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Review on *Curcuma longa* leaves exhibiting Antioxidant property

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ABSTRACT

Curcuma longa (turmeric) has been used in Ayurvedic medicine for many years. Turmeric has been used as a functional food ingredient and as a medical herb but other parts of it such as leavesis discarded as a byproduct. Turmeric aerial parts have their own functionality due to curcumin and other bioactive components. Hydro distillation was used to extract the essential oil from the leaves. Other extraction methods are available, but hydro distillation is much preferred. Gas chromatography-Mass spectrometry (GC-MS) is used to determine the oil content in the leaves. The oil of GC-MS analysis revealed that α-phelladrene, p-cymene, and terpinolene were major components present in *Curcuma longa* leaves.These components show potent biological activity and therapeutic uses such as antioxidant, anti-inflammatory and beneficial for skin immunity. The oil yield of leaves is high when compared to rhizome. According to the findings, water was the most effective at extracting antioxidant contents containing phenolic compounds.

Keywords: *Curcuma longa,* turmeric leaf oil, hydro distillation, α-phellandrene.

INTRODUCTION

Turmeric (*Curcuma longa* L.,) belonging to the Zingiberaceae family has been traditionally used as a medicinal herb, dietary, spice, food source, food preservative and as a coloring agent in many Asian countries[1,2].It is a perennial herb distributed throughout tropical and sub-tropical regions of the world including India, Pakistan, Bangladesh and Srilanka[3]. The belowground part is made up of avoluminous main rhizome on which grow side rhizomes are bearing numerous roots. The aboveground portion is made up of two types of leaves, one at the stem base and the other higher up with a well-developed elliptical limb. The inflorescence consists of a spike covered in green bracts that bears a yellow flower[4].Rhizomes are used as cosmeceuticals, expectorants, anthelmintics, blood purifiers and in the treatment of leprosy, spleen disorders, rheumatism, bronchitis, cough and cold, insecticide, spasmolytic hypotensive, cholera, and syphilis[5].

Dependent on its free radical scavenging function, it has antioxidant, antitumor, antibacterial, anticoagulant, and antidiabetic properties[6]. The rhizome was the most often used component of the turmeric plant in conventional therapies. *C.longa* rhizomes have been found to contain three main curcuminoid compounds (curcumin, demethoxycurcumin, and bisdemethoxycurcumin), which are often used as a flavouring and seasoning[7].

After harvesting, the aerial portions of this plant species are regarded as waste products. However, available research on the biological properties of *C.longa* leaves reveals that they can also be beneficial to health[8]. Almost all turmeric related research has concentrated on the turmeric rhizome. The research on turmeric byproducts such as leaves and stems are incomplete and restricted in explaining their properties and functionality. Turmeric leaves have their own distinct characteristics due to the use of curcumin and other

bioactive ingredients. Turmeric leaves have a wide surface area and volume[9, 10]

Turmeric leaf extract show physiological benefits such as antioxidant properties, skin whitening, cosmeceuticals, skin immunity and anti-inflammation. These effects are primarily attributed to curcumin, total phenolic compounds, and flavonoids found in turmeric leaves[6]. *Curcuma longa* leaves show great promise as an antifungal agent that could be used as for therapeutic treatment against pathogenic fungi due to their diverse *in vitro* and *in vivo* antifungal action, long shelf-life, tolerability of high inoculum density, thermo-stability, wide spectrum of antidermatophytic activity and lack of any adverse effects.[11]

The antioxidant, anti-inflammatory and other activities of the leaf oil varies due to several factors including the harvesting time, climatic and agronomic conditions, type of extraction used can be considered for fluctuations in chemical composition.

EXTRACTION OF TURMERIC LEAF OIL

The most important production method for essential oils is distillation. The basic principle of distillation is same but carried out in different ways based on the botanical material and its condition. Three types of distillation are used such as water and steam, water and direct steam. Water distillation is preferred for dried plant material. The dried material comes into direct contact with boiling water for extraction.

Fully grown *Curcuma longa* leaves were picked, washed and air dried or hot air dried in a convection oven at 50°C for 24 hours before powdering. The dried turmeric leaf powder was hydrodistilled in a Clevenger type apparatus for 5 hours. The oil was dried over anhydrous sodium sulphate before being subjected to GC-MS analysis[12].

The essential oil was analysed using Gas chromatography-Mass spectrometry (GC-MS) to identify individual constituents. Specific constituents of essential oils are identified using retention indices and a comparison of their mass spectral fragmentation patterns[13].

Steam distillation, supercritical fluid extraction, subcritical water extraction, ultrasonic extraction, microwave radiation (solvent-free microwave extraction, microwave-assisted extraction), and solvent extraction are some other techniques for obtaining *Curcuma longa* essential oil[14] [Table-1].

Table 1: Different extraction methods to obtain *Curcuma longa* essential oil advantages and limitations.

METHOD	ADVANTAGES	LIMITATIONS
STEAM DISTILLATION	Can be modified and/or combined with other techniques to maximize the yield and efficiency, e.g., ↑13–29% yield[15,16]	Huge amounts of raw material needed, Time-consuming, High price, Evaporation of steam-volatile compounds and even collapse[17,18]
HYDRO DISTILLATION	Low-cost efficiency, Easy implementation, Clevenger gives better deodorization results than other processes[19,20]	Long extraction times, Production of wastewater, Loss and/or alteration in the composition of essential oils[16,19]
SUPER CRITICAL FLUID EXTRACTION	Reduction of extraction times, Higher quality extracts CO2 as nontoxic, non-flammable and free-of-residues solvent. Superior yields[21]	No significant differences in qualitative and quantitative composition of turmeric essential oil with respect to other methods: 67.7–75% turmerone purity at 313–320 K and 20.8–26 MPa, Under study to achieve higher optimization[17,18]
SUBCRITICAL WATER EXTRACTION	Especially useful to extract non-polar compounds Selective to enhance a target compound Green and effective to extract the essential oil and curcumin[22]	Low implementation in industry currently
ULTRA SONIC EXTRACTION	Improved mass transfer between plant cell and solvent. Combination with other techniques: ↑ efficiency, ↓ processing time, ↓costs[16]	
MICROWAVE ENERGY (SFME, MAE)	↓ Costs ↓ Extraction times ↓ Energy consumption ↓ CO2 emissions Combination with other techniques to improve the performance: HDAM, SDAM, VMHD, MHG ↓ Extraction time from 4 h of hydro distillation to 1 h. No degradation products. Maximum yield.[23,24]	
SOLVENT EXTRACTION	Overcomes the problem of excessive heat; avoids the loss of compounds and properties of the essential oil. Suitable and safe extractants: chloroform	

and freons[25].

SFME: solvent-free microwave extraction, MAE: microwave-assisted extraction, HDAM: hydro distillation assisted by microwave, SDAM: steam distillation assisted by microwave, VMHD: vacuum microwave hydro distillation and MHG: microwave by hydro diffusion and gravity. ↑: Increase, ↓: Decrease.

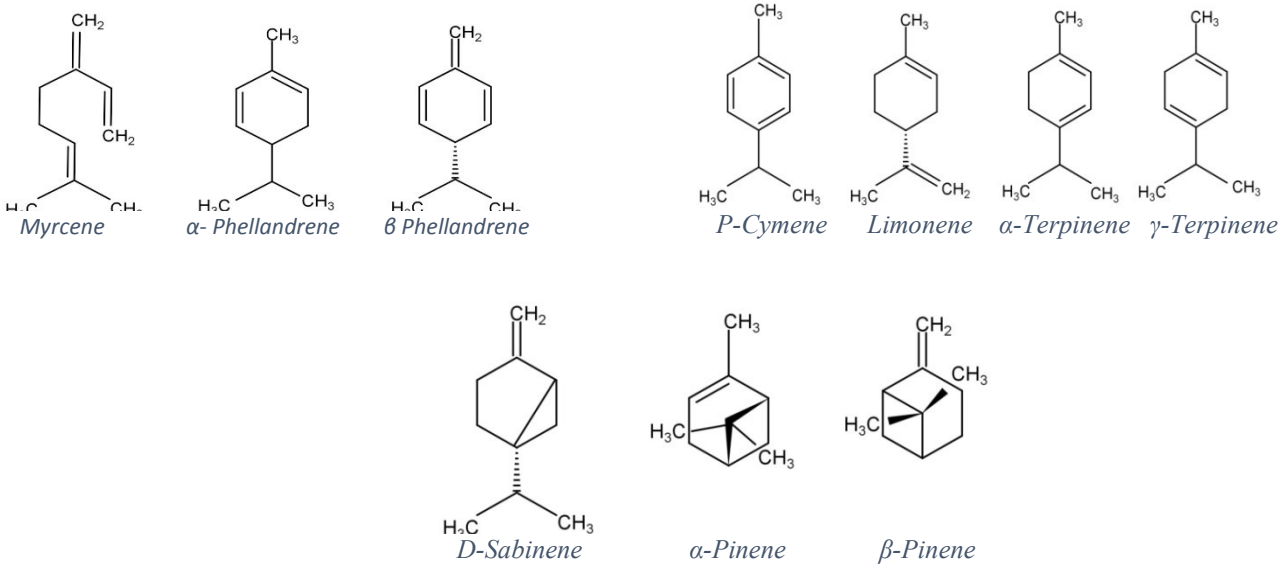
IDENTIFICATION OF CONSTITUENTS

The constituents were characterized by comparing 400 MHz 'H-NMR spectra to authentic specimens and/or GC-MS spectra with those of authentic specimens or by comparing 'H- and I3C-NMR and MS data to literature values (Table 2). It is worth noting that the main constituent of the rhizome essential oil containsesquiterpene ketone which was not included in the leaf essential oil. Terpinolene, α- and γ-terpinene, β-pinene, Δ-3-carene, and myrcene were discovered in turmeric leaves for the first time[26].

Table 2-Composition of Essential Oil of *Curcuma longa* L. Leaves[26]

Compounds	Composition (%)	Identification
α-Pinene	2.2	GC-MS, H^1 NMR
β-Pinene + mycrene	6.3	H^1 NMR
α-Phellandrene	47.7	GC-MS,H^1 and ^{13}C –NMR
Δ-3-Carene	1.2	GC-MS, H^1 NMR
α-Terpinene	1.8	GC-MS, H^1 NMR
*p-C*ymene	1.2	GC-MS, H^1 NMR
Limonene+1,8 cineole	6.0	GC-MS, H^1 NMR
γ-Terpinolene	2.0	GC-MS, $H^1$and ^{13}C-NMR
Terpinolene	28.9	GC-MS, H^1 NMR
Sesquiphellandrene	0.8	GC-MS
α-Terpinolene	0.2	GC-MS
4-Terpineol	0.2	GC-MS
Sabinol	0.2	GC-MS

MONOTERPENES FROM TURMERIC LEAF OIL



EVALUATION OF ANTIOXIDANT ACTIVITY

The antioxidant activity of all turmeric leaf extracts is measured using the ABTS (2, 2'-azino-bis (3-ethylbenzthiazoline-6-sulphonic acid) decolorisation assay, which includes the oxidation of ABTS with potassium persulfate to produce ABTS+ chromophore. The radical scavenging function (%) of ABTS+ was determined, and its absorbance was compared to that of the trolox reference curve (μmTE/mol) as a standard antioxidant.

Antioxidant activity of the extracts can also be determined by using 1, 1-diphenyl-2-picrylhydrazyl (DPPH) assay using three different solvents such as water, ethanol 10% and 50% respectively[27]. The DPPH radical-scavenging activity is calculated from inhibition rate (%) compared with that of sample blank. For the determination of antioxidant activity of turmeric leaf, water is considered as the suitable solvent to enhance radical-scavenging activity.

DETERMINATION OF ANTIOXIDANT CONTENT

Total Phenolic Compounds: Total phenolic compound content was determined by the Folin–Ciocalteu method. To measure the total phenolic content, 0.5 mL of the turmeric leaf extract was mixed with 0.3 mL of distilled water then; 0.75 mL of 10% sodium carbonate solution was added and then incubated for 3 minutes. After that, 0.95 mL of distilled water and 0.25 mL of Folin–Ciocalteu reagent were added to the mixture and incubated for another 30 min at room temperature. Absorbance was measured at a wavelength of 750 nm. The result was expressed as mg of gallic acid (mg GAE/g) based on the gallic acid standard curve.

Total Flavonoid Content: Total flavonoid content was determined by the aluminum chloride colorimetric method[27, 28]. To measure the total flavonoid content, 0.5 mL of the turmeric leaf extract was mixed with1.5 mL of methanol, 2.8 mL of distilled water, and 0.3 mL of3% sodium nitrite. After reaction, 0.1 mL of 10% aluminum chloride and 0.1 mL of 1 M potassium acetate were added and incubated for 30 min at room temperature. Then, absorbance was measured at a wavelength of 415 nm. The result was expressed as mg of quercetin (mg QCE/g) based on the quercetin standard curve.

ANTIOXIDANT PROPERTIES OF C.*longa* LEAVES

The total phenolic content (TPC) of turmeric leaf extract is expressed as milligrammes of gallic acid equivalent per gram (mg GAE/g). The reported TPC value of water extract was 2.741 ± 0.099, 2.552 ± 0.464 for 10% ethanol extract and 1.628 ± 0.271 for 50% ethanol extract respectively. This suggests that water is the most effective solvent for extracting the antioxidant content of turmeric leaves. The total flavonoid content (TFC) of turmeric leaf extracts is given inmilligrammes of Quercetin equivalent (mg QUE/g). The TFC values for water extract was 4.78 ± 0.01 and for 10% ethanol extract was 3.58±0.01 and for 50% ethanol extract the value was 1.61 ± 0.01respectively.As a result, the extraction shows that the optimum extraction state of turmeric leaves was accomplished using water as a solvent. Turmeric leaves have antioxidant components such as total phenolic compound (2.741±0.099 mg GAE/g) and flavonoid content (4.776±0.010 mg QUE/g) that indicate a possible source. The protein content of dried and fresh turmeric leaves differs slightly. Even though the moisture content of both leaves is almost the same, the protein content of fresh turmeric leaves was higher than that of dried turmeric leaves. This may be attributed to protein degradation caused by hot-air drying[29].

CONCLUSION

The turmeric leaves occupies mass volume and large surface area in the whole plant, which makes it a plentiful resource. The leaf extract shows potential as a food source and effective in cosmetics from its antioxidant components such as total phenolic compound and flavonoid content. The antioxidant properties of curcuma longa leaves are investigated in this review. The yield value and antioxidant properties are affected by both the extraction process and the solvent used. Water and ethanol are considered as ideal extraction solvents that are also appropriate for human use. The essential oil of the leaf had a high concentration of terpinolene and phellandrene. There is a strong association between total phenol content and antioxidant activity, indicating that phenol may contribute to antioxidant power. Flavonoids are large compounds occurring ubiquitously in food plants and found to be strong free radical scavengers. The antioxidant ability of turmeric leaf is also believed to be due to its various flavonoids. The relative antioxidant ability to scavenge radicals was compared to the criteria Trolox and gallic acid, and it is an excellent method for evaluating the antioxidant function of hydrogen donating antioxidants and chain breaking antioxidants. The essential oil of curcuma longa leaves is a promising candidate for the prevention of oxidative stress-mediated destruction.

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