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COMPARATIVE STUDY OF DRYING METHODS FOR PREPARATION OF TURMERIC POWDER

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Abstract: Turmeric powder is produced from *Curcuma longa* rhizomes and is used in medicinal products and cosmetics. One important step of the preparation of turmeric powder is the drying method. The objective of this study was to compare drying methods used in cultivating area to decrease processing time while maintaining the quality of turmeric powder. Drying methods were drying (1) under sunlight, (2) in gas hot air oven, (3) in electric hot air oven and (4) hot air oven combined with microwave oven. *Curcuma longa* rhizomes harvested at 18 months were collected from Banthakhun Suratthani province, Thailand. Total curcuminoid content was analyzed using spectrophotometric method as defined in Thai Herbal Pharmacopoeia (THP). Volatile oil content was determined using distillation method. Total curcuminoid content was in the range 6.76-8.67 %w/w, which was higher than 5.0 %w/w specified by THP. Using the method of hot air oven at 60 °C for 40-90 minutes combined with microwave oven for 30-40 minutes was the shortest drying time of the four methods. There was no statistical difference of total curcuminoid amount among these drying methods by ANOVA. In addition, volatile oil content of all samples was in the range of 7.99-8.99 %v/w, which was above 6.0% v/w of standard criteria of THP.

Keywords: Turmeric powder, Hot air oven, Microwave oven, Curcuminoid, Volatile oil

INTRODUCTION

Curcuma longa L. rhizome or turmeric is used worldwide as a food ingredient and medicinal herb. Turmeric exhibits activity as anti-oxidant (Thaikert and Paisooksantivatana, 2009), anti-flatulence, anti-peptic ulcer (Yadav *et al*., 2013), anti-bacterial especially *Helicobactor pylori* (Moghadamtousi *et al*., 2014), anti-inflammatory (Hewlings and Kalman, 2017) and potential anti-cancer activity (Vallianou *et al*., 2015). In addition, turmeric powder is used in the cosmeceutical industry as a whitening agent (Phan, 2003). *C. longa* L. is cultivated in many areas in Thailand and South East Asia. *C. longa* L. rhizomes planted in southern area of Thailand contain relatively high content of curcuminoids. The process to derive turmeric powder from the rhizome includes cleaning, boiling, slicing, drying, grinding and packing. Drying is one of the important steps to preserve components in the rhizomes. Sun-drying is the customary method employed by farmers. Gas or electric hot air oven is usually used for drying plant raw materials. Hot air oven combined with microwave is designed to decrease drying time while preserving major components of plant materials. Gas

and electricity are the energy sources to provide heat in the hot air oven. Gas hot air oven drying is less expensive than electric hot air oven. Therefore, this study aimed to compare the quality of turmeric powder prepared by different drying methods: (1) sunlight, (2) gas hot air oven, (3) electric hot air oven and (4) hot air oven combined with microwave.

Khamin Chan Monograph of Thai Herbal Pharmacopoeia defines turmeric as dried rhizomes of *C. longa* L (Department of Medical Sciences, 2016). Turmeric contains not less than 5.0 %w/w of curcuminoids calculated as curcumin and not less than 6.0 %w/w of volatile oil. *C. longa* L. rhizomes mainly contain curcuminoids, sesquiterpenes, and monoterpenes. Curcuminoids found in turmeric powder are mostly curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin. In this study, total curcuminoid content was determined by spectrophotometric method. The physicochemical properties of turmeric powder were also determined.

MATERIALS AND METHODS

Plant materials

The rhizomes of *C. longa* L. were harvested at 18 months of age at Banthakun district, Suratthani Province, Thailand. They were washed in washing machine for 5 minutes, then boiled in water for 30 minutes, sliced and dried employing four different methods as specified in Table 1. Afterwards, they were ground to fine powder and packed in air-tight plastic bags. Turmeric power sampling for the analysis is shown in Figure 1.

Table 1. Sample preparation

Sample ID	Drying method
7	sunlight for 2 days
9	sunlight for 2 days
2	gas hot air oven 60 °C for 5 hours
10	gas hot air oven 60 °C for 2 hours and sunlight for 1 days
1	electric hot air oven 60 °C for 5.50 hours
4	electric hot air oven 60 °C for 6.50 hours
5	electric hot air oven 60 °C for 5.50 hours
3	electric hot air oven 60 °C for 40 min and microwave 630 watt for 40 min
6	electric hot air oven 60 °C for 90 min and microwave 630 watt for 30 min
8	electric hot air oven 60 °C for 40 min and microwave 630 watt for 40 min

Figure 1. Turmeric powder samples

Figure 2. Drying methods

Chemical and solvents

Standard curcumin was purchased from Fluka, US. Tetrahydrofuran was purchased from J.T.Baker, US. Methanol and toluene were obtained from Burdick & Jackson, Korea. Ultra-pure water was supplied by Econoz Milli-Q water purifier system.

Determination of total curcuminoids content

Total curcuminoid content was determined using spectrophotometric technique according to Thai Herbal Pharmacopoeia 2016 (Khamin Chan Monograph). The samples were accurately weighed 300 mg (n=2) and stirred in 10 mL of tetrahydrofuran for 24 hours using a shaker (WiseShake® SHO-2D, Witeg Germany). The samples (10 μL) were diluted in methanol (990 μL) and pipetted (20 μL) into 96 well plate (n=4). The standard curcumin was prepared at the concentration of 400 μg/mL in methanol and diluted to prepare sub-stock solution. Aliquots (50 μL) were pipetted into 96 well plate (n=4) and made up to 250 μL to obtain final concentration of 0.8 – 3.2 μg/mL. Absorbance was determined at 420 nm using a microplate spectrophotometer (Biorad®). The content of curcuminoid in the sample was calculated relative to the standard curve of curcumin.

Determination of volatile oil content

Volatile oil content was determined using distillation method (Thai Herbal Pharmacopoeia, 2016 Appendix 7.3H). Turmeric powder was accurately weighed 10 g (n=2) in a 500 mL round bottom flask to which 100 mL of water were added. The samples were distilled for 5 hours and the volatile oil was collected and measured. The volatile oil content was calculated as %volume by weight of dried plant material as shown in the equation.

$$\%\, Volatile\ oil\ content\ (\%v/w) = \frac{Volume\ of\ volatile\ oil\ (mL)}{Dried\ weight\ of\ plant\ powder\ (g)} \times 100$$

Determination of water

Water content was determined using azeotropic distillation method (Thai Herbal Pharmacopoeia, 2016 Appendix 4.12). Toluene 200 mL and water 2 mL were distilled for 2 hours and cooled down. Then turmeric powder was accurately weighed 10 g (n=2) and added. The distillation was continued for 2 hours. Water content was calculated as % volume by weight as shown in the equation.

$$\%\ Water\ content\ (\%v/w) = \frac{Volume\ of\ water\ (mL)}{Dried\ weight\ of\ plant\ powder\ (g)} \times 100$$

Total ash and acid insoluble ash

Total ash was determined according to Thai Herbal Pharmacopoeia (Appendix 7.7). The crucible was heated at 120 °C until the constant weight was obtained. Turmeric powder was accurately weighed 1 g (n=3) in a tare crucible. The samples were dried at 100° – 105 °C for 1 hour and were ignited in the furnace at 500° ± 5 °C for 5 hours. The crucible was allowed to cool in a desiccator after each ignition and accurately weighed. The total ash was calculated by % weight by weight of plant powder as shown in the equation.

$$\%\ Total\ ash\ (\%w/w) = \frac{Weight\ of\ plant\ ash\ after\ ignition\ (g)}{Dried\ weight\ of\ plant\ powder\ (g)} \times 100$$

Acid insoluble ash was determined according to Thai Herbal Pharmacopoeia (Appendix 7.6). The total ash was boiled with 25 mL of 10% hydrochloric acid for 5 minutes in the water bath. The insoluble matter was collected on an ashless filter paper (Whatman No.41) and washed with hot water until the neutral pH of the filtrate was obtained. The residue was ignited in the furnace at 500° ± 5 °C for 5 hours. The acid insoluble ash was calculated by % weight of the residue by weight of plant powder as shown in the equation.

$$\%\ Acid\ insoluble\ ash\ (\%w/w) = \frac{Weight\ of\ plant\ residue\ after\ ignition\ (g)}{Dried\ weight\ of\ plant\ powder\ (g)} \times 100$$

Ethanol soluble extractives

Soluble extractive content of *C. longa* L. rhizomes was determined according to the procedure in Thai Herbal Pharmacopoeia, 2016 Appendix 7.12A. Turmeric powder was accurately weighed 5 g (n=2) and added to 100 mL of 95% ethanol in a closed Erlenmeyer flask. The sample solutions were shaken frequently for 6 hours using a shaker (WiseShake® SHO-2D, Witeg Germany) and then allowed to stand for 18 hours. The sample solution was filtered and 20 mL of the solution were transferred to a tare evaporating dish. The solution was evaporated to dryness and dried at 105°C until constant weight. Ethanol soluble extractive was calculated as % weight by weight of plant powder.

$$\%\ Ethanol\ soluble\ extractives\ (\%w/w) = \frac{Dried\ weight\ of\ extractives\ (g)}{Dried\ weight\ of\ plant\ powder\ (g)} \times 100$$

Statistical analysis

The data were analyzed using ANOVA with IBM SPSS version 21.

RESULTS AND DISCUSSION

The quality of these turmeric powder samples is displayed in Table 2. They were within standard criteria of Thai Herbal Pharmacopoeia. Total curcuminoid content was in the range of 8.03–9.83 %w/w while their volatile oil content was in the range of 7.99–8.99 %v/w. The volatile oil was light-yellow to yellow color (Figure 4) and the smell was sweet. Total curcuminoid content of these turmeric samples was similar to that reported by Thaikert and Paisooksantivatana. 2009. Turmeric powder from south area of Thailand showed the highest content (10.13±1.27%w/w). Turmeric powders obtained from these four drying methods showed little moisture content. Total ash and acid insoluble ash were not above the limits of THP standard. Turmeric powder showed relatively high ethanol soluble extractives.

Table 2. Quality of turmeric powder

Sample ID	Total curcuminoids (%w/w)	Volatile oil (%v/w)	Water (%v/w)	Total ash (%w/w)	Acid insoluble ash (%w/w)	Ethanol soluble extractives (%w/w)
1	9.45 ± 0.34	8.99 ± 0.00	2.50 ± 0.00	3.63 ± 0.07	0.06 ± 0.03	21.72 ± 1.45
2	8.63 ± 0.91	8.48 ± 0.01	2.00 ± 0.00	3.81 ± 0.16	0.09 ± 0.02	21.19 ± 0.47
3	8.03 ± 0.49	8.75 ± 0.39	3.50 ± 0.71	3.54 ± 0.21	0.10 ± 0.06	20.50 ± 0.38
4	9.10 ± 0.44	8.49 ± 0.72	4.00 ± 1.42	3.50 ± 0.07	0.03 ± 0.05	20.93 ± 0.23
5	8.78 ± 0.20	8.00 ± 0.01	2.75 ± 1.06	3.47 ± 0.11	0.05 ± 0.06	20.39 ± 2.27
6	9.83 ± 0.22	7.99 ± 0.00	3.25 ± 1.06	3.34 ± 0.07	0.01 ± 0.01	23.63 ± 0.08
7	8.49 ± 0.50	8.50 ± 0.00	4.00 ± 1.41	3.64 ± 0.04	0.03 ± 0.03	21.19 ± 0.05
8	8.41 ± 0.51	8.75 ± 0.36	3.99 ± 0.00	3.32 ± 0.05	0.05 ± 0.01	17.63 ± 1.33
9	8.67 ± 1.09	8.49 ± 0.00	2.75 ± 0.35	3.22 ± 0.42	0.06 ± 0.08	19.23 ± 0.90
10	8.22 ± 0.43	8.24 ± 0.35	3.00 ± 0.00	3.57 ± 0.20	0.06 ± 0.06	19.42 ± 0.18
THP criteria	NLT 5.0	NLT 6.0	NMT 10.0	NMT 8.0	NMT 1.0	NLT 10.0

The values are average ± SD.

The highest total curcuminoid content (sample 6) was obtained from the drying method using electric hot air oven combined with a microwave. Drying with electric hot air oven (sample 1) gave the highest volatile oil content. Samples (7, 4, 8) dried by sunlight, electric hot air oven or electric hot air oven combined with a microwave showed the highest moisture content (3.99-4.00 %v/w). The duration time for each drying method was slightly different depending upon the batch size and observer skill. Proper training of farmers helps to improve the quality of turmeric powder.

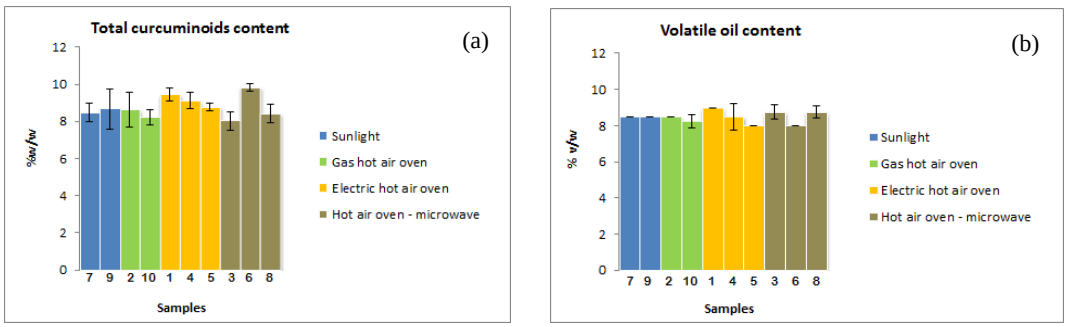

Figure 3. (a) Total curcuminoids content (b) Volatile oil content

Each sample in different drying methods showed slightly different values although the average value of each drying method was not significantly different (Table 4). Results of three types of ovens were compared with drying under sunlight. Gas hot air oven without ventilation generated heat from bottom to top of the oven so the air flow may not have been consistent. In contrast, in the electric hot air oven with ventilation, air flowed consistently from left to right. These different instruments and drying methods may affect the color of turmeric samples. The small, mobile microwave oven is suitable for the farm location, but requires small scale samples for drying. Thus, drying in the electric hot air oven is required first.

Although total ash and acid insoluble ash may not be directly relevant to the drying methods, they were the criteria (Department of Medical Sciences, 2016a) by which to determine the quality of plant materials, especially turmeric rhizomes. In this study, total ash and acid insoluble ash proved that the washing process was adequate since the inorganic contaminants were within the standard limits. The highest total ash was found in samples dried with gas hot air oven (sample 2). Even samples (7 and 9) dried under sunlight had inorganic contaminants within the acceptable limits. Extractives were used to determine major ethanol soluble components in turmeric samples. Ethanol is a medium polarity solvent able to dissolve polar and nonpolar compounds. The relatively high yield of ethanol soluble extractives suggests that drying methods were particularly effective. These results also showed reasonable correlation to total curcuminoid content when tetrahydrofuran was the solvent. Thus, our results support the practicality of the methods under different cultivating circumstances.

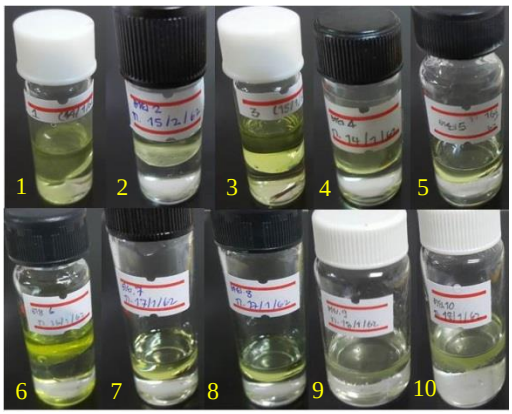

Figure 4. Characteristics of volatile oils obtained from ten turmeric powder samples

Four drying methods showed no significant differences of total curcuminoid, volatile oil or water content (Figure 3). Total ash, acid insoluble ash and ethanol soluble extractives were not significantly different between these methods also (Table 3).

Table 3. Statistical analysis

Parameters	Drying method				
	Sunlight	Gas hot air oven	Electric hot air oven	Hot air oven and microwave	Sig
Total curcuminoids	8.59 ± 0.35	8.42 ± 0.31	9.11 ± 0.16	8.76 ± 0.37	.449
Volatile oil	8.50 ± 0.00	8.36 ± 0.12	8.49 ± 0.22	8.49 ± 0.18	.950
Water	3.37 ± 0.55	2.50 ± 0.29	3.08 ± 0.44	3.58 ± 0.27	.318
Total ash	3.43 ± 0.14	3.69 ± 0.09	3.53 ± 0.04	3.40 ± 0.15	.062
Acid insoluble ash	0.05 ± 0.05	0.08 ± 0.04	0.05 ± 0.04	0.05 ± 0.05	.693
Ethanol soluble extractives	20.21 ± 0.62	20.31 ± 0.53	21.02 ± 0.55	20.59 ± 1.12	.900

The values are average ± SEM.

CONCLUSION

Physicochemical properties of turmeric powder for the four drying methods showed no statistical difference The methods are comparable and can be substituted for sunlight under various processing circumstances. Temperature and duration time of drying are important to maintain high chemical composition of turmeric powder. In addition, adequate cleaning is an important step to reduce inorganic contaminants. Therefore, the modified drying method employing hot air oven combined with microwave can be an alternative method for cultivation in rural areas. The microwave oven is small and mobile making it practical. Moreover, the procedure can be set as a standard protocol applicable to routine work.

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REFERENCES

Department of Medical Sciences. 2016a. *Thai Herbal Pharmacopoeia* Khamin Chan. Ministry of Public Health, Nonthaburi, 11000, Thailand: 38-44

Department of Medical Sciences. 2016b. *Thai Herbal Pharmacopoeia* Appendix 4.12. Ministry of Public Health, Nonthaburi, 11000, Thailand: 569-570

Department of Medical Sciences. 2016c. *Thai Herbal Pharmacopoeia* Appendix 7.3H. Ministry of Public Health, Nonthaburi, 11000, Thailand: 575-576

Department of Medical Sciences. 2016d. *Thai Herbal Pharmacopoeia* Appendix 7.6. Ministry of Public Health, Nonthaburi, 11000, Thailand: 577

Department of Medical Sciences. 2016e. *Thai Herbal Pharmacopoeia* Appendix 7.7. Ministry of Public Health, Nonthaburi, 11000, Thailand: 577

Department of Medical Sciences. 2016f. *Thai Herbal Pharmacopoeia* Appendix 7.12A. Ministry of Public Health, Nonthaburi, 11000, Thailand: 578

Hewlings SJ and Kalman DS. 2017. Curcumin: A review of its' effect on human health. Foods. 6*(92):* 1-11. doi: 10.3390/foods6100092

Moghadamtousi SZ, Kadir HA, Hassandarvish P, Tajik H, Abubakar S, Zandi K. 2014. A review on antibacterial, antiviral, and antifungal activity of curcumin. *BioMed Research International*. 1-12. http://dx.doi.org/10.1155/2014/186864

Phan D. 2003. United States Patent. Compositions and methods of treatment for skin conditions using extracts of turmeric. US 6,521,271 B1

Thaikert R and Paisooksantivatana Y. 2009. Variation of total curcuminoids content, antioxidant activity and genetic diversity in turmeric (Curcuma long L.) collections. *Kasetsart J. (Nat. Sci).* 43: 507-518.

Vallianou NG, Evangelopoulos A, Schizas N, Kazazis C. 2015. Potential anticancer properties and mechanisms of action of curcumin. *Anticancer Research*. *35:* 645-652.

Yadav SK, Sah AK, Jha RK, Sah P, Shah DK. 2013. Turmeric (curcumin) remedies gastroprotective action. *Pharmacognosy Reviews*. *7:* 42-46. doi: 10.4103/0973-7847.112843.