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Curcumin Content and Antioxidant/Antimicrobial Activities of Selected *Curcuma* Genus and *Zingiber purpureum* Powders

ORN ANONG CHAIYACHET*, KANLAYANI CHAROENSOPHARAT[1] AND WORACHAT TOKAEW[1]

Division of Biotechnology, Faculty of Science and Technology, Rajabhat Maha Sarakham University, Talat, Mueang, Maha Sarakham, P. O. Box 44000, Thailand
**(e-mail: ornanong.ch@rmu.ac.th; Mobile: +66892767907)*

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ABSTRACT

This study was aimed at determining the curcumin content and antioxidant/antimicrobial activities of *Curcuma longa* Linn. (CL), *Curcuma aromatic* Salisb. (CA) and *Zingiber purpureum* Roscoe (ZP) powders. The alcohol and water soluble extractive values were estimated. The curcumin content was analyzed by high-performance liquid chromatography. The antioxidant activity was investigated by DPPH assay, and the antimicrobial activity was evaluated using the agar diffusion method. The alcohol-soluble extractive value of CL was the highest, while the water-soluble extractive value of CL was the lowest. The curcumin content was highest for CL, followed by CA and ZP. CL had the lowest IC_{50}, indicating the highest antioxidant activity, which was strongly correlated with the curcumin content. The herbal powders showed no antibacterial activity against *Propionibacterium acnes* but exhibited antifungal activity against *Trichophyton mentagrophytes*. This study demonstrated the effective activity of the *C. longa*, *C. aromatica* and *Z. purpureum* powders which can be further applied in cosmetic products.

Key words: Antimicrobial, *Curcuma aromatic, Curcuma longa,* curcumin, *Zingiber purpureum*

INTRODUCTION

Curcuma longa Linn., *Curcuma aromatic* Salisb. and *Zingiber purpureum* Roscoe are rhizomatous herbs belonging to the Zingiberaceae family. The rhizomes of these herbal plants are widely used in traditional medicine due to the pharmacological activity demonstrated through the various phytochemical actions of secondary metabolites including alkaloids, flavonoids, tannins and terpenoids. Specifically, curcumin is a polyphenol that provides diverse clinical effects. Plants of the genera *Curcuma* and *Zingiber* possess numerous therapeutic benefits, including antioxidant, anti-aging enzymatic (Rungruang *et al.*, 2021), cosmeceutical, antifungal/ antimicrobial (Han *et al.*, 2021) and anti-inflammatory (Chongmelaxme *et al.*, 2017). In addition, their bioactive effects and safety profile are utilized in cosmetics, pharmaceuticals and some medical preparations (Sharifi-Rad *et al.*, 2020).

Curcumin can be extracted from the dried root of the rhizome in *Curcuma* and *Zingiber* species. The extraction process requires the raw material to be ground into powder and washed with a suitable solvent that selectively extracts colouring matter. The dried powder derived from the rhizome of *Curcuma* and *Zingiber* is commonly used for culinary, medicinal and cosmetic purposes. According to good herbal processing practices for herbal preparations, drying involves the removal of moisture necessary for bacteria growth that eventually causes spoilage and deterioration and the preservation of phenolic and bioactive compounds such as curcumin. Regarding its application in cosmetics, curcumin is used as an active compound in skin care and dermatology due to its antioxidant, anti-inflammatory and antiaging activity (Gopinath and Karthikeyan, 2018). Clinical studies have found that the administration of curcumin from turmeric (*C. longa*), both orally and topically, was beneficial

[1]Division of Biology, Faculty of Science and Technology, Rajabhat Maha Sarakham University, Talat, Mueang, Maha Sarakham, P. O. Box 44000, Thailand.

in treating various skin diseases and improving overall skin health. Wild turmeric (*C. aromatica*) is extensively used as an aromatic medicinal cosmetic and possesses an anti-melanogenic, antioxidative and free radical scavenging profile. As a promising herb in the cosmetic industry, it also can prevent the photoaging of skin. Cassumunar ginger (*Z. purpureum*) has potential applications in natural cosmetic and pharmaceutical products for preventing and treating hypopigmentation, skin aging, dermatitis (Han *et al.*, 2021) and acne vulgaris. Here in this study, the curcumin content and antioxidant/ antimicrobial activities of selected *Curcuma* and *Zingiber* powders were investigated. Additionally, the information obtained can be used as a guideline for the further development of herbal cosmetics.

MATERIALS AND METHODS

The fresh rhizomes of *Curcuma longa* (CL), *Curcuma aromatica* (CA) and *Zingiber purpureum* (ZP) were collected from the herbal group of Borabue Sub-District (Borabue District, Maha Sarakham Province). The collected plants were washed and drained. The herbal materials were then sliced into 1-2 mm disks and dried in a hot air oven at 60°C for 6 h. The dried plant material of each plant species was ground into a fine powder and passed through a 60 mesh sieve to form a 250 µm fine powder. The powder samples were collected in a sealed plastic bag and stored at room temperature for further analysis.

Five grams of the dried powder sample was macerated with 100 ml of 95% ethanol in a closed conical flask for 24 h, shaken frequently during the first 6 h and allowed to stand for 18 h. The sample were then filtered rapidly with Whatman No.1. Twenty milliliters of the filtrate were evaporated to dryness in an evaporating dish, further dried at 105°C to a constant weight, and weighed. The percentage of alcohol soluble extractives was calculated using the dry powder of the plant material (Eq. 1):

$$\% \text{ Extractive value} = \frac{\text{Mass of dry extract}}{\text{Mass of plant material}} \times 100 \quad \text{...(Eq.1)}$$

Five grams of dried powder sample was macerated with 100 ml of chloroform water in a closed flask for 24 h, frequently shaken for the first 6 h and allowed to stand for 18 h, and then filtered rapidly. Twenty milliliters of the filtrate were evaporated to dryness in an evaporating dish, further dried at 105°C to a constant weight, and weighed. The percentage of water-soluble extractives was calculated for the dry powdered plant material using Eq. 1.

High-performance liquid chromatography (HPLC) was used to quantitatively determine the curcumin content of dried CL, CA and ZP powders. Standard curcumin samples were prepared at concentrations of 10-100 µg/ml, and the curcumin content of each sample was calculated from the peak area relative to the standard curve.

DPPH assay was used to estimate antioxidant activity. Briefly, L-ascorbic acid standards were prepared at concentrations of 0.002, 0.004, 0.006, 0.008 and 0.010 mg/ml, and 0.1 mM of DPPH (2,2-diphenyl-1-picrylhydrazyl) was prepared. DPPH free radical scavenging activity was determined using 100 µl of sample solution; 100 µl of DPPH solution was added to a 96-well plate and incubated for 20 min in the dark at room temperature. The absorbance was measured using a UV spectrophotometer at a wavelength of 517 nm, and the percentage of DPPH radical scavenging activity was calculated as:

$$\% \text{ Radical scavenging} = \frac{A_{517} \text{ of control} - A_{517} \text{ of sample}}{A_{517} \text{ of control}} \times 100$$

Where, A_{517} was the absorbance measured at 517 nm. Radical scavenging activity was expressed as the inhibition concentration (IC_{50}) i.e. the sample concentration required to decrease the initial concentration of DPPH radicals by 50%. The results were obtained by linear regression analysis of the dose–response curve plotted using the % radical scavenging and concentration.

To determine the antimicrobial activity, standard test strains of microorganisms were used: *Propionibacterium acnes* (DMST 14916) and *Trichophyton mentagrophytes* (DMST 19735) obtained from the National Institute of Health, Department of Medical Sciences (Thailand).

The antibacterial activity against *P. acnes* and the antifungal activity against *T. mentagrophytes* of dried CL, CA and ZM powders were determined using an agar diffusion method. The blood agar medium for *P. acnes* and Sabouraud dextrose agar medium for *T. mentagrophytes* were prepared using 20 ml per test dish. The prepared test inoculums was smeared into each test dish. A hole was then punched into the center of the agar and filled with 20 µl per well of 100 mg/ml dried powder samples. The *P. acnes* test medium was incubated under anaerobic growth conditions at 35±2°C for 48 h, while the *T. mentagrophytes* test medium was incubated under aerobic growth conditions at 35°C for 7-14 days. The samples were examined for antimicrobial activity, with each sample measured by the width of the diameter of the inhibition zone with a vernier caliper.

RESULTS AND DISCUSSION

Compared to chloroform water, ethanol extraction yielded more crude extract from the CL powder and less from the CA and ZP powders (Table 1). Use of different solvents in the extraction process increased the capacity and efficiency of extraction. Suitable solvents were used following the control standards for extracting herbal compounds i.e. polar solvents such as ethanol were used to extract the polar secondary metabolite. Other solvents used included non-polar and organic solvents mixed with water. Ethanol was the most suitable organic solvent for the extraction of curcumin from turmeric, with the concentration of ethanol used playing a crucial role in determining extraction efficiency. Chloroform was a non-polar solvent used to extract terpenoids, flavonoids, fats, and oils. Aqueous extract quantification with chloroform water revealed a higher extract yield from the powders of CA and ZP than with ethanol extract.

Table 1. Extractive values and curcumin content of dried herbal powders

Dried herbal powders	Ethanol extractive values (% w/w)	Water extractive values (% w/w)	Curcumin content (mg/100 g)
CL	3.20±0.14	2.82±0.04	3,582.63
CA	0.98±0.04	3.19±0.06	887.55
ZP	1.76±0.05	3.15±0.13	57.04

Data are means of three replicates±standard error, CL–*Curcuma longa,* CA–*Curcuma aromatica* and ZP–*Zingiber purpureum.*

The HPLC results showed that CL powder had the highest curcumin content, followed by CA and ZP powders (Table 1). Curcumin was abundant in *C. longa* but may also be obtained from other plants of *Curcuma* species, such as *C. aromatica.* Several studies have reported an effective HPLC method for determining curcumin content from *C. longa* powder (Kulyal *et al.*, 2016), *Z. purpureum* powder and *C. aromatica* powder (Liu *et al.*, 2018).

The DPPH free radical scavenging of CL, CA and ZP powders is shown in Table 2. As shown in Fig. 1, the inhibitory concentration (IC_{50}) values of the standards (L-ascorbic acid) recorded the lowest IC_{50} value of 4.8 µg/ml, followed by CL (78.7 µg/ml), CA (269.3 µg/ml) and ZP (925.2 µg/ml). The CL and ZP powders, respectively, had the lowest and highest IC_{50}, indicating the highest and lowest antioxidant activity. The high antioxidant activity was correlated with high curcumin content in the herbal powder samples (Rungruang *et al.*, 2021). The regulation of oxidative stress was directly related to the natural properties of curcumin in scavenging free radicals in reactive oxygen and nitrogen species, metal chelation, regulation of enzyme activity (Jakubczyk *et al.*, 2020) and the inhibition of lipid peroxidation.

The dried powders of CL, CA and ZP were investigated to evaluate their antibacterial activity against bacteria-causative agents in the pathogenesis of acne (i.e. *P. acnes*) and fungal agents that frequently cause the chronic dermatophyte infection of the skin (i.e. *T. mentagrophytes*) using agar diffusion. The sample powders showed no activity against *P. acnes*, but exhibited antimicrobial activity against *T. mentagrophytes* (Table 2). The inhibition clear zone against *T. mentagrophytes* was highest in CA powder and lowest in ZP powder. The antimicrobial activity of CA was significantly higher against fungi than bacteria (Xiang *et al.*, 2017). CA showed antifungal activity against dermatophytes (Umar *et al.*, 2020) including *Trichophyton*, *Epidermophyton* and *Microsporum*, which are fungal genera of human eczema pathogens.

Table 2. Antioxidant/free-radical scavenging activity assays and antimicrobial activities of dried CL, CA and ZP powders

Dried herbal powders	DPPH free radical scavenging assay		Diameter of zone inhibition (mm) of dried powders against microorganisms at 100 mg/ml concentration	
	Concentration (mg/ml)	% radical scavenging	*P. acnes*	*T. mentagrophytes*
CL	0.02	12.7284±0.65	-	25.48±0.29
	0.04	24.3340±1.33		
	0.06	37.8891±1.09		
	0.08	49.7805±0.15		
	0.10	64.7749±0.72		
CA	0.10	32.1644±0.40	-	26.48±0.24
	0.20	42.7742±1.87		
	0.30	52.5240±0.45		
	0.40	64.2841±1.86		
	0.50	74.5589±0.68		
ZP	1.00	39.0051±0.43	-	23.87±0.02
	1.50	45.1725±0.04		
	2.00	50.2080±0.11		
	2.50	57.0362±0.30		
	3.00	63.0690±0.25		

Data are means of three replicates±standard error. –: No antimicrobial activity, CL–*Curcuma longa,* CA–*Curcuma aromatica* and ZP–*Zingiber purpureum.*

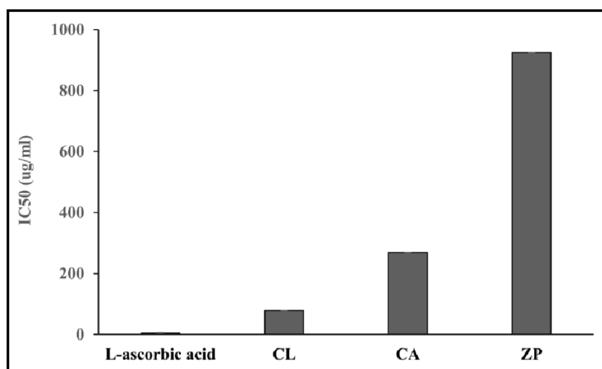

Fig. 1. Inhibitory concentration (IC_{50}) values of the *Curcuma longa* (CL), *Curcuma aromatic* (CA) and *Zingiber purpureum* (ZP) dried powders and the standard (L-ascorbic acid).

CONCLUSION

Among the powders, the alcohol-soluble extractive value of CL was the highest, while the water-soluble extractive value of CL was the lowest. The curcumin content was highest in CL, followed by CA and ZP. The antioxidant activity showed CL had the lowest IC_{50}, indicating the highest antioxidant activity, which was strongly correlated with the curcumin content. The dried herbal powders showed no antibacterial activity against *P. acnes* but exhibited antifungal activity against *T. mentagrophytes*. This study demonstrated the potential antimicrobial activity of the *C. longa*, *C. aromatica* and *Z. purpureum* powders, which can be further applied in cosmetic products.

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