CellMed
Cellmed Orthocellular Medicine and Pharmaceutical Association

Review article

Curcuma longa: A treasure of medicinal properties

Saba Ansari[1], Shazia Jilani[2], Hana Abbasi[3], Mantasha binth Siraj[4], Ayshah Hashimi[5], Yasmeen Ahmed[6], Rizwana Khatoon[7], AL Mohd. Rifas[8*]

[1,3,4,5,6,7,8] *MD Scholar,* [2]*Assistant Professor Dept. of Moalejat, SUMER, Jamia Hamdard, India.*

ABSTRACT

Nature is full of precious treasure to cure us from various disorders. One of them is *Curcuma longa* belonging to *Zingiberaceae* family, present with outstanding therapeutic value and used since time immemorial. Part used from the plant is rhizome native to India (south east continent) which is the world's largest producer, consumer and exporter of turmeric. The active principle called curcumin or diferuloylmethane is a yellow pigment that exhibits numerous activities and wide spectrum of biological actions which include anti-inflammatory, hepatoprotective, anti-cancerous, anti-fungal, neuroprotective activities and many more. This paper focuses on the comparative evaluation of medicinal properties of *Curcuma longa* as mentioned in Unani classical literature with its modern scientific researches.

Keywords Turmeric, Unani medicine, therapeutic uses.

INTRODUCTION

Curcuma longa Linn (vernacular names: Arabic - Urooq ul Asfar, Chinese – Chiang Huang, Yu Chin, English – Turmeric, (Indian saffron), Sanskrit- Haridra, Persian – Zard chob, Darzardi, Urdu- Haldi), belonging to *Zingiberaceae* family, is used in Unani medicine of system since time immemorial and has been attributed a significant place as a single drug or as a constituent in various formulations to treat innumerous medical conditions. Traditional use of (*Curcuma longa*) Haldi dated back to nearly 4000 years to the Vedic culture in India, where it was used in the Indian kitchen as culinary spice as well as to treat various ailments which included improving digestion and intestinal flora, relieving gas and eliminate intestinal worms, relieve swelling, strengthens liver, for local application on sprains, burns, cuts, bruises, insect bites and itches, for soothing action in cough and asthma, and in any condition of weakness or debility, indicated topically and internally (Meylers, 2009). Various pharmacological actions and uses of *Curcuma longa* have been mentioned in classical Unani literature ranging from gastroenterology, cosmetology and respiratory system to name a few. Because of its multifaceted pharmacological actions and uses it is the focus of various research activities which includes both animal and clinical studies. A few clinical studies (Meylers, 2009) as well as the Food and Drug Administration (FDA) concluded curcumin to be safe (Prasad, *et al.*, 2014).

CLASSIFICATION OF *CURCUMA LONGA* (Lal, 2012)

Kingdom	Plantae
Subkingdom	*Tracheobionta*
Super division	*Spermatophyta*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Sub class	*Zingiberidae*
Order	*Zingiberales*
Family	*Zingiberaceae*
Genus	*Curcuma L.*
Species	*Curcuma longa* L.

BOTANICAL DESCRIPTION

Curcuma longa is a perennial herb, grows to a height of 60-90 cm. Its leaves are very large, in tuft up to 1.2 m or longer including the petiole which resembles blade, oblong lanceolate, tapering to the base (Parrotta, 2001). Turmeric is mainly cultivated at 20° to 30° C in tropical regions in Southeast Asia especially in India (Punjab, Bihar, Tamil Nadu) and China. (Chopra, *et al.*, 1956) (Sirisidthi, *et al.*, 2016) (Bentley, *et al.*, 2009) (Parrotta, 2001). It is an important medicinal and aromatic plant considered as one of the golden resource with massive exports prospective as medicine, cosmetic, cooking spice dye (Das, 2016) (Anonymous, 1986). Flowers are yellow, 10-15 cm in length and grouped together in dense spikes, which appears from the end of spring till mid of autumn (Evans, *et al.*, 2002) (Kumar, *et al.*, 2013) (Thomas, YNM) (Khan, 2013). This plant is devoid of fruits. Rhizome is used which is ovate or pear shaped and resembles the bulb known as round turmeric measuring 2.5-7.0 cm in length and 2.5 cm in diameter with finger like projection branching off. It is yellowish brown with a dull orange from interior section that looks bright yellow or when powdered. (K.R, *et al.*, 1996) (Kabiruddin, 2007)

*Correspondence: AL Mohd. Rifas
E-mail: rrripas@gmail.com
Received Nov 02, 2019; **Accepted** Mar 05, 2020; **Published** May 29, 2020
doi: http://dx.doi.org/10.5667/CellMed.2020.0009

CHEMICAL CONSTITUENTS

Curcumin (diferuloylmethane) is the active principal curcuminoid present in *Curcuma longa*. The other two curcuminoids are desmethoxycurcumin and bis-desmethoxycurcumin and various volatile oils, including tumerone, atlantone, and zingiberone. Other constituents include sugars, proteins, and resins.

The curcuminoids are polyphenols and are responsible for the yellow colour of turmeric.

Derivatives of curcumin are

- demethoxycurcumin
- bis-demthoxycurcumin
- 5′-methoxycurcumin
- dihydrocurcumin
- cyclocurcumin

(Sambhav*, et al.*, 2014) (Asolkar*, et al.*, 1992) (Omosa*, et al.*, 2017).

PART USED

In Unani classical literature Rhizomes (root) is mentioned for use (Khan, 2013) (Anonymous, 2004) (Kabiruddin, 2007) (WHO, 2004) (CCRUM, 2001) (Government of India, 2001) (CCRUM, 2009).

MIZAJ (TEMPERAMENT)

According to Hakeem Mohd.Azam Khan its temperament is Hot[3] and Dry[3] (Kabiruddin, 2007) (Khan, 2013).

According to Sheikh Ibn Sina, its temperament is Hot[2] and Dry[2] (Khan, 2013).

TASTE & COLOUR

Bitter &Yellow

(K.R, *et al.*, 1996) (Thomas, YNM)

Afaal (ACTIONS)

Qatil-e-didaan (Antihelmenthic) (Kabiruddin, 2007) (Ghani, 1912)	*Mufatteh* (Dissolve blood clots) (Ghani, 1912)
Qatil-e –Jarasim (Antimicrobial) (Kabiruddin, 2007)	*Jali* (Detergent) (Kabiruddin, 2007) (Khan, 2013)
Qatil e didaan (Antiparasitic) (Ghani, 1912)	*Mudammil-Qarah* (Healing) (Kabiruddin, 2007) (Khan, 2013) (Ghani, 1912) (CCRUM, 2009) (CCRUM, 2001)
Mubakkhir (Antiflatulant) (CCRUM, 2009)	*Muaqawwi-e-Kabid* (Hepatoprotective) (Kabiruddin, 2007)
Kasir e riyah (Carminative) (CCRUM, 2009)	*Muqawwi-e-Basr* (Improves eye sight) (Kabiruddin, 2007) (Khan, 2013) (Ghani, 1912)
Mohallil-e-Warm (Antiinflammatory) (Kabiruddin, 2007) (Khan, 2013) (Ghani, 1912) (CCRUM, 2009)	*Habis ud dam* (Bleeding disorders) (Ghani, 1912)
Qabiz (Astringent) (Kabiruddin, 2007) (Khan, 2013) (CCRUM, 2009)	*Mufatteh* (Deobstruent) (Kabiruddin, 2007)
Musaafi-e-Khoon (Blood purifier) (Kabiruddin, 2007) (Ghani, 1912) (CCRUM, 2001)	*Muaqawwi-e-Asab* (Neuroprotective) (Kabiruddin, 2007) (Ghani, 1912)

*Istemaal (*USES)

*Istisqa (*Ascites) (Kabiruddin, 2007) (Ghani, 1912)	*Waram al-Kabid* (Hepatitis) (Ghani, 1912)
Diq-al-Nafas (Asthma) (Kabiruddin, 2007) (CCRUM, 2009)	*Tukhma* (Indigestion) (Ghani, 1912)
Ehtebas e Tams (Amenorrhea) (CCRUM, 2001)	*Yaraqan Suddi* (Obstructive Jaundice) (Khan, 2013) (Kabiruddin, 2007) (Ghani, 1912)
Dummal (Boils) (Ghani, 1912)	*Namla & Humayqa* (Herpes & chicken pox) (Khan, 2013)
Radd' (Bruise) (Ghani, 1912) (CCRUM, 2001)	*Kalaf* (Melasma) (Khan, 2013) (Ghani, 1912)
*Dama (*Catarrh) (Khan, 2013) (Ghani, 1912)	*Nakhuna (*Pterygium) (Ghani, 1912) (Khan, 2013)
Muzmin Sual-o-Surfa Chronic bronchitis (Kabiruddin, 2007)	*Jarab* (Scabies) (Kabiruddin, 2007) (Khan, 2013)
Muzmin Ishal (Chronic diarrhoea) (Ghani, 1912)	*Amraz-e-Jild* (Skin diseases) (Khan, 2013) (Ghani, 1912)
Muzmin Humma (Chronic fever) (Ghani, 1912)	Skin lightening (Khan, 2013) (Ghani, 1912)
Ramad (Conjunctivitis) (Khan, 2013) (Kabiruddin, 2007) (Ghani, 1912)	*Bahaq Abyad'* (Pitryasis Alba) (Khan, 2013)
Sual (Cough) (Ghani, 1912)	*Fasad al-Hazm* (Dyspepsia) (Ghani, 1912)
Mukhrij-i-Didan-i-Ama (Helmenthiasis) (Ghani, 1912) (Kabiruddin, 2007)	

MUSLEH (CORRECTIVE)

Distilled Lemon water and Turanj (Citrus senensis) (Khan, 2013) (Kabiruddin, 2007)

BADAL (SUBSTITUTE)

Majeeth (Rubia cordifolia)

(Khan, 2013) (Kabiruddin, 2007) (Ghani, 1912)

MIQDAAR E KHURAK (DOSAGE)

Powder- 1 to 3 gms (Kabiruddin, 2007) (WHO, 2004)

Powder- 3 to 7 gms (Khan, 2013) (Ghani, 1912)

PHARMACOLOGICAL STUDIES

I. Anti-inflammatory Activity

- In a study on male Sprague–Dawley rats , use of crude extract of Curucma longa shows anti-inflammatory effect on collagen-induced arthritis and inhibition of inflammatory markers, such as phospholipase, lipooxygenase, cycloxoygenase-2, leukotrienes, thromboxane, prostaglandins, nitric oxide, collagenase, elastase, hyaluronidase, interferon-inducible protein,

tumor necrosis factor, and interleukin-12 (Chainani, 2003) (Taty *, et al.*, 2011).

- In another study performed in vitro Curcumin derivative (bis-demethylcurcumin) is found effective as an anti-inflammatory agent as it suppresses factor-induced nuclear factor (NF-kB) of tumour necrosis (Ravindran*, et al.*, 2010).

II. Hepatoprotective Activity

- The hepatoprotective effect of curcumin was evidenced in lipopolysaccharide/d-galactosamine model of liver injury in rats, via decrease in ALT and AST levels as well as in lipid peroxidation (Cerny*, et al.*, 2011).
- Ethanolic extract of Curucma longa was reported to have hepatoprotective effect in liver cirrhosis in rats via its ability to act as an antioxidant and anti-inflammatory agent (Salama*, et al.*, 2013).
- In another study for evaluating the hepatoprotective effect of fermented Curucma longa in rats under carbon tetrachloride (CCl4)-induced oxidative stress, it was observed that pre-treatment with plant extract at a dose of 30 or 300 mg/kg body weight orally administered for 14 days drastically prevented the elevated activities of serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and lactate dehydrogenase (LDH) caused by CCl4-induced hepa-totoxicity. Furthermore, extract from fermented Curucma longa enhanced antioxidant capacities with higher activities of catalase, glutathione-S-transferase, glutathione reductase, and glutathione peroxidase. Hence, researcher advised that the extract could be used as prevention against various liver diseases induced by oxidative stress via elevating antioxidative potentials and decreasing lipid peroxidation (Kim*, et al.*, 2014).

III. Antibacterial Activity

- Aqueous extract of *Curcuma longa* exhibites antibacterial effect against Staph-ylococus epidermis, Staphylococus aureus, Klebsiella pneumoniae, and Escherichia coli with the minimum inhibitory concentration (Moghadamtousi*, et al.*, 2014) (Niamsa*, et al.*, 2009).
- In a study of methanol extracts *Curcuma longa* also showed antibacterial effect against an array of bacteria including, Vibrio harveyi, Vibrio alginolyticus, Vibrio vulnificus, Vibrio parahaemolyticus, Vibrio cholerae, B. subtilis, Bacillus cereus, Aeromonas hydrophila, Streptococcus agalactiae, S. aureus, Staphylococcus intermedius (Lawhavinit*, et al.*, 2010).

IV. Antifungal Activity

- The methanol extract of *Curcuma longa* inhibited the growth of some clinical isolates of dermatophytes (Wuthi-udomlert*, et al.*, 2000).
- Active constituent of *Curcuma longa* (curcumin) prepared with ethyl acetate extract exhibited inhibitory effects on the growth of R. solani, P. recondita, and P. infestans (Kim*, et al.*, 2003).
- The methanol extract of *Curcuma longa* revealed antifungal activity against Cryptococcus neoformans and Candida albicans (Ungphaiboon*, et al.*, 2005).

V. Antiviral Activity

- The aqueous extract of *Curcuma longa* exhibited antiviral activity against hepatitis B virus (HBV) in HepG2 cells containing HBV genomes via repression of HBsAg secretion from liver cells, without any cytotoxic effect. The HBV particles production and the rate of mRNA production of HBV on infected cells were also suppressed (Kim*, et al.*, 2009).
- Curcumin was recognised as the antiviral constituent of the plant against hepatitis C virus (HCV), decreasing HCV gene expression and replication through suppression of the Akt-SREBP-1 pathway in vitro (Kim*, et al.*, 2010).

VI. Wound healing Activity

- Wound healing property of *Curcuma longa* showed progressive decrease in wound area and margin was traced every 3 days on tracing paper. Wound contraction was measured as percentage and reduction of damaged skin prior to treatment and regenerated skin after in wound area in each animal was examined.Powdered *Curcuma longa* with Oleum olivae showed a faster contraction when compared to normal control (Gayathri*, et al.*, 2015).
- *Curcuma longa* rhizome is reported to possess antibacterial, antifungal, anti -inflammatory and also show regeneration as well as wound healing properties in rats (Alam*, et al.*, 2011).

VII. Fibrinogenolytic Activity

- Shivalingu reported the possible involvement in blood coagulation cascade with respect to procoagulant activity by reducing the human plasma clotting time from the dialyzed crude enzyme fractions of turmeric species viz., Curcuma aromatica, *Curcuma longa*. It was concluded that turmeric species are rich in serine and cysteine proteases that exhibited procoagulant associated with fibrinogenolytic activity (Shivalingu*, et al.*, 2015).

VIII. Anti-platelet Activity

- Lee studied the antiplatelet activity of *Curcuma longa* rhizome-derived materials using rabbit's platelet through aggregometer and compared with those of aspirin as antiplatelet agent. Active constituent of Curcuma. Longa was isolated and characterized as ar-turmerone by various spectral analyses. At 50% inhibitory concentration value, ar-turmerone was effective in inhibiting platelet aggregation induced by collagen and arachidonic acid. In comparison, ar-turmerone was significantly more potent platelet inhibitor than aspirin against platelet aggregation induced by collagen (Lee, 2006).
- In another study, it has been shown that curcumin inhibits human platelet aggregation and dense granule secretion induced by GPVI agonists through interfering with the kinase activity of Syk (spleen tyrosine kinase) (Mayanglambam*, et al.*, 2010).

IX. Anti-coagulant Activity

- It has been reported that curcumin and its derivative (bisdemethoxycurcumin) prolong activity of partial thromboplastin time and prothrombin time significantly and inhibits thrombin and activated factor X activities (Kim*, et al.*, 2012).

X. Neuroprotective Activity

- Ethanol extract of *Curcuma longa*, in demonstration of neuroprotective effects on neuronal loss induced by dexamethasone treatment in rat hippocampus (Issuriya*, et al.*, 2014).

- Neuroprotective effect of curcumin, through attenuation of quinoprotein formation, p-p38 mitogen activated protein kinases (MAPKs) expression, and caspase-3 activation in 6-hydroxydopamine treated SH-SY5Y neuroblastoma cells in vivo and vitro system (Meesarapee*, et al.*, 2014).
- Chronic administration of curcumin significantly improved memory retention, attenuated oxidative damage, acetylcholinesterase activity, and aluminium concentration in aluminium treated rats indicating that this compound has neuroprotective effects against aluminium-induced cognitive dysfunction and oxidative damage (Kumar*, et al.*, 2009).

XI. Cardio protective Activity

- Curcumin showed promising role as a cardio protective agent in vitro and vivo studies against palmitate and high fat diet mediated cardiac dysfunction (Zeng*, et al.*, 2015).
- Curcuma oil was also reported to reduce endothelial cell–mediated inflammation in post myocardial ischemia/reperfusion in rats (Manhas, A*, et al.*, 2014).
- In a study of curcumin to know effect on cardiovascular risk factors in humans with coronary artery disease, it has been observed that serum triglyceride, LDL and VLDL cholesterol levels lowers significantly in the group of individuals taking curcumin. Blood lipid profile shows proven effects to lower levels, but no such effect on inflammatory markers (Mirzabeigia*, et al.*, 2015).

XII. Anticancer Activity

- Curcumin, decreases the proliferation of cell lines involved in various cancers, such as prostate carcinoma PC-3 cells (Wilken*, et al.*, 2011) (Cheng*, et al.*, 2013), breast adenocarcinoma MDA-MB-231 cells (Sun*, et al.*, 2012) MCF- 7 cells (Liu*, et al.*, 2013), colon carcinoma HCT-8/VCR cells (Lu*, et al.*, 2013) HCT-15 cells (Shehzad*, et al.*, 2013) and liver cancer HepG2 cells (Fan*, et al.*, 2014).
- Curcumin is effective in reducing and preventing various cancer types including multiple myeloma, colon, pancreas, breast, prostates and lung cancers in clinical study (Anand*, et al.*, 2008) (Devassy *, et al.*, 2015).
- In-vitro and in-vivo study on colon cancer cells dealing with monocarbonyl analogue of B63 acquired through some chemical modifications of curcumin's structure, this component has been shown develop antiproliferative effect and at the same time, suppression of tumor growth with use of less B63 (50 mg/kg B63, 100 mg/ kg curcumin) (Zheng*, et al.*, 2014).

XIII. Antidiabetic Activity

- Frozen dried rhizome powder of Curcumin longa dissolved in milk in streptozotocin-induced diabetic rats was effective with dose 200 mg/kg body weight as it increases high density lipoprotein (HDL), haemoglobin and body weight with significant decrease in the levels of blood glucose, lipid profile, and hepatoprotective enzymes (Rai*, et al.*, 2010).
- In vitro study showed antidiabetic effect and low-density lipoprotein (LDL) oxidation, angiotensin converting enzyme, α-glucosidase and α-amylase were inhibited by the ethyl acetate extract of plant with advanced outcome compared to that of reference drug acarbose. Protein glycation inhibitory potential of ethyl acetate extract was 800 times higher than that of ascorbic acid. The accumulation of advanced glycation end products (AGE's) in the body, due to the nonenzymatic glycation of proteins is associated with numerous pathological conditions like aging and diabetes mellitus (Lekshmi*, et al.*, 2014).

XIV. Topical Activity (Skin diseases)

- In a mouse model, curcumin relieves the psoriasis-like inflammation by decreasing the levels of IL-17A, IL-17F, IL-22, IL-1β, IL-6 and TNF-α cytokines (Sun *, et al.*, 2013)

XV. Anti -allergic and Anti asthmatic Activity

- Allergy and asthma are proinflammatory diseases, stemming from inflammatory cytokines. In a study it is proven that *Curcuma longa* exhibits anti-allergic activity by suppressing the 48/80-induced histamine release from rat mast cells (Yano*, et al.*, 2000).
- Curcumin has been determined to lower the production of IgE antibodies and cytokine, and enabling the formation of less inflammatory response in murine models (Vishwanath*, et al.*, 2008).

CONCLUSION

Curcuma longa has been reputed as a treasure of medicinal properties and has been used for the same in most traditional systems of medicine, especially Unani system of medicine. The scientific research, based on the results of various in vitro studies, in vivo studies, and clinical trials, has generated enough evidence based data to support the same. Besides, the fact that curcumin is a safe natural product and its cost is lower than many drugs may indicate that curcumin may be effective in prevention and treatment of various disorders. Even after exhaustive work has been reported on this herb, still its extensive medicinal potential remains un-trapped and leaves room for future exploration in this field.

ACKNOWLEDGEMENTS

None

CONFLICT OF INTEREST

No conflict of interest is involved in writing of this article

REFERENCES

Alam G, Singh MP and Singh A. Wound healing potential of some medicinal plants. *Journal of Pharmaceutical Sciences Review and Research.* 2011; 1:9:136-145.

Anand P, Sundaram C, Jhurani S, Kunnumakkara AB, Aggarwal BB. Curcumin and cancer: An "old-age" disease with an "ageold" solution. *Cancer Lett*. 2008:267:133-164.

Anonymous. Indian Medicinal Plants. (Chennai: Orirnt Longmen limited), 2004, pp 259.

Anonymous. The Useful Plants of India. (Calcutta: CSIR), 1986, pp 151-152.

Aronson JK. Meyler's Side effect of Medicinal Herb. (Elsevier Science), 2009; 233-234.

Asolkar LV, Kakkar KK and Chakkre OJ. Second Supplement to Glossary of Indian Medicinal Plants with Active Prociples (New Delhi: CSIR), 1992, pp. 246-247.

Bentley R and Trimen H. Medicinal Plants. (New Delhi: Asiatic Publishing House), vol. 4, 2009, 269.

CCRUM. Medicinal Plants in Folklores of Southern India. (New Delhi: CCRUM), 2001, pp 76.

CCRUM. Unani Medicinal Plants of Siddhart nagarForest Divivsion UP. (Uttar Pardesh: CCRUM), 2009, pp 68.

Cerný D, Lekić N, Váňová K, Muchová L, Hořínek A, Kmoníčková E, Zídek Z, Kameníková L, Farghali H. Hepatoprotective effect of curcumin in lipopolysaccharide/-galactosamine model of liver injury in rats: relationship to HO-1/ CO antioxidant system. *Fitoterapia*. 2011; 5:82:786-791.

Chainani WN. Safety and anti-inflammatory activity of curcum: a component of tumeric (*Curcuma longa*). *J. Altern. Complement Med*. 2003;1:9:161-168.

Cheng TS, Chen WC, Lin YY, Tsai CH, Liao CI, Shyu HY, Ko CJ, Tzeng SF, Huang CY, Yang PC, Hsiao PW and Lee MS. Curcumin-targeting pericellular serine protease matriptase role in suppression of prostate cancer cell invasion, tumor growth, and metastasis. *Cancer Prev. Res*. 2013;5:6:495-505.

Chopra RN, Nayar SL and Chopra IC. Glossary of Indain Plants. (New Delhi: CSIR), 1956, pp 84-85.

Das K. Turmeric (*Curcuma longa*) oils. In: Preedy, V.R. (Ed.), Essential Oils in Food Preservation, Fla-vor and Safety. (San Diego: Academic Press), 2016, pp 835-841.

Devassy J, Nwachukwu I and Jones P. Curcumin and cancer: Barriers to obtaining a health claim. *Nutr. Rev*. 2015;3:73:155-165.

Evans WC. Trease and Evans' Pharmacognosy. (A Divisionof Reed Elsevier India Pvt. Limited), 2002, pp 280.

Fan H, Tian W and Ma X. Curcumin induces apoptosis of HepG2 cells via inhibiting fatty acid syn-thase. *Target Oncol*. 2014; 3:9:279-286.

Gayathri D, Sathish S and Sakthi R. Wound Healing Activity of *Curcuma longa* with Oleum olivae. *Journal of Academia and Industrial Research (JAIR).* 2015; 10:3.

Ghani Najmul. Khazeenat-ul-Advia. (Lahore: Daimond Publisher), 1912; 3(3):1049-1051.

Government of India. The Ayurvedic Pharmacopoeia of India (Delhi: Ministry of Helath & Welfare), 2001; 1(1):45-46.

Issuriya A, Kumarnsit E, Wattanapiromsakul C, Vongvatcharanon U. Histological studies of neuroprotective effects of *Curcuma longa* Linn. on neuronal loss induced by dexamethasone treatment in the rat hippocampus. *Acta Histochem*. 2014; 8(116):1443-1453.

Kabiruddin Mohd. Makhzanul-ul –Mufridat. (New Delhi: Idara Kitab-u-Shifa), 2007, pp 314-315.

Kanjana S, Piya K and Kanitta J, Jiraungkoorskul W. Antithrombotic activity of turmeric (*Curcuma longa*): A review. *Agricultural research communication centre*. 2016; 50: 101-106.

Khan MA. Muheet Azam trans. (Delhi: CCRUM), 2013; 2:757-758.

Kim HJ, Yoo HW, Kim JC, Park CS, Choi MS, Kim MJ, Choi HS, Jung SM, Kim YS, Yoon SW, Ahn JK. Antiviral effect of *Curcuma longa* Linn extract against hepatitis B virus replication. *Journal of ethonopharmacology*, 2009; 124(2);189-96

Kim K, Kim KH, Kim HY, Cho HK, Sakamoto N, Cheong JH. Curcumin inhibits hepatitis C virus replication via suppressing the Akt-SREBP-1 pathway. *FEBS Lett.* 2010; 4:584:707-712.

Kim M K, Choi GJ and Lee HS. Fungicidal property of *Curcuma longa* L. rhizome-derived curcumin against phytopathogenic fungi in a greenhouse. *J Agric. Food Chem*. 2003; 51(6):1578-1581.

Kim Y, You Y, Yoon HG, Lee YH, Kim K, Lee J, Kim MS, Kim JC, Jun W. Hepatoprotective effects of fermented *Curcuma longa* L. on carbon tetrachloride-induced oxidative stress in rats. *Food Chem*. 2014; 151:14-153.

Kim YJ, You YH and Jun WJ. Hepatoprotective activity of fermented *Curcuma longa* L.on galactosamine-intoxicated rats. Korean Soc. *Food Sci. Nut*. 2012; 41:790-795.

Kritikar KR, Basu BD, Blatter E, Caius JF and Mhaskar KS. Indian Medicnal Plants. (Dehradun: Internatinal Book Distriibutor), 1996.

Kumar A, Dogra S and Prakash A. Protective effect of curcumin (*Curcuma longa*), against aluminium toxicity: Possible behavioral and biochemical alterations in rats. *Behav. Brain Res*. 2009; 2:205:384-390.

Kumar N and Kumar S. Ethnopharmacological properties of *Curcuma longa*: a review. *International Journal of Pharmaceutical Sciences and Research.* 2013; 1:4:103-112.

Lal J. Turmeric curcumin and our life:a review. Bull.Env.Pharmacol Life Science. 2012; 1:11-17.

Lawhavinit OA, Kongkathip N and Kongkathip B. Antimicrobial activity of curcuminoids from Cur-cuma longa L. on pathogenic bacteria of shrimp and chicken Kasetsart. *J. Nat. Sci.* 2010; 3:44:364-371.

Lee HS. Antiplatelet property of *Curcuma longa* L. rhizome-derived ar-turmerone. *Biores. Technol*. 2006; 97:1372-1376.

Lekshmi PC, Arimboor R, Nisha VM, Menon AN, Raghu KG. In vitro anti-diabetic and inhibitory potential of turmeric (*Curcuma longa* L) rhizome against cellular and LDL oxidation

and angiotensin converting enzyme. *J. Food Sci. Technol*. 2014; 2:52:3910–3917.

Liu D and Chen Z. The effect of curcumin on breast cancer cells. *J. Breast Cancer*. 2013; 2:16:133-137.

Lu WD, Qin Y, Yang C, Li L, Fu ZX. Effect of curcumin on human colon cancer multidrug resistance in vitro and in vivo. *Clinic.* 2013; 5:68:694-701.

Manhas A, Khanna V, Prakash P, Goyal D, Malasoni R, Naqvi A, Dwivedi AK, Dikshit M, Jagavelu K. Curcuma oil reduces endothelial cell-mediated inflammation in postmyocardial ischemia reperfusion in rats. *J. Cardiovasc. Pharmacol*. 2014; 3:64:228-236.

Mayanglambam A, Dangelmaier CA, Thomas D, Damodar Reddy C, Daniel JL, Kunapuli SP. Curcumin inhibits GPVI-mediated platelet activation by interfering with the kinase activity of Syk and the subsequent activation of PLCã2. *Platelets*. 2010; 21:211-220.

Meesarapee B, Thampithak A, Jaisin Y, Sanvarinda P, Suksamrarn A, Tuchinda P, Morales NP, Sanvarinda Y. Curcumin I mediates neuroprotective effect through attenuation of quinoprotein formation, p-p38 MAPK expression, and caspase-3 activation in 6-hydroxydopamine treated SH-SY5Y cells. *Phytother. Res.* 2014; 28(4): 611-616.

Mirzabeigia P, Mohammadpour AH, Salarifar M, Gholami K, Mojtahedzadeh M, Javadia MR. The effect of curcumin on some of traditional and nontraditional cardiovascular risk factors: A pilot randomized, double-blind, placebo-controlled trial. J. *Pharm. Res*. 2015; 14(2):479–486.

Moghadamtousi SZ, Kadir HA, Hassandarvish P, Tajik H, Abubakar S, Zandi K. A review on antibacterial, antiviral, and antifungal activity of curcumin. *Biomed. Res*. Int. 2014;

Niamsa N and Sittiwet C. Antimicrobial activity of *Curcuma longa* aqueous extract. *J. Pharmacol. Toxicol*. 2009; 4: 4:173-177.

Omosa LK, Midiwo JO and Kuete V. *Curcuma longa* Medicinal Spices and Vegetables from Africa. (Elsevier). 2017, pp 425-435. Parrotta JA. Healing Plants of Peninsular India (New York: CABI), 2001, pp 726-727.

Prasad S, Gupta SC, Tyagi AK, Aggarwal BB. Curcumin, a component of golden spice: From bedside to bench and back. *Biotechnol.Adv*. 2014; 32:1053–1064.

Rai PK, Jaiswal D, Mehta S, Rai DK, Sharma B, Watal G. Effect of *Curcuma longa* freeze dried rhizome powder with milk in STZ induced diabetic rats. *Indian J. Clin. Biochem*. 2010; 25(2):175-181.

Ravindran J, Subbaraju GV, Ramani MV, Sung B, Aggarwal BB. Bisdemethylcurcumin and structurally related hispolon analogues of curcumin exhibit enhanced prooxidant, anti-proliferative and anti-inflammatory activities in vitro. *Biochem. Pharmacol*. 2010; 79(11):1658-1666.

Salama SM, Abdulla MA, AlRashdi AS, Ismail S, Alkiyumi SS, Golbabapour S. Hepatoprotective effect of ethanolic extract of *Curcuma longa* on thioacetamide induced liver cirrhosis in rats. *BMC Complement Altern. Med*. 2013; 13:56.

Sambhav J, Rohit R, Raj UA, Garima M. *Curcuma longa* in the management of inflammatory diseases: a review. *Int. Ayur. Med.* J. 2014; 2(2):33-40.

Shehzad A, Lee J, Huh TL, Lee YS. Curcumin induces apoptosis in human colorectal carcinoma (HCT-15) cells by regulating expression of Prp4 and p53. *Mol. Cells*. 2013; 6:35.

Shivalingu BR, Vivek HK, Nafeesa Z, Priya BS, Swamy SN. Comparative analysis of procoagulant and fibrinogenolytic activity of crude protease fractions of turmeric species. *J. Ethnopharmacol. 2015; 172:261-264.*

Sun J, Zhao Y and Hu J Curcumin Inhibits Imiquimod-Induced Psoriasis-Like Inflammation by Inhibiting IL-1beta and IL-6 Production in Mice *PLoS ONE* .2013; 6: 8.

Sun XD, Liu XE and Huang DS. Curcumin induces apoptosis of triple-negative breast cancer cells by inhibition of EGFR expression. *Mol. Med. Rep*. 2012; 6:1267-1270.

Taty Anna K, Elvy Suhana MR, Das S, Faizah O, Hamzaini AH. Anti-inflammatory effect of *Curcuma longa* (turmeric) on collagen-induced arthritis: an anatomico-radiological study. *Clin.Ter*. 2011; 162(3): 201-207.

Thomas F. PDR for Herbal Medicines (Medical Economics Company), 2000, pp 846-847.

Ungphaiboon S, Tanomjit S, Pechnoi S, Supreedee S, Pranee R, Itharat A. Study on antioxidant and antimicrobial activities of turmeric clear liquid soap for wound treatment of HIV patients. Songklanakarin *J. Sci. Technol.* 2005; 27(2):269-578.

Vishwanath PK and Christy SB. Immunomodulatory effects of curcumin in allergy. *Mol. Nutr. Food Res*. 2008; 52:1031–1039.

WHO. The Use of Traditional Medicine in Primary Health Care. (Delhi: ATIBS), 2004:28-29.

Wilken R, Veena MS, Wang MB, Srivatsan ES. Curcumin: a review of anti-cancer properties and therapeutic activity in head and neck squamous cell carcinoma. *Mol. Cancer*. 2011; 12:10.

Wuthi-udomlert M, Grisanapan W, Luanratana O, Caichompoo W. Antifungal activity of *Curcuma longa* grown in Thailand. *Southeast Asian J. Trop. Med. Public Health*. 2000; 1:31:178-182.

Yano S , Terai M, Shimizu KL, Futagami Y, Horie S, Tsuchiya S, Ikecami F, Sekine T, Takamoto K, Saito K, Ueno K, Watanabe K. Antiallergic activity of *Curcuma longa* (II). Features of inhibitory actions on histamine release from mast cells. *Nat. Medicines*. 2000; 54:325-329.

Zeng C, Zhong P, Zhao Y, Kanchana K, Zhang Y, Khan ZA, Chakrabarti S, Wu L, Wang J, Liang G. Curcumin protects hearts from FFA-induced injury by activating Nrf2 and inactivating NF-kappaB both in vitro and in vivo. *J. Mol. Cell Cardiol*. 2015; 79:1-12.

Zheng A, Li H, Wang X, Feng Z, Xu J, Cao K, Zhou B, Wu J, Liu J. Anticancer effect of a curcumin derivative B63: ROS production and mitochondrial dysfunction. *Current Cancer Drug Targets.* 2014; 14: 156-166.