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# A REVIEW ON EXTRACTION AND ANALYSIS OF CURCUMIN

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## ABSTRACT

*Curcumin is the main coloring substance present in Turmeric (Curcuma longa L., Zingiberaceae) and two related compounds, demethoxycurcumin and bisdemethoxycurcumin are altogether known as curcuminoids. Curcumin due to its potential biological activity, is high on demand and has high market potential as well as high cost. The present review work was mainly focused on compilation of data related to extraction of curcuminoids from turmeric using different techniques and further isolation, identification, and analysis of curcumin.*

***Keywords*** *– Curcumin, HPTLC, Isolation, Identification, HPLC Analysis*

## 1. INTRODUCTION

Turmeric (*Curcuma longa* L. Family: Zingiberaceae) is a widely cultivated spice in India and other Asian countries. Curcumin is the main coloring substance in *Curcuma longa* and two related compounds, demethoxycurcumin and bisdemethoxycurcumin are altogether known as curcuminoids (Fig.1). Turmeric is rich in curcuminoids and recognized for their broad spectrum of biological activities [1].

The medicinal properties of turmeric, the source of curcumin, have been known for thousands of years; however, the ability to determine the exact mechanism(s) of action and to determine the bioactive components have only recently been investigated Curcumin is available in several forms including capsules, tablets, ointments, energy drinks, soaps, and cosmetics. Curcuminoids have been approved by the US Food and Drug Administration (FDA) as "Generally Recognized As Safe" (GRAS)[2].

Curcumin (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione), also called diferuloylmethane, is the main natural polyphenol found in the rhizome of Curcuma longa (turmeric) and in others Curcuma spp.[3] *Curcuma longa* has been traditionally used in Asian countries as a medical herb due to its antioxidant, anti-inflammatory, antimutagenic, antimicrobial, and anticancer properties [4-8].

Curcumin, a polyphenol, has been shown to target multiple signaling molecules while also demonstrating activity at the cellular level, which has helped to support its multiple health benefits [2]. It has been shown to benefit inflammatory conditions, metabolic syndrome, pain, and to help in the management of inflammatory and degenerative eye conditions [9-13]. In addition, it has been shown to benefit the kidneys [14]. While there appear to be countless therapeutic benefits to curcumin supplementation, most of these benefits are due to its antioxidant and anti-inflammatory effects [2-9]. Despite its reported benefits via inflammatory and

antioxidant mechanisms, one of the major problems with ingesting curcumin by itself is its poor bioavailability [15], which appears to be primarily due to poor absorption, rapid metabolism, and rapid elimination. Several agents have been tested to improve curcumin's bioavailability by addressing these various mechanisms. Most of them have been developed to block the metabolic pathway of curcumin in order to increase its bioavailability. For example, piperine, a known bioavailability enhancer, is the major active component of black pepper and is associated with an increase of 2000% in the bioavailability of curcumin [16-17]. Therefore, the issue of poor bioavailability appears to be resolved by adding agents such as piperine that enhance bioavailability, thus creating a curcumin complex.

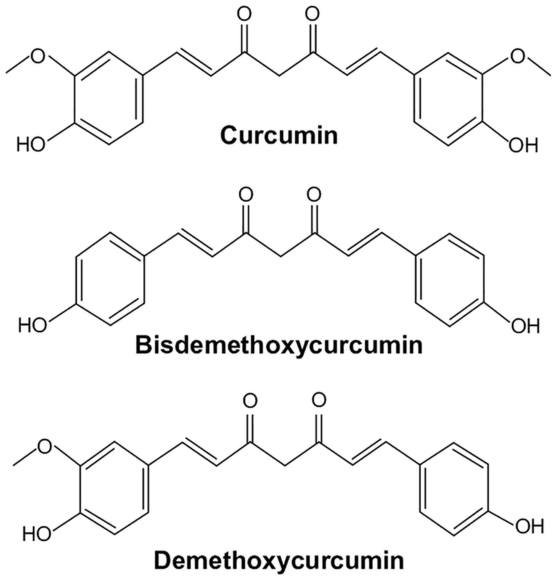


**Fig. 1: Chemical structures of different Curcuminoids**

**2. Extraction of Curcuminoids and Curcumin**

The choice of solvents for extraction is restricted to the few solvents of defined purity allowed by national and international food laws in the processing of food materials. Hexane, acetone, alcohol (ethanol, methanol), isopropanol and ethyl acetate are used in the extraction of oleoresins of spices. From consideration of solubility of active constituents, the curcuminoids are poorly soluble in the hydrocarbon solvents. Alcohol and acetone are good extractants and the yields can also be expected to be high because of extraction of non-flavor components. Soxhlet extraction of turmeric powder with acetone gave a yield of about 4.1% containing in 3 hours. Acetone as solvent was slightly superior to alcohol and ethyl acetate, the curcuminoids content also is on the high side, suggesting selective extraction. The results of extraction with acetone have, however been reported to give high yields of curcuminoids than alcoholic and remaining extraction [18].

Although extraction and separation of curcumin from turmeric powder was reported way back in 1815, more improved and advanced extraction methods are still being reported, even after two centuries. Solvent extraction followed by column chromatography has been the most employed method reported for separating curcumin from turmeric, and several polar and non-polar organic solvents have been used, including hexane, ethyl acetate, acetone, methanol, etc. Of the organic solvents employed, ethanol has been found to be the most preferred solvent for extracting curcumin. Although chlorinated solvents extract curcumin very efficiently from turmeric, they are not commonly employed due to their non-acceptability in the food industry. Soxhlet extraction, ultrasonic extraction, microwave, zone-refining and dipping methods have been tried, and among these the Soxhlet, ultrasonic and microwave extractions are the most commonly employed methods. Recently pulse ultrasonic and microwave-

assisted extraction methods have also been reported to be better than the continuous methods. Increasing the temperature in the range of 60 to 80 °C has been found to improve the extraction. With its increasing use in dietary supplements, researchers are developing extraction methods employing food grade solvents like triacylglycerols to give good yields.

Another commercially viable and efficient extraction method is using supercritical carbon dioxide. Being free from organic solvents, pilot plants based on supercritical carbon dioxide have been established in several countries for the extraction of curcumin from turmeric. Normal operating conditions for this are at pressures between 25 to 30 MPa and a temperature of 318 K. There are also a few reports on enzyme-assisted extraction, where pretreatment of turmeric with enzymes like α-amylase and glucoamylase yielded significant increases in curcumin yield. However due to increase in the cost of extraction, this method is not commercially viable.

Curcumin can be separated from curcumin mix (a mixture of curcumin, desmethoxycurcumin and bisdemethoxycurcumin) by column chromatography by adsorbing the mixture on silica gel using mixtures of solvents like dichloromethane/acetic acid or methanol/chloroform to yield three different fractions. The curcumin fraction is further purified on silica gel using chloroform/dichloromethane and ethanol/methanol mixtures as eluents [19-35].

**3. ANALYSIS OF CURCUMINOIDS / CURCUMIN**

Various analytical methods have been reported in previously published literatures for qualitative and quantitative analysis of Curcumin / Curcuminoids. Few reported methods are discussed below:

Sharma et al.[36] developed and validated UV-visible spectrophotometric method for the estimation of curcumin using methanol as solvent and detection wavelength of 421nm. The detector response was linear over the concentration range of 1-7µg/ml with correlation coefficient 0.9995. The LOD and LOQ were 0.05 and 0.172µg/ml respectively.

Gupta et al.[37] developed a spectrofluorimetric method for the estimation of curcumin by preparing a calibration curve in the concentration range of 1-10ng/ml using methanol. The spectrofluorimetrically scanned solution showed excitation at 232nm and emission at 614nm. The correlation coefficient obtained was 0.99.

Ashrafl et al.[38] developed and validated HPTLC method for the estimation of curcumin using toluene: chloroform: methanol (5:4:1, v/v/v) as mobile phase and silica gel 60 F254 as stationary phase and detection wavelength of 430nm. Linearity was observed in the concentration range of 200-1000ng/ml.

Gantait et al.[39] developed a validated HPTLC method using silica gel 60 F254 as stationary phase, dichloromethane: methanol (99:1) as mobile phase and 427nm as detection wavelength. Linearity was observed in the concentration range of 0.8- 1.3µg/spot with correlation coefficient of 0.99395. LOD was 49ng and LOQ was 148ng/spot.

Soni et al.[40] carried out HPLC separation of curcumin using Cyber Lab C18 column (250 x 4 mm, 5µ) as stationary phase and mobile phase comprising of acetonitrile and 0.1% orthophosphoric acid solution in water in the ratio of 60:40 (v/v) at flow rate of 0.5ml/min and detection wavelength of 425nm.

Nagappan et al. [41] developed a liquid chromatography method for the simultaneous determination of curcumin and piperine in food products using C18 column (250 x 4.6mm) by isocratic elution with 50mM potassium dihydrogen orthophosphate (pH3.5): acetonitrile (40:60) and detection at 424nm and 340nm using photodiode array detector for curcumin and piperine respectively. The calibration plot was linear over the range 100-3200ng/ml and 200-700ng/ml respectively with a correlation of 0.999.

Wichitnithad et al.[42] developed and validated isocratic HPLC method for the simultaneous determination of curcuminoids in commercial turmeric extracts using Alltima C18 column with isocratic elution of acetonitrile and 2% V/V acetic acid (40:60, V/V) at a flow rate of 2.0 ml/min and UV detection at 425nm.

Moorthi and Kathiresan[43] developed and validated RP-HPLC-PDA method for simultaneous estimation of curcumin and silibinin in nano-formulation using C18 column with an isocratic elution of mobile phase composed of a degassed mixture of 0.1% orthophosphoric acid and acetonitrile (50:50V/V) at a flow rate of 1.0ml/min.

**5. CONCLUSION**

Turmeric, a spice that has long been recognized for its medicinal properties, has received interest from both the medical/scientific world and from culinary enthusiasts, as it is the major source of the polyphenol curcumin. Curcumin is being recognized and used worldwide in many different forms for multiple potential health benefits. This review has presented a comprehensive overview about the extraction and analysis of Curcumin from turmeric. The compiled information will be useful to the scientists and researchers for extraction and isolation of curcumin from turmeric, identification, and quantitation of Curcumin in crude extracts, curcuminoids and their formulations.

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