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Variation of bioactive components in *Curcuma longa* in Thailand

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Curcuma longa* L. (turmeric) is a popular medicinal herb of Thailand as a spice and a colouring agent. Medicinal uses of the rhizome arise from volatile oil as a carminative and for antifungal activity, and yellow curcuminoids for anti-oxidative and anti-inflammatory properties. In Thailand, *C. longa* is mainly used in forms of capsules/tablets of turmeric powder for herbal medicine, while its extract is popularly used in herbal cosmetics. Thus quality assessment of this plant needs to be controlled for the limits of volatile oil and total curcuminoids contents. This study was undertaken to evaluate the contents of essential oil and total curcuminoids in dried powder of *C. longa* rhizome collected from 13 locations from North, Northeast, Central and South Thailand during January to April 2005. The highest content (8.20 ± 1.66% v/w) of essential oil was found in samples from the North where the climate is cool, while the lowest oil content (7.00 ± 0.00% v/w) was found in samples from the South where it rains all year. In contrast, the highest total curcuminoids content (8.99 ± 0.83% w/w) was found in the southern samples while the lowest content (4.80 ± 1.83% w/w) was found in the northern samples. The total curcuminoids in all samples was found in the limit of 3.07 ± 0.09 to 9.58 ± 0.20% dry weight. The average of volatile oil content was found to be 7.77 ± 1.20% w/w, while the average of total curcuminoids content was found to be 6.24 ± 1.95% w/w. This information will be useful as a guidance for standardization of *C. longa* powder and the extracts, and finding sources of good quality of *C. longa* in Thailand.

Keywords: *Curcuma longa*, curcuminoid content, turmeric oil, Thailand.

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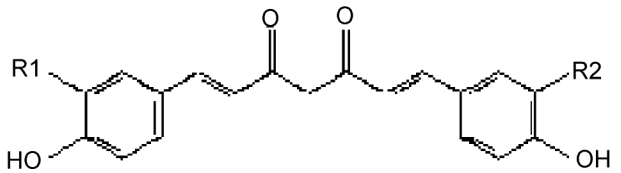
THE rhizomes of turmeric (*Curcuma longa* L., Zingiberaceae) play an important role as a colouring agent in foods, cosmetics and textiles[1]. The main yellow bioactive substances in the rhizomes are due to curcumin and two related demethoxy compounds, demethoxycurcumin and bisdemethoxycurcumin (Figure 1). Turmeric has been reported to possess anti-inflammatory, hepatoprotective, antitumour, and antiviral activities[2], anticancer activity[3] and used in gastrointestinal and respiratory disorders[4]. Curcuminoids exhibit free-radical scavenging property[5,6], antioxidant activity[7], and act as inhibitors of human immunodeficiency virus type 1 (HIV-1) integrase[8]. Turmeric oil is composed of several monoterpene and sesquiterpene compounds such as zingiberene; ar-, α- and β-turmerone[9]. The main biological activities of the oil are carminative, antiflatulence, antifungi[10] and as an antiplatelet agent[11].

In Thailand, *C. longa* can be cultivated in all regions of the country. The *Standard of ASEAN Herbal Medicine* and *Thai Herbal Pharmacopoeia* (*THP*) recommended that dried turmeric should contain not less than 6.0% v/w of turmeric oil and 5.0% w/w of total curcuminoids[9,12], while WHO recommended that dried turmeric should contain not less than 4.0% v/w of turmeric oil and 3.0% w/w of total curcuminoids[13]. Thus, this study was undertaken to determine the amount of volatile oil and total curcuminoids in the powder of turmeric collected from different parts of Thailand during the harvesting period (December–February)[14]. The results could be used for a database of medicinal plants of the country and also as a basis in further standardization of turmeric extracts that have not been reported.

Rhizomes of *C. longa* were collected from 13 different locations in the North, Northeast, Central and South of Thailand (Figure 2) during January–April 2005. The samples were identified by comparison with specimens at the Forest Herbarium, Department of National Park, Wildlife and Plant Conservation, Ministry of Natural Resources and Environment, Bangkok. The voucher specimens (WCL01051–WCL010513) were deposited at the Department of Pharmacognosy, Faculty of Pharmacy, Mahidol University, Bangkok, Thailand.



Curcumin: $R_1 = R_2 = OCH_3$
Demethoxycurcumin: $R_1 = H$, $R_2 = OCH_3$
Bisdemethoxycurcumin: R_1, $R_2 = H$

Figure 1. Structure of curcuminoids.

Fresh rhizomes were cleaned and cut into small pieces and air dried for 2 days. The samples were further dried in a hot-air oven at 50°C for 24 h, and then ground into powder and passed through a sieve (20 mesh).

Volatile oil content in turmeric powder was determined as described in *THP*[14]. Turmeric powder (10 g) was taken in a 500 ml round-bottom flask. Distilled water (100 ml) was added and the mixture was distilled at a rate of 2–3 ml per min for 5 h. The content of volatile oil was calculated as percentage in dried powder (Figure 3).

Quantitative determination of total curcuminoids content in each sample of *C. longa* was performed by the method described in the *Standard of ASEAN Herbal Medicine*[9] and *THP*[12] with a Perkin–Elmer spectrophotometer in the visible range at 420 nm using a 1.0 cm quartz cell. Software UV Winlab was used for all absorbance measurements (Figure 3). Total curcuminoids content was calculated using a standard curve (Figure 4). Analysis of each sample was done in triplicate.

For preparation of standard solution, standard curcumin (2.00 mg) (cat # C-1386, purity 60–70%) was accurately weighed and transferred to a 5-ml volumetric flask. Methanol was added and adjusted to a final concentration of 400 μg/ml. From this solution, concentrations of 0.8, 1.6, 2.0, 2.4 and 3.2 μg/ml were prepared and used for preparation of the calibration curve. For preparation of sample solution from turmeric powder, the powder (300.00 mg) of each sample was separately transferred to a 10-ml volumetric flask. Tetrahydrofuran was added to volume and mixed. The mixture was set aside at room temperature for 24 h with frequent shaking. One millilitre of the clear supernatant liquid was transferred and diluted with methanol to 25 ml volume. This solution (1 ml) was then transferred to a 50-ml volumetric flask, and diluted to volume with methanol (Figure 3).

All samples of turmeric rhizome were collected during winter–summer (January–April 2005) during the harvesting period. High volatile oil content was found in the samples from the North (average 8.20 ± 1.66% v/w) and Northeast (average 8.00 ± 0.00% v/w) of Thailand where the weather is cool and dry during winter, while low volatile oil content (average 7.00 ± 0.00% v/w) was found in samples from the South where the weather is humid, and not warm or cool during all seasons (Table 1).

The contents of volatile oil in all powdered samples are within the limits recommended by the *Standard of ASEAN Herbal Medicine*[9] and *THP*[12], which should not be less than 6.00% v/w in dried powder.

For total curcuminoids, only three of thirteen samples contained less than 5% w/w dried powder, which is within the recommended amount by *THP*. Samples from the South contained the highest contents (average 8.99 ± 0.83% w/w), while those from the North contained the lowest contents (average 4.80 ± 1.83% w/w; Table 1).

In this study, the limit of volatile oil in all turmeric samples was in the range of 6–10%v/w and the limit of

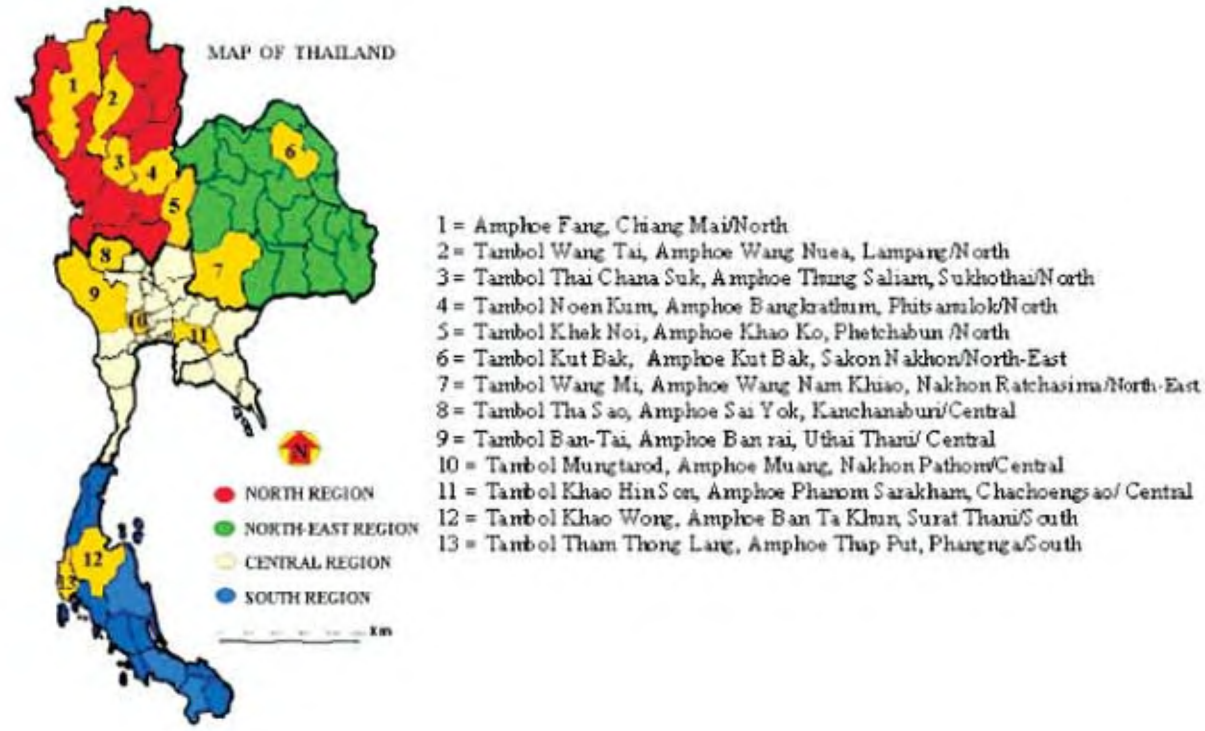


Figure 2. *Curcuma longa* rhizomes collected from different locations in Thailand.

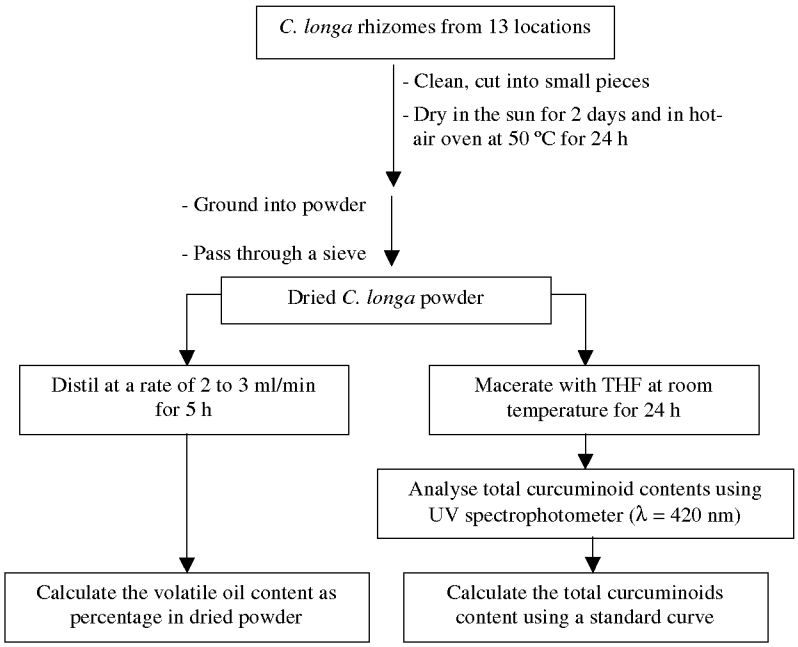


Figure 3. Process for extraction and determination of volatile oil and curcuminoid contents of *C. longa* from 13 locations.

total curcuminoids was 3–10% dry weight. The results show that 77% of all samples passed the standardized limits of volatile oil and total curcuminoids according to *THP* and the *Standard of ASEAN Herbal Medicine*. According to WHO guidelines, all samples were found to pass the recommended limits of volatile oil and total curcuminoids. These results indicate that most of the *C. longa* grown in Thailand contains high yield of bioactive

Table 1. Contents of volatile oil and total curcuminoids in turmeric powder collected from different locations in Thailand

Location	Code	Volatile oil content (% v/w)		Total curcuminoids (% w/w)	
		Content	Average	Content	Average
North (N)	Chiang Mai	7.33 ± 0.58	8.20 ± 1.66	3.70 ± 0.04	4.80 ± 1.83
	Lampang	10.00 ± 0.00		7.34 ± 0.04	
	Phitsanulok	8.00 ± 0.00		6.09 ± 0.02	
	Phetchabun	9.67 ± 0.58		3.78 ± 0.02	
	Sukhothai	6.00 ± 0.00		3.07 ± 0.09	
Northeast (NE)	Nakhon Ratchasima	8.00 ± 0.00	8.00 ± 0.00	7.54 ± 0.03	7.57 ± 0.04
	Sakon Nakhon	8.00 ± 0.00		7.60 ± 0.03	
Central (C)	Kanchanaburi	6.33 ± 0.58	7.50 ± 1.11	5.51 ± 0.02	5.60 ± 0.88
	Nakhon Pathom	7.33 ± 0.58		7.32 ± 0.03	
	Chachoengsao	7.33 ± 0.58		5.58 ± 0.01	
South (S)	Phangnga	7.00 ± 0.00	7.00 ± 0.00	9.58 ± 0.20	8.99 ± 0.83
	Surat Thani	7.00 ± 0.00		8.41 ± 0.04	
Average		7.77 ± 1.20		6.24 ± 1.95	

% contents were expressed as mean ± SD.
Analysis of each sample was done in triplicate.

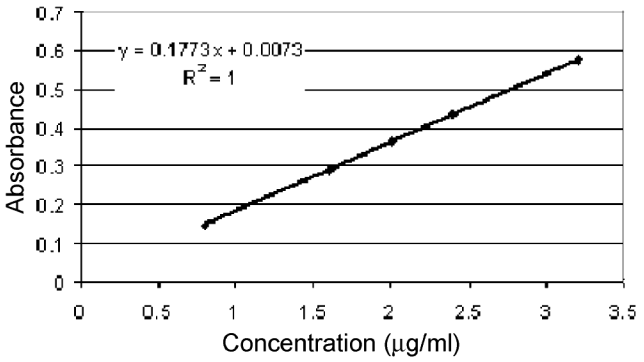


Figure 4. Calibration curve of curcumin standard in methanol determined by UV spectrophotometer.

constituents. The data will be useful as a basic information of finding appropriate locations of high-quality turmeric in Thailand. It can also be used as a guidance for further standardization of turmeric extracts for pharmaceutical production and cosmetics.

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