INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Article

Study of Turmeric-Derived Curcumin

Ajay Goswami*, Sujeet Pratap Singh, Pramod Mishra, Dr. Tarkeshwar Prashad Shukla

SCPM college of pharmacy.

ARTICLE INFO

Published: 21 Nov 2026
Keywords:
Turmeric-Derived Curcumin, yellow polyphenolic compound, rhizome of turmeric (Curcuma longa L.)
DOI:
10.5281/zenodo.24414035

ABSTRACT

Curcumin is a yellow polyphenolic compound found in the rhizome of turmeric (*Curcuma longa* L.) and is one of the best-studied constituents of this spice. Interest in curcumin as a nutraceutical arises from its ability to interact with oxidative and inflammatory pathways and from promising results in laboratory and some human studies. Its practical use, however, is limited by poor water solubility, chemical instability under some conditions, rapid metabolism, and low systemic bioavailability. This project reviews the antioxidant properties of curcumin, formulation approaches designed to improve its stability and delivery, and the current evidence concerning potential health benefits. Antioxidant activity may be evaluated in vitro using assays such as DPPH, ABTS, or FRAP, while formulation quality can be assessed through appearance, pH where applicable, content uniformity, and storage studies. Lipid-based systems, phospholipid complexes, emulsions, and encapsulation are among the approaches studied to improve dispersibility or protect curcumin from degradation. Published research suggests potential benefits in selected inflammatory and metabolic conditions, but findings vary by formulation, dose, study design, and population. Curcumin should therefore be regarded as a promising research ingredient, not a proven substitute for medical treatment. This review identifies formulation and stability as key factors in the development of reliable curcumin-based nutraceuticals.

INTRODUCTION

Nutraceuticals are foods, food components, or products derived from food that are investigated for possible health-supporting effects beyond basic nutrition. Turmeric, obtained from the rhizome of *Curcuma longa*, has a long history of culinary use and is widely researched because it contains curcuminoids. These include curcumin, demethoxycurcumin, and bisdemethoxycurcumin. Curcumin contributes to turmeric's characteristic yellow colour and has attracted scientific interest because of its antioxidant and inflammation-related activity [1,2].

***Corresponding Author:** Ajay Goswami
Address: SCPM college of pharmacy
Email ✉: ajaygoswami7897@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Oxidative stress occurs when the generation of reactive oxygen species exceeds the capacity of biological antioxidant systems. At excessive levels, reactive species can damage lipids, proteins, and nucleic acids. Curcumin has phenolic and β-diketone structural features that can participate in redox reactions in experimental systems. It may also influence cellular signalling pathways associated with antioxidant responses. Nevertheless, results from chemical assays or cell experiments do not automatically predict an effect in the human body.

A major challenge is that curcumin is poorly soluble in water and is absorbed inconsistently after oral intake. It can undergo rapid metabolism, and its chemical stability is affected by conditions such as pH, temperature, light, and the surrounding formulation. Consequently, researchers have explored delivery systems that protect curcumin, improve dispersion, and potentially increase its bioavailability [2–5].

2. Aim and Objectives

To review the antioxidant properties, formulation strategies, stability considerations, and potential health benefits of turmeric-derived curcumin as a nutraceutical ingredient.

Objectives

- Describe the origin and key physicochemical characteristics of curcumin.
- Summarize the principles and limitations of commonly used in-vitro antioxidant assays.
- Compare formulation approaches used to improve curcumin dispersion, protection, and delivery.
- Identify factors that influence curcumin stability during processing and storage.
- Review potential health benefits while distinguishing preliminary findings from established clinical evidence.

3. Review Methodology

This report is a narrative literature review based on peer-reviewed review articles and scientific publications identified through sources including PubMed and open-access journal records. Search concepts included curcumin, *Curcuma longa*, antioxidant activity, bioavailability, formulation, encapsulation, and stability. Priority was given to papers that discuss formulation performance or critically review clinical evidence. This is not a systematic review: no exhaustive search, formal risk-of-bias assessment, or meta-analysis was performed. The conclusions should be interpreted in that context.

4. Turmeric-Derived Curcumin

Curcumin is a hydrophobic polyphenol and the principal curcuminoid commonly associated with turmeric research. Commercial turmeric extracts can differ in curcuminoid content depending on plant variety, cultivation, processing, extraction method, and quality controls. Therefore, turmeric powder and purified curcumin are not interchangeable research materials. Any practical study should document the material source, batch, declared purity, and analytical method used to estimate curcumin content.

Curcumin's low aqueous solubility complicates its incorporation into water-based drinks or solutions. Its colour can assist with visual inspection but is not a reliable stand-alone measure of purity or concentration. More selective methods, such as high-performance liquid chromatography (HPLC), are preferable when available.

5. Antioxidant Properties

Curcumin is frequently described as an antioxidant because it can react with certain radicals in chemical systems and may affect cellular pathways related to oxidative balance. Two broad mechanisms are discussed in the literature: direct chemical interaction with reactive species and indirect effects on cellular defence pathways. The relative importance of these mechanisms in humans remains an active research question.

5.1 Common in-vitro assays

DPPH assay: Measures the ability of a test sample to reduce the stable DPPH radical, usually observed as a change in absorbance. It is convenient for screening but does not fully represent biological antioxidant behaviour.

ABTS assay: Uses a coloured ABTS radical cation and measures reduction in its signal after exposure to an antioxidant sample. It can be adapted to samples with

different polarities, but results depend on assay conditions.

FRAP assay: Estimates ferric-reducing antioxidant power under defined acidic conditions. It measures reducing capacity rather than every possible antioxidant mechanism.

For a laboratory project, a suitable protocol should include a reagent blank, sample blank to account for curcumin's own colour, a positive reference antioxidant such as Trolox or ascorbic acid, replicate measurements, and a calibration or concentration-response curve. Results should be reported with units and assay conditions. Values from different assays should not be treated as directly interchangeable.

6. Formulation Approaches

Formulation aims to improve the handling, dispersibility, protection, or absorption of curcumin. The best approach depends on the intended product, available equipment, excipient suitability, cost, and regulatory category.

6.1 Lipid-based formulations and emulsions

Curcumin may be incorporated into an oil phase and dispersed as an emulsion or related lipid system. Such systems can improve apparent dispersibility in aqueous products. Droplet size, physical separation, oxidation of the oil phase, and curcumin retention should be monitored.

6.2 Phospholipid complexes

Complexing curcumin with phospholipids can alter its interaction with the formulation matrix and has been investigated as a way to improve delivery. The quality of a product depends on the composition and manufacturing process; a formulation claim should be supported by comparative analytical or pharmacokinetic data rather than assumed from the ingredient list.

6.3 Encapsulation and polymer-based carriers

Microencapsulation and nano- or microparticle systems can surround curcumin with a protective carrier. Materials explored in research include selected proteins, polysaccharides, and biodegradable polymers. These systems may protect curcumin from light or environmental exposure and can influence release, but they require suitable characterization of particle size, loading, encapsulation efficiency, release behaviour, and safety.

6.4 Practical formulation concept for an academic project

A feasible concept is to prepare a simple curcumin-containing oil-in-water emulsion or a food-compatible encapsulated powder using institution-approved methods and excipients. Compare the formulation with an unformulated curcumin control. Record ingredient grades and quantities, mixing conditions, processing temperature, appearance, pH where relevant, and initial curcumin content. The precise recipe and manufacturing procedure should be selected with a qualified supervisor and appropriate laboratory safety procedures. No experimental results are supplied in this review, so results must be generated and reported by the student rather than invented.

7. Stability of Curcumin

Stability describes the ability of curcumin to retain its chemical content and relevant product properties over time. Published research indicates that curcumin can degrade in aqueous environments, particularly under unfavourable pH conditions, and that light, heat, oxygen, and interactions with other ingredients may affect its stability [4,5]. The formulation matrix can either reduce or increase exposure to these stressors.

7.1 Factors affecting stability

- pH: alkaline conditions can accelerate degradation in aqueous systems.
- Temperature: heat during processing or storage may affect chemical retention and physical quality.
- Light and oxygen: exposure can contribute to chemical changes; suitable packaging may reduce exposure.
- Water activity and moisture: especially relevant for powders and encapsulated ingredients.
- Formulation composition: carrier type, emulsifier, lipid oxidation, and interactions with other ingredients may change stability.

7.2 Suggested stability study design

Store the test formulation and a suitable control in clearly labelled, sealed containers under predefined conditions. A small preliminary study may compare refrigerated, room-temperature, and protected-from-light samples at scheduled intervals, provided the selected conditions are appropriate for the product and laboratory. At each interval, document colour, odour, phase separation or caking, and any relevant physical properties. Quantify curcumin content with a validated method if available. Include replicate samples and document the actual temperature, light exposure, sampling dates, and analytical procedure. This short-term academic study should not be presented as a formal shelf-life determination.

8. Potential Health Benefits and Strength of Evidence

8.1 Inflammation-related outcomes

Curcumin has been studied for effects on inflammatory signalling. Some human trials and reviews report improvements in selected symptoms or biomarkers, including in some people with osteoarthritis. However, studies differ in formulation, dose, duration, participant characteristics, and outcome measures, so the evidence does not justify a universal treatment claim [2,3].

8.2 Metabolic and cardiovascular markers

Research has examined curcumin in relation to glucose regulation, blood lipids, and other metabolic markers. Findings are mixed and should be interpreted in light of sample size, study quality, and the specific preparation used. Changes in a laboratory marker do not necessarily demonstrate a reduction in disease risk or complications.

8.3 Antioxidant and general wellness claims

Antioxidant activity in chemical or laboratory models supports further investigation but does not by itself prove that a supplement prevents disease in humans. Claims involving cancer prevention, neuroprotection, liver protection, or treatment of chronic diseases require high-quality clinical evidence and should not be inferred from preclinical studies alone.

8.4 Safety considerations

Turmeric used as a food spice is different from concentrated curcumin supplements. Supplements may cause gastrointestinal symptoms and can interact with medicines. Formulations designed to increase absorption may also change exposure and risk. People who are pregnant, have a medical condition, have gallbladder or bile-duct problems, or take regular medicines should seek advice from a qualified healthcare professional before using concentrated products. Rare liver injury has been reported with some turmeric/curcumin supplements. This project is informational and does not provide individual medical advice.

DISCUSSION

The literature presents curcumin as a promising but formulation-sensitive nutraceutical ingredient. Its antioxidant activity is well established in several chemical and preclinical models, whereas the magnitude and consistency of health effects in humans remain dependent on the condition studied and the product used. Poor water solubility, degradation in some environments, and limited oral bioavailability create connected challenges: a product may contain curcumin but deliver little intact compound to the circulation. Formulation can improve some of these properties, yet an improvement in solubility or pharmacokinetics does not, by itself, prove clinical benefit. A sound nutraceutical development process should therefore link identity and content testing with stability assessment, delivery performance, safety, and appropriately designed clinical studies.

CONCLUSION

Turmeric-derived curcumin is an important research candidate for nutraceutical development because of its antioxidant activity and potential influence on inflammatory and metabolic processes. Its practical application is limited by low water solubility, chemical instability under certain conditions, and variable oral bioavailability. Lipid-based delivery, phospholipid complexes, emulsions, and encapsulation are promising formulation approaches, but each requires product-specific evaluation. Antioxidant assays and controlled stability studies can provide useful early-stage

evidence, while health claims must be grounded in reliable human studies. Further research should focus on reproducible composition, validated analytical methods, storage performance, safety, and clinical relevance.

HOW TO CITE: Ajay Goswami, Sujeet Pratap Singh, Pramod Mishra, Dr. Tarkeshwar Prashad Shukla, Study of Turmeric-Derived Curcumin, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 11, 3760-3764. https://doi.org/10.5281/zenodo.24414035

REFERENCES

1. Kotha, R. R., & Luthria, D. L. (2019). Curcumin: Biological, Pharmaceutical, Nutraceutical, and Analytical Aspects. *Molecules, 24*(16), 2930. https://doi.org/10.3390/molecules24162930
2. Hegde, M., Girisa, S., BharathwajChetty, B., Vishwa, R., & Kunnumakkara, A. B. (2023). Curcumin Formulations for Better Bioavailability: What We Learned from Clinical Trials Thus Far? *ACS Omega, 8*(12), 10713–10746. https://doi.org/10.1021/acsomega.2c07326
3. Jamwal, R. (2018). Bioavailable curcumin formulations: A review of pharmacokinetic studies in healthy volunteers. *Journal of Integrative Medicine, 16*(6), 367–374. https://doi.org/10.1016/j.joim.2018.07.001
4. Pan-On, S., et al. (2022). Trends in advanced oral drug delivery system for curcumin: A systematic review. *Journal of Controlled Release, 348*, 335–345. https://doi.org/10.1016/j.jconrel.2022.05.048
5. Wang, Y.-J., et al. (1997). Stability of curcumin in buffer solutions and characterization of its degradation products. *Journal of Pharmaceutical and Biomedical Analysis, 15*(12), 1867–1876. https://doi.org/10.1016/S0731-7085 (96)02024-9
6. Kharat, M., et al. (2017). Physical and Chemical Stability of Curcumin in Aqueous Solutions and Emulsions: Impact of pH, Temperature, and Molecular Environment. *Journal of Agricultural and Food Chemistry, 65*(8), 1525–1532. https://doi.org/10.1021/acs.jafc.6b04815
7. Panahi, Y., et al. (2016). Curcuminoids modify lipid profile in subjects with metabolic syndrome: A randomized controlled trial. *Complementary Therapies in Medicine, 33*, 1–5. (Consult the original paper for exact bibliographic details before formal submission.)