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## TURMERIC: A COMPREHENSIVE REVIEW

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### ABSTRACT

This comprehensive review aims to evaluate research examining the nutraceutical attributes and bioactive compounds found in turmeric, elucidating their roles in promoting human nutrition, enhancing health, and preventing chronic diseases. Turmeric, scientifically known as *Curcuma longa* L. (root and rhizome), holds significant medicinal and economic importance globally, primarily utilized as both a spice and a dietary supplement. Its primary bioactive constituents, known as curcuminoids, comprise curcumin (the principal pigment responsible for turmeric's yellow hue), demethoxycurcumin, and bisdemethoxycurcumin. Additionally, turmeric contains volatile oils such as tumerone, atlantone, and zingiberene, alongside carbohydrates, proteins, and resins. Renowned for its potent anti-inflammatory and antioxidant properties, turmeric serves as a promising candidate in combating various ailments. Notably, its potential anticancer effects are closely linked to its anti-inflammatory properties.

Turmeric, renowned for its medicinal prowess, has captivated both the scientific community and culinary enthusiasts alike, primarily due to its abundance in the polyphenol curcumin. This compound offers a multitude of health benefits, including the management of oxidative stress, inflammation, metabolic syndrome, arthritis, anxiety, and hyperlipidemia. Moreover, it demonstrates potential in alleviating exercise-induced inflammation and muscle soreness, thereby augmenting recovery and performance among physically active individuals. Even at modest doses, curcumin holds promise for enhancing health in individuals without diagnosed conditions, largely attributable to its potent antioxidant and anti-inflammatory properties. However, consuming curcumin in isolation may not yield the desired health outcomes due to its poor bioavailability, stemming from limited absorption, rapid metabolism, and elimination. Fortunately, several strategies exist to enhance its bioavailability, with piperine, a key component of black pepper, notably boosting absorption by up to 2000% when combined with curcumin. Through synergistic interactions with enhancing agents, curcumin offers a spectrum of health benefits. This review aims to provide a concise overview of the extensive body of research elucidating the health-promoting effects of curcumin.

**Keywords:** Curcumin, Polyphenol, Medicinal properties, Health benefits, metabolic syndrome, Bioavailability, Antioxidant, Anti-inflammatory, Nutraceutical

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### 1. INTRODUCTION

Turmeric, a spice of considerable interest in both medical/scientific circles and the culinary realm, is derived from the rhizomatous herbaceous perennial plant *Curcuma longa*, a member of the ginger family [1]. While the medicinal properties of turmeric, particularly its active compound curcumin, have been recognized for millennia, only recently have efforts intensified to elucidate its precise mechanisms of action and identify its bioactive components. Curcumin, also known as diferuloylmethane, serves as the primary natural polyphenol found in the rhizome of *Curcuma longa* (turmeric) and other *Curcuma* species. Traditionally utilized in Asian countries as a medicinal herb, *Curcuma longa* boasts antioxidant, anti-inflammatory, antimutagenic, antimicrobial, and anticancer properties.

The utilization of turmeric has evolved from its historical roles in textile dyeing and ancient medicinal practices to a contemporary exploration of its potential health benefits, including anti-carcinogenic, anti-inflammatory, anticoagulant, antimicrobial, and antioxidant effects (17). Throughout centuries, turmeric has been ascribed various medicinal virtues, purportedly aiding in wound healing, allergy alleviation, asthma management, sinusitis relief, and addressing hepatic and heart diseases. While some studies have investigated the efficacy of whole turmeric root in managing inflammation and other health concerns, comprehensive research in this area remains limited. Turmeric is deemed safe for moderate consumption and contributes to a healthy lifestyle.

The primary curcuminoid responsible for turmeric's healing properties is curcumin, first isolated from turmeric in 1815, with its molecular formula elucidated in 1910. Curcumin, with the chemical formula  $C_{21}H_{20}O_6$  and the moniker diferuloylmethane, stands as the predominant molecule studied in recent years. Being inherently hydrophobic, curcumin does not dissolve in water but readily disperses in solvents like dimethyl sulfoxide, acetone, ethanol, and oil. Turmeric typically contains 3–8% curcumin, with an average of 30–90 mg of curcumin per dessert spoon of turmeric powder. Extensive research supports turmeric's antiseptic, anti-inflammatory, and antioxidant properties, positioning it as a potential complementary treatment for conditions such as Alzheimer's, diabetes, asthma, and stomach ulcers. Over the past few decades, significant attention has been directed towards curcumin due to its various health-promoting properties, including potent antioxidant effects, antimicrobial activity, anti-inflammatory

actions, anticancer potential, cardio-protective qualities, and hypoglycemic effects. While cell culture studies suggest that low doses of curcumin are sufficient for biological activity, animal and clinical studies indicate the necessity of higher doses to achieve optimal effects due to its poor bioavailability. Hence, this review focuses on strategies to enhance curcumin bioavailability and its implications for human health, metabolism, mechanisms of action, as well as limitations and potential applications in food.



Fig.1

❖ **Taxonomical classification:-**

1. Kingdom: Plantae
2. Clade: Angiosperms
3. Clade: Monocots
4. Order: Zingiberales
5. Family: Zingiberaceae
- 6 Genus: Curcuma
- 7 Species: Curcuma longa

❖ **Synonyms:-**

1. English: Turmeric
2. Spanish: Cúrcuma
3. French: Curcuma
4. German: Kurkuma
5. Italian: Curcuma
6. Portuguese: Açafraão-da-terra
7. Hindi: हल्दी (Haldi)
8. Bengali: হলুদ (Holud)
9. Tamil: மஞ்சள் (Manjal)
10. Chinese (Mandarin): 姜黄 (Jiānghuáng)

❖ **Chemical Constituents in turmeric with their uses:-**

Sr. No.	chemical constituents	uses
1	Curcumin	Curcumin is the most abundant and biologically active compound in turmeric. It has potent antioxidant, anti-inflammatory, antimicrobial, anticancer, and neuroprotective properties. Curcumin is widely studied for its potential therapeutic effects on various health conditions, including arthritis, cancer, Alzheimer's disease, diabetes, cardiovascular diseases, and skin disorders.
2	Turmerone	2. Turmerone is a bioactive compound found in turmeric that has been investigated for its potential neuroprotective and anti-inflammatory effects. It may help improve cognitive function and protect against neurodegenerative diseases like Alzheimer's disease.

3	Gingerols	Although more commonly found in ginger, small amounts of gingerols are present in turmeric. Gingerols are known for their anti-inflammatory and antioxidant properties, which may contribute to the overall health benefits of turmeric.
4	Curcuminoids	These compounds also possess antioxidant and anti-inflammatory properties and may synergistically enhance the therapeutic effects of curcumin.
5	Essential oils	Turmeric contains essential oils like turmerone, atlantone, and zingiberene, which contribute to its aroma and flavor. These essential oils also have antimicrobial and anti-inflammatory properties, making them useful in skincare and aromatherapy.
6	Polysaccharides	Turmeric contains polysaccharides, which are complex carbohydrates with various biological activities. Polysaccharides may have immunomodulatory effects and contribute to the overall health benefits of turmeric.
7	Volatile compounds	Turmeric contains volatile compounds such as turmerone, ar-turmerone, and curlone, which contribute to its characteristic aroma and flavor. These compounds may have antimicrobial and anti-inflammatory effects, making them useful in food preservation and flavoring.

❖ **Detailed uses of turmeric in skincare:**

1. **Antioxidant:** Curcumin is also a potent antioxidant that helps neutralize free radicals, which can damage skin cells and lead to premature aging. Using turmeric in skincare can help protect the skin from environmental stressors and oxidative damage.
2. **Brightening:** Turmeric has skin-brightening properties that can help even out skin tone and reduce the appearance of dark spots, hyperpigmentation, and sun damage. It can give the skin a radiant and more youthful appearance.
3. **Acne treatment:** Due to its anti-inflammatory and antibacterial properties, turmeric can be effective in treating acne. It helps reduce inflammation, unclog pores, and kill acne-causing bacteria, making it a natural and gentle treatment option for acne-prone skin.
4. **Wound healing:** Turmeric has been traditionally used to promote wound healing and skin regeneration. Its anti-inflammatory and antimicrobial properties can help speed up the healing process and reduce the risk of infection when applied topically to minor cuts, wounds, or burns.
5. **Exfoliation:** Turmeric can be used as a natural exfoliant to remove dead skin cells and promote cell turnover. Mixing turmeric with other ingredients like yogurt, honey, or oatmeal can create a gentle exfoliating scrub that helps reveal smoother and brighter skin.
6. **Oil control:** Turmeric has astringent properties that can help regulate oil production in the skin, making it beneficial for people with oily or acne-prone skin. It can help minimize the appearance of pores and control excess sebum production.
7. **Anti-aging:** The antioxidant properties of turmeric help protect the skin from damage caused by free radicals, which can contribute to premature aging. Regular use of turmeric in skincare can help reduce the appearance of fine lines, wrinkles, and other signs of aging.

❖ **Traditional uses of turmeric:-**

1. **Culinary:** Turmeric is widely used as a spice in cooking, especially in South Asian and Southeast Asian cuisines. It adds a vibrant yellow color and a warm, earthy flavor to dishes such as curries, soups, rice, and vegetable dishes.
2. **Medicinal:** Turmeric has been used for centuries in traditional medicine systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani medicine. It is believed to have various health benefits, including anti-inflammatory, antioxidant, antibacterial, and digestive properties. Turmeric has been used to treat a wide range of ailments, including digestive disorders, arthritis, skin conditions, infections, and respiratory problems.

3. Skincare: As mentioned earlier, turmeric is used in skincare for its anti-inflammatory, antioxidant, and antibacterial properties. It has been traditionally used to improve skin complexion, treat acne and other skin conditions, promote wound healing, and delay the signs of aging.

4. Dye: Turmeric is also used as a natural dye to color fabrics, textiles, and food products. Its vibrant yellow-orange hue makes it a popular choice for dyeing clothes, especially in traditional ceremonies and festivals.

5. Rituals and ceremonies: In many cultures, turmeric holds symbolic significance and is used in various rituals, ceremonies, and religious practices. For example, in Hindu weddings, turmeric paste is applied to the bride and groom's skin in a ceremony called "haldi" to bless them with healthy and glowing skin.

6. Traditional drinks: Turmeric is used to make traditional beverages such as turmeric milk (golden milk), which is a warm and soothing drink made by mixing turmeric with milk and other spices like ginger, cinnamon, and black pepper. Golden milk is believed to have numerous health benefits and is often consumed for its immune-boosting and anti-inflammatory properties.

#### ❖ Industrial uses of turmeric in detail:-

1. Food Coloring and Flavoring: Turmeric is commonly used as a natural food coloring and flavoring agent in the food industry. Its vibrant yellow-orange color adds appeal to a wide range of food products, including baked goods, snacks, sauces, dairy products, beverages, and condiments. Turmeric's earthy flavor also enhances the taste of many dishes, especially in savory foods like curries, soups, and sauces.

2. Cosmetics and Skincare: Turmeric is utilized in the cosmetics and skincare industry for its beneficial properties for the skin. It is a common ingredient in skincare products such as creams, lotions, serums, masks, and cleansers due to its anti-inflammatory, antioxidant, and antibacterial properties. Turmeric extracts or powders are incorporated into formulations targeting issues like acne, inflammation, hyperpigmentation, and aging.

3. Pharmaceuticals: Turmeric and its active compound curcumin have garnered interest in the pharmaceutical industry for their potential therapeutic properties. Research suggests that curcumin may have anti-inflammatory, antioxidant, and anti-cancer, antimicrobial, and neuroprotective effects. Pharmaceutical companies are exploring the development of curcumin-based drugs and supplements for various health conditions, including arthritis, cancer, Alzheimer's disease, diabetes, and cardiovascular diseases.

4. Natural Dye: Turmeric is used as a natural dye in the textile industry to color fabrics, yarns, and garments. Its vibrant yellow-orange hue can be extracted from the turmeric rhizomes and used to dye cotton, silk, wool, and other natural fibers. Turmeric dyeing is particularly popular in regions where traditional textile crafts are practiced, adding value to handcrafted textiles and garments.

5. Herbal Extracts and Supplements: Turmeric extracts and supplements are produced for the nutraceutical and dietary supplement industries. These products typically contain concentrated forms of curcumin, the active compound in turmeric, and are marketed for their potential health benefits, including anti-inflammatory and antioxidant properties. Turmeric supplements come in various forms, such as capsules, tablets, powders, and liquid extracts.

6. Animal Feed Additive: Turmeric is sometimes used as an additive in animal feed to promote animal health and enhance the nutritional value of feed formulations. It is believed to have anti-inflammatory and antioxidant effects in animals, potentially improving immune function, digestion, and overall well-being.

## 2. CONCLUSION

Turmeric, scientifically known as *Curcuma longa*, has been the subject of extensive research due to its diverse range of medicinal properties and industrial applications. This review paper has provided a comprehensive overview of the scientific literature surrounding turmeric, focusing on its chemical composition, pharmacological activities, traditional uses, and industrial applications. Throughout the paper, it became evident that turmeric contains bioactive compounds, notably curcumin, which exhibit antioxidant, anti-inflammatory, antimicrobial, anticancer, and neuroprotective properties. These properties make turmeric a promising candidate for the development of pharmaceuticals, nutraceuticals, and functional foods aimed at preventing and treating various diseases and health conditions. Moreover, the traditional uses of turmeric in culinary, medicinal, skincare, and cultural practices have been highlighted, emphasizing its importance and cultural significance across different regions and communities worldwide. In the industrial context, turmeric finds applications in food coloring, flavouring, cosmetics, skincare, pharmaceuticals, natural dyeing, supplements, and animal feed additives, showcasing its versatility and commercial value in various sectors. Despite the wealth of research conducted on turmeric, there are still gaps in knowledge regarding its mechanisms of action, bioavailability, safety profile, and clinical efficacy. Future studies should focus on addressing these gaps to unlock the full potential of turmeric for improving human health and well-being.

### 3. REFERENCE

- [1] Priyadarsini K.I. The chemistry of curcumin: From extraction to therapeutic agent. *Molecules*. 2014; 19:20091–20112. doi: 10.3390/molecules191220091. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [2] Gupta S.C., Patchva S., Aggarwal B.B. Therapeutic Roles of Curcumin: Lessons Learned from Clinical Trials. *AAPS J*. 2013; 15:195–218. doi: 10.1208/s12248-012-9432-8. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [3] Aggarwal B.B., Kumar A., Bharti A.C. Anticancer potential of curcumin: Preclinical and clinical studies. *Anticancer Res*. 2003; 23:363–398. [PubMed] [Google Scholar]
- [4] Lestari M.L., Indrayanto G. Curcumin. *Profiles Drug Subst. Excip. Relat. Methodol*. 2014; 39:113–204. [PubMed] [Google Scholar]
- [5] Mahady G.B., Pendland S.L., Yun G., Lu Z.Z. Turmeric (*Curcuma longa*) and curcumin inhibit the growth of *Helicobacter pylori*, a group 1 carcinogen. *Anticancer Res*. 2002; 22:4179–4181. [PubMed] [Google Scholar]
- [6] Reddy R.C., Vatsala P.G., Keshamouni V.G., Padmanaban G., Rangarajan P.N. Curcumin for malaria therapy. *Biochem. Biophys. Res. Commun*. 2005; 326:472–474. doi: 10.1016/j.bbrc.2004.11.051. [PubMed] [CrossRef] [Google Scholar]
- [7] Vera-Ramirez L., Perez-Lopez P., Varela-Lopez A., Ramirez-Tortosa M., Battino M., Quiles J.L. Curcumin and liver disease. *Biofactors*. 2013; 39:88–100. doi: 10.1002/biof.1057. [PubMed] [CrossRef] [Google Scholar]
- [8] Wright L.E., Frye J.B., Gorti B., Timmermann B.N., Funk J.L. Bioactivity of turmeric-derived curcuminoids and related metabolites in breast cancer. *Curr. Pharm. Des*. 2013; 19:6218–6225. doi: 10.2174/1381612811319340013. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [9] Aggarwal B.B., Harikumar K.B. Potential therapeutic effects of curcumin, the anti-inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. *Int. J. Biochem. Cell Biol*. 2009; 41:40–59. doi: 10.1016/j.biocel.2008.06.010. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [10] Panahi Y., Hosseini M.S., Khalili N., Naimi E., Simental-Mendia L.E., Majeed M., Sahebkar A. Effects of curcumin on serum cytokine concentrations in subjects with metabolic syndrome: A post-hoc analysis of a randomized controlled trial. *Biomed. Pharmacother*. 2016; 82:578–582. doi: 10.1016/j.biopha.2016.05.037. [PubMed] [CrossRef] [Google Scholar]
- [11] Sanidad K, Sukamtoh E, Xiao H, McClements DJ, Zhang G. Curcumin: recent advances in the development of strategies to improve oral bioavailability. *Ann Rev Food Sci Technol*. 2019; 10:597–617.
- [12] Douglass B, Clouatre D. Beyond yellow curry: assessing commercial curcumin absorption technologies. *J Am Coll Nutr*. 2015; 34:347–358.
- [13] Prasad S, Tyagi A, Aggarwal B. Recent developments in delivery, bioavailability, absorption and metabolism of curcumin: the golden pigment from golden spice. *Cancer Res Treat*. 2014; 46:2–18.
- [14] Shoba G, Joy D, Joseph T, et al. Influence of piperine on the pharmacokinetics of curcumin in animals and human volunteers. *Planta Med*. 1998; 64:353–356.
- [15] Schiborr C, Kocher A, Behnam D, et al. The oral bioavailability of curcumin from micronized powder and liquid micelles is significantly increased in healthy humans and differs between sexes. *Mol Nutr Food Res*. 2014; 58:516–527.
- [16] Briskey D, Sax A, Mallard A, Rao A. Increased bioavailability of curcumin using a novel dispersion technology system (LipiSpurse®). *Eur J Nutr*. 2019; 58:2087–2097. doi.org/10.1007/s00394-018-1766-2.
- [17] Sasaki H, Sunagawa Y, Takahashi K, et al. Innovative preparation of curcumin for improved oral bioavailability. *Biol Pharm Bull*. 2011; 34:660–665.
- [18] Vitaglione P, Lumaga R, Ferracane R, et al. Curcumin bioavailability from enriched bread: the effect of microencapsulated ingredients. *J Agric Food Chem*. 2012; 60:3357–3366.
- [19] Kocher A, Bohnert L, Schiborr C, Frank J. Highly bioavailable micellar curcuminoids accumulate in blood, are safe and do not reduce blood lipids and inflammation markers in moderately hyperlipidemic individuals. *Mol Nutr Food Res*. 2016; 60:1555–1563.
- [20] Antony B, Merina B, Iyer V, et al. A pilot cross-over study to evaluate human oral bioavailability of BCM-95®CG (Biocurcumax™), a novel bioenhanced preparation of curcumin. *Ind J Pharm Sci*. 2008; 70:445–449.

- [21] Kwon Y, Magnuson BA. Age-related differential responses to curcumin-induced apoptosis during the initiation of colon cancer in rats. *Food Chem Toxicol* 2009;47:377-85.
- [22] Zeng Y, Qiu F, Takahashi K, Liang J, Qu G, Yao X. New sesquiterpenes and calebin derivatives from *Curcuma longa*. *Chem Pharm Bull (Tokyo)* 2007;55:940-3.
- [23] Dujic J, Kippenberger S, Ramirez-Bosca A, Diaz- Alperi J, Bereiter-Hahn J, Kaufmann R, et al. Curcumin in combination with visible light inhibits tumor growth in a xenograft tumor model. *Int J Cancer* 2009;124:1422-8.
- [24] Huang MT, Lou YR, Xie JG, Ma W, Lu YP, Yen P, et al. Effect of dietary curcumin and dibenzoylmethane on formation of 7,12-dimethylbenz a anthracene-induced mammary tumors and lymphomas/leukemias in Sencar mice. *Carcinogenesis* 1998;19:1697-700.
- [25] Rabiei Z, Rafieian-kopaei M, Heidarian E, Saghaei E, Mokhtari S. Effects of *Zizyphus jujube* extract on memory and learning impairment induced by bilateral electric lesions of the nucleus basalis of meynert in rat. *Neurochem Res* 2014;39(2):353-60.
- [26] Rabiei Z, Rafieian-Kopaei M, Mokhtari S, Alibabaei Z, Shahrani M. The effect of pretreatment with different doses of *Lavandula officinalis* ethanolic extract on memory, learning and nociception. *Biomed Aging Pathol* 2014; 4(1):71-6.
- [27] Kwon Y, Magnuson BA. Age-related differential responses to curcumin-induced apoptosis during the initiation of colon cancer in rats. *Food Chem Toxicol* 2009;47:377-85.
- [28] Zeng Y, Qiu F, Takahashi K, Liang J, Qu G, Yao X. New sesquiterpenes and calebin derivatives from *Curcuma longa*. *Chem Pharm Bull (Tokyo)* 2007;55:940-3.
- [29] Dujic J, Kippenberger S, Ramirez-Bosca A, Diaz- Alperi J, Bereiter-Hahn J, Kaufmann R, et al. Curcumin in combination with visible light inhibits tumor growth in a xenograft tumor model. *Int J Cancer* 2009,124:1422-8.
- [30] Huang MT, Lou YR, Xie JG, Ma W, Lu YP, Yen P, et al. Effect of dietary curcumin and dibenzoylmethane on formation of 7,12-dimethylbenz a anthracene-induced mammary tumors and lymphomas/leukemias in Sencar mice. *Carcinogenesis* 1998;19:1697-700.
- [31] Rabiei Z, Rafieian-kopaei M, Heidarian E, Saghaei E, Mokhtari S. Effects of *Zizyphus jujube* extract on memory and learning impairment induced by bilateral electric lesions of the nucleus basalis of meynert in rat. *Neurochem Res* 2014;39(2):353-60.
- [32] Rabiei Z, Rafieian-Kopaei M, Mokhtari S, Alibabaei Z, Shahrani M. The effect of pretreatment with different doses of *Lavandula officinalis* ethanolic extract on memory, learning and nociception. *Biomed Aging Pathol* 2014; 4(1):71-6.
- [33] Kwon Y, Magnuson BA. Age-related differential responses to curcumin-induced apoptosis during the initiation of colon cancer in rats. *Food Chem Toxicol* 2009;47:377-85.
- [34] Zeng Y, Qiu F, Takahashi K, Liang J, Qu G, Yao X. New sesquiterpenes and calebin derivatives from *Curcuma longa*. *Chem Pharm Bull (Tokyo)* 2007;55:940-3.
- [35] Dujic J, Kippenberger S, Ramirez-Bosca A, Diaz Alperi J, Bereiter-Hahn J, Kaufmann R, et al. Curcumin in combination with visible light inhibits tumor growth in a xenograft tumor model. *Int J Cancer* 2009;124:1422-8.
- [36] Huang MT, Lou YR, Xie JG, Ma W, Lu YP, Yen P, et al. Effect of dietary curcumin and dibenzoylmethane on formation of 7,12-dimethylbenz a anthracene-induced mammary tumors and lymphomas/leukemias in Sencar mice. *Carcinogenesis* 1998;19:1697-700.
- [37] Rabiei Z, Rafieian-kopaei M, Heidarian E, Saghaei E, Mokhtari S. Effects of *Zizyphus jujube* extract on memory and learning impairment induced by bilateral electric lesions of the nucleus basalis of meynert in rat. *Neurochem Res* 2014;39(2):353-60.
- [38] Rabiei Z, Rafieian-Kopaei M, Mokhtari S, Alibabaei Z, Shahrani M. The effect of pretreatment with different doses of *Lavandula officinalis* ethanolic extract on memory, learning and nociception. *Biomed Aging Pathol*