & Jirawatnotai, S. (2012). Curcumin Extract for Prevention of Type 2 Diabetes. *DiabetesCare*, 35(11), 2121-2127.

18. Gupta, S.C., Kim, J.H., Prasad, S. & Aggarwal, B.B. (2010). Regulation of Survival Proliferation, Invasion, Angiogenesis and Metastasis of Tumor Cells through Modulation of Inflammatory Pathways by Nutraceuticals. *Cancer Metastasis and Revelations*, 29(3), 405-434.
19. Yallapu, M.M., Nagesh, P.K., Jaqqi, M. & Chauhan, S.C. (2015). Therapeutic Applications of Curcumin Nanoformulations. *American Association of Pharmaceutical Scientists*, 17(6), 1341-1356.
20. Chin, D., Huebbe, P., Pallauf, K. & Rimbachi, G. (2013). Neuroprotective Properties of Curcumin in Alzeimer's disease- merits and limitations. *Current Medicinal Chemistry*, 20(32), 3955-3985.
21. Mattson, M.P. & Rydel, R.E. (1996). Alzheimer's Disease. Amyloid Ox-Tox Transducer, *Nature*, 382,674-675.
22. Ringman, J.M., Frautschy, S.A., Cole, G.M., Masterman, D.L. & Cumming, J.L. (2005). A Potential Role of the Curry Spice Curcumin in Alzheimer's Disease. *Current Alzheimer's Resources*, 2(2), 131-136.