International Research Journal of Pharmaceutical and Applied Sciences (IRJPAS)
Available online at **www.irjpas.com**
Int. Res J Pharm. App Sci., 2013; 3(6):75-79

Review Article

CURCUMINOID CONTENT IN *CURCUMA* SPP.: AN OVERVIEW

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Abstract: Turmeric is the common name used for dried rhizome of *Curcuma longa L.*, a monocotyledonous plant belonging to the family Zingiberaceae. Curcumin is responsible for the biological actions of turmeric and comprises of curcumin, demethoxy curcumin and bis demethoxy curcumin. Generally, the commercially produced curcumin is a mixture of the above with curcumin as the main constituent. Turmeric powder, curcumin and its derivatives and many other extracts from the rhizome were found to be bioactive. Studies on the extent of variation in content and quality characters of turmeric are important for selection of genotype with higher yield and better quality. This paper gives the comprehensive description about the work done in the field of evaluation, selection and characterization of turmeric genotypes.
Key words: Turmeric, Curcumin, HPLC

INTRODUCTION

The success of the drug discovery process is often a function of the diversity of chemotypes examined. Natural products screening represents a potential source of organic chemicals of unparallel diversity. The screening of natural products is one of the earliest steps in drug discovery-Lead identification. A lead compound, also frequently referred to as a chemical template, is a compound with many of the characteristics of a desired new drug which will be used as a model for chemical modification, but which lacks either the potency or specificity expected of a product candidate. Historically, medicinal plants and microorganisms have been extraordinarily rich sources of medicinally and agriculturally useful compounds. Interest in these sources of new bioactive molecules continues to present time. A medicinal herb can be compared with a chemical factory due to presence of number of chemical constituents like alkaloids, glycosides, saponins, resins, oleoresins, sesquiterpene lactones and oils (essential and fixed). With introduction of sophisticated techniques, the scientists started exploring the plant flora for active constituents. The concept of standardization has great impact on quality of herbal products. Standardization helps in adjusting the herbal drug formulation to a defined content of a constituent or constituents with therapeutic activity. Turmeric is used as traditional medicine in many countries because of the antibiotic and antiseptic effects of curcumin, an important constituent of turmeric. A yellow-pigmented fraction isolated from the rhizomes of *Curcuma* contains curcuminoids belonging to the dicinnamoyl methane group. Curcuminoids are present to the extent of 3 - 5 %[1]. It is an important active ingredient responsible for the biological activity of *Curcuma* . Though the major activity is anti inflammatory, it has also been reported to possess antioxidant, anti allergic, wound healing, anti bacterial, anti fungal and anti tumor activity[2]**.** Turmeric is the common name used for dried rhizome of *Curcuma longa* L., a monocotyledonous plant belonging to the family Zingiberaceae. Turmeric powder, curcumin and its derivatives and many other extracts from the rhizome were found to be bioactive. Studies on the extent of variation in morphological and quality characters of turmeric are important for selection of genotype with higher yield and better quality. This chapter gives the comprehensive description about the work done in the field of evaluation, selection and characterization of turmeric genotypes.

LITERATURE REVIEW

Medicinal plants comprise a group of large number of plant species that produce raw material for pharmaceuticals and phyto-chemicals for manufacturing drugs. In the commercial market, medicinal herbs are used as raw drugs, extracts or tinctures.

Muralidharan and Ramankutty, in 1976 evaluated the performance of selected 20 clones of turmeric (*Curcuma spp*.) in Wynad, Kerala for the highest yield of cured rhizome. The highest curcumin content (6.2%) was obtained from Alleppy[3].

Mathai, in 1976 reported the variability in turmeric (*Curcuma* species) germplasm for essential oil and curcumin in freshly harvested mature rhizomes of 38 varieties representing *C. longa* and *C. aromatica*. The curcumin content ranged from 2.5% to 8.1% [4].

Philip, in 1982 evaluated the sixteen-turmeric cultivars for the variation of yield and quality. The highest yield of curcumin was 560.6 kg/ha and oleoresin was 1470.3 kg/ha[5].

Muthuswamy and Shah, in 1982 evaluated the comparative quality of Salem and Erode turmeric types for curcumin content of mother and finger rhizomes of turmeric. Curcumin content was 4.75% compared with 3.9% in Erode[6].

Mangalakumari and Mathew, in 1986 studied the localization of the pigment curcumin, essential oil, starch

and polyphenols in *Curcuma longa* rhizomes at different stages of maturation and during sprouting and found curcumin and essential oil-containing cells were distributed throughout the rhizome[7].

Nadgauda and Mascarenhas, in 1986 determined the curcumin concentration in the swollen rhizome-like portions of the base of *in vitro* grown shoots of plantlets (cultivars Tekurpeta and Duggirala) derived from callus was positively correlated (r = 0.87) with curcumin concentration in rhizomes of callus-derived plantlets grown to maturity in the field. It is suggested that screening regenerated plantlets provides a convenient laboratory selection method for variants with high concentrations of curcumin among large plant populations.[8].

Cooray and other scientists in 1988 studied the effects of maturity on rhizome yield and on the content and composition of essential oils and curcumins. Contents of curcumin, demethoxycurcumin and bis-demethoxycurcumin (i.e. curcumins I, II and III) were monitored by TLC coupled initially with UV spectrophotometry or later with UV densitometry. In mother and finger rhizomes, the contents showed the order I > III > II; the ratio hardly changed with maturity. Maximum curcumin per bush was reached after about 9 months and declined thereafter[9].

Taylor and McDowell, in 1992 compared the HPLC and spectrophotometric results for the determination of the total curcuminoid content for a number of turmeric samples, revealed that the spectrophotometric method invariably yielded higher estimates, indicating an overestimation of curcuminoids[10].

Verghese, in 1993 reviewed and evaluated the methods for the retrieval of the yellow pigment, curcumin (a mixture of 3 curcuminoids). Solvent extraction of the rhizome appeared to be the best route.[11]

Tonnesen and other scientists in 1995 reported that curcuminoids possess a broad spectrum of biological activities including antiinflammatory and antineoplastic properties. They studied the intra- and intermolecular hydrogen bonding capacity of curcuminoids, the sensitivity of the absorption and emission properties of curcumin. Intermolecular hydrogen bond formation was observed both in the ground state and in the excited state of the curcuminoids with a phenolic group[12].

Satish and other scientists in 1997 investigated the growth and yield of twelve *C. domestica* [*C. longa*] cultivars in the southern dry region of Karnataka. The highest curcumin content (8.08%) was observed in rhizomes of PCT-8.[13]

Rakhunde and other scientists in 1998 estimated the curcumin and essential oil contents of some commonly grown turmeric (*Curcuma longa* L.) cultivars of Maharashtra and found that the curcumin contents in mother rhizomes of all cultivars were comparatively higher than those in the fingers, except in the case of cv. Rajapuri. Mother rhizomes of Mydukur and fingers of Salem exhibited the highest curcumin content[14].

He and other scientists in 1998 used on-line high-performance liquid chromatography-UV diode-array and electrospray mass spectrometry simultaneously to analyze curcuminoids and sesquiterpenoids in a fresh turmeric (*Curcuma longa*) extract. Five major components: curcumin (1), demethoxycurcumin (2), bisdemethoxycurcumin (3), ar-turmerone (5) and curlone (6) have been unambiguously identified, based on their UV spectra, mass spectra and retention times in comparison with the data of standard compounds[15]

Torres and other scientists in 1998 studied on isolation and spectroscopic of curcumin from Philippine *Curcuma longa* L. The infrared and UV-vis spectra of compounds were found to be almost identical, indicating the high purity of the isolate. A yield of 2-3% curcumin was obtained[16]

Garg , in 1999 reported the variation in the rhizome essential oil and curcumin contents and oil quality in the land races of turmeric of North Indian plains for twenty-seven accessions of *C. longa*. Curcumin content was found to vary from 0.61% to 1.45%[17].

Barrero and Carreno in 1999 studied on the histochemical evaluation for turmeric rhizomes of Venezuela. The highest curcumin was 3.6% among studied genotypes. He investigated the pigments from turmeric (*Curcuma longa*) cultivated in the Acarigua area, Portuguesa, Venezuela. The total pigment content was 3.6%. High performance liquid chromatographic separation was used for the determination of the pigments. They were identified as curcumin, demethoxycurcumin and bis-demethoxycurcumin, respectively[18].

. Gupta and other scientists in 1999 developed a rapid and simple HPLC method for the simultaneous quantitation of the pharmacologically important diaryl heptanoids, curcumin, demethoxy curcumin and bis-demethoxy curcumin, in rhizomes of *C. longa* and *C. amada*. The assay combines the isolation and separation of curcuminoids on silica gel 60F254 high performance thin layer chromatographic plates, followed by scanning of the spots at 366 nm using a UV detection mode[19].

Chempakam and other scientists in 2000 separated the three curcuminoids from turmeric and estimated quantitatively by thin layer chromatography, based on the absorption maxima of the compounds at 428, 423 and 418 nm, respectively. The distribution of the pigments has been observed individually in mother, primary and secondary rhizomes during different stages of growth. In all the three types of rhizomes, bisdemethoxy curcumin and demethoxy curcumin decrease with maturity with a corresponding increase in curcumin (methylated form). Higher content of curcumin was seen in primary and secondary rhizomes compared to mother rhizomes.[20]

Kumar and other scientists in 2000 evaluated the effect of different processing techniques on the recovery of total curcumin for two of the high yielding varieties with high curcumin content. Sun drying of rhizomes cut into thin slices and boiled in water gave an average curcumin recovery of 7.31 and 7.29% for Prabha and Prathibha, respectively, compared to 6.39% recovery (for both the varieties) under the normal method of sun drying whole rhizomes after boiling in water[21].

Jayaprakasha and other scientists in 2002 developed an improved HPLC method for the determination of curcumin, demethoxycurcumin, and bisdemethoxycurcumin. Curcuminoids were isolated by column chromatography and identified by spectroscopic studies. The purity of the curcuminoids was analyzed by an improved HPLC method. HPLC separation was performed on a C (18) column using three solvents, methanol, 2% AcOH, and acetonitrile, with detection at 425 nm. Four different commercially available varieties of turmeric, namely, Salem, Erode, Balasore, and local market samples, were analyzed to detect the percentage of these three curcuminoids. The percentages of curcumin, demethoxycurcumin, and bisdemethoxycurcumin as estimated using their calibration curves were found to be 1.06 +/- 0.061 to 5.65 +/- 0.040, 0.83 +/- 0.047 to 3.36 +/- 0.040, and 0.42 +/- 0.036 to 2.16 +/- 0.06, respectively, in four different samples. The total percentages of curcuminoids are 2.34 +/- 0.171 to 9.18 +/- 0.232%.[22]

Kita and other scientists in 2002 developed a method of micellar electrokinetic chromatography (MEKC) for the analysis of curcuminoids (curcumin, demethoxycurcumin and bisdemethoxycurcumin) in turmeric samples. Ethanol was the best solvent for curcuminoid extraction. Curcuminoids were separated by HPLC. Standard curves obtained for curcumin, demethoxycurcumin and bisdemethoxycurcumin over the range 6.25-100 µg/ml showed straight lines, with the detection limits for curcuminoids by HPLC and MEKC being 0.02 and 0.1 µg/ml, respectively[23].

Niranjan and other scientists in 2003 analyzed dried rhizomes of *C. longa*, fresh rhizomes of *C. longa*, *C. amada* and *C. zeodaria*, as well as leaves, petioles and stems of all species for biochemical contents. In the rhizomes, protein content was 3.6-6.8%, anthocyanins 18.9-37.0 µg/g, phenols 0.15-0.62%, tannins 0.32-0.76%, sugars 20.5-43.4%, oil 3.7-5.3%, curcumin 3.4%, ash 6.9-9.8%, moisture 90.2-91.3%, and ethanol and ethanol:water extractives 7.5-13.4 and 10.5-19.5%, respectively[24].

Pfeiffer and other scientists in 2003 investigated to the stability of curcuminoids in physiological media, two samples with different composition of curcumin (CUR I), mono-demethoxycurcumin (CUR II) and bis-demethoxycurcumin (CUR III) were incubated in phosphate buffer and cell culture medium without or with fetal calf serum. The stability differed between the curcuminoids: CUR I was the least, and CUR III was the most stable curcuminoid. Several degradation products of CUR I were detected, most of which were not yet identified; ferulic acid and vanillin were disclosed as minor products[25] .

Manzan and other scientists in 2003 studied the extraction of essential oil and pigments from *Curcuma longa* [L] by steam distillation and extraction with volatile solvents. They developed the best processing conditions to maximize the yields of essential oil and pigments. Autoclave pressure and distillation time were the variables studied for the steam distillation process. The highest yields of essential oil (0.46 wt %) and pigment (0.16 wt %)-expressed as curcumin, demethoxycurcumin, and bisdemethoxycurcumin-were obtained at a pressure of 1.0 x 10(5) Pa and a time of 2 h[26].

Lechtenberg and other scientists in 2004 developed a method for Quantitative determination of curcuminoids in *Curcuma* rhizomes and rapid differentiation of *Curcuma domestica* Val. and *Curcuma xanthorrhiza Roxb*. by capillary electrophoresis. The three major curcuminoids, curcumin, demethoxycurcumin and bis-demethoxy-curcumin, from *Curcuma domestica* Val. (*Curcuma longa* L.) and *Curcuma xanthorrhiza* Roxb. (Zingiberaceae) were fully separated and quantified in less than 5 min using a capillary zone electrophoresis method with standard fused-silica capillaries and photodiode array detection[27]

CONCLUSION

Turmeric (*Curcuma*) is the common name used for the dried rhizome of *Curcuma longa* L., a monocotyledonous plant belonging to the family Zingiberaceae. It has been used in traditional medicine as a household remedy for various diseases including biliary disorders, anorexia, cough, diabetes, wounds, hepatic disorders, rheumatism and sinusitis. Curcumin (diferuloymethane), the main yellow bioactive component of *Curcuma* has been shown to have a wide spectrum of biological actions. These include its anti-inflammatory, antioxidant, anticarcinogenic, antimutagenic, anticoagulant, antifertility, antidiabetic, antibacterial, antifungal activities. Due to changing ecological factors in the forest and unscrupulous collection of medicinal plants, the wealth of medicinal plant is getting depleted. The collection of these plants from forest cannot cope up with the ever increasing and changing demand from the pharmaceutical industries. Hence, in order to provide regular and sustained supply of medicinal plants, it is essential to domesticate and systematically cultivate these plants on a large scale. The availability of quality planting material is to be ensured.

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