

PREPARATION PROCESS OF CURCUMINOID POWDER FROM TURMERIC RHIZOME (*Curcuma longa domestica*, Vahl) AND ITS CHARACTERISTIC AS FOOD INGREDIENTS

PROSES PEMBUATAN BUBUK CURCUMINOID DARI RIMPANG KUNYIT (*Curcuma longa domestica*, Vahl) DAN KARAKTERISTIKNYA SEBAGAI BAHAN INGREDIEN PANGAN

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ABSTRAK

*Studi pada proses pembuatan bubuk curcuminoid dari akar kunyit (*Curcuma longa domestica* Vahl) dan karakteristiknya sebagai bahan pangan telah dilakukan. Hasil percobaan menunjukkan bahwa jenis pelarut, perbandingan antara padatan-larutan dan suhu ekstraksi yang digunakan berpengaruh terhadap rendemen kandungan curcuminoid. Kandungan curcuminoid berkisar antara 11,96% hingga 14,01% (untuk ekstraksi dengan pelarut ethanol 60%), berkisar antara 12,91% hingga 15,20% (ekstraksi dengan pelarut ethanol 80%), dan berkisar antara 3,85 hingga 7,19% (ekstraksi dengan pelarut ethanol 50%). Hasil penelitian menunjukkan bahwa nilai tertinggi dan terbaik kandungan total senyawa fenol tercatat pada ekstraksi dengan ethanol (perbandingan S/L 1 : 50 dan suhu ekstraksi 60°C) dengan nilai 148,99 mg GAE/100 g sedang nilai terendah tercatat untuk ekstraksi menggunakan pelarut 50% (perbandingan S/L 1 : 30) dan suhu ekstraksi 30°C dengan nilai 101,43 mg GAE/100 g. Hasil penelitian juga menunjukkan bahwa nilai tertinggi aktifitas antioksidan tercatat pada ekstraksi menggunakan ethanol 80% dan menggunakan bahan kunyit kering sebanyak 15,0 g dengan nilai 47,65% ; sedang nilai terendah sebagai aktifitas antioksidan pada ekstraksi menggunakan ethanol 50% dan menggunakan bahan kunyit kering sebanyak 1,50 g dengan nilai 20,04%.*

Kata kunci : rimpang kunyit (*Curcuma longa domestica* Vahl), kurkuminoid, proses ekstraksi, sifat karakteristik, ingredien pangan

ABSTRACT

Study on the preparation process of curcuminoid from turmeric root (*Curcuma longa domestica* Vahl) and its characteristics as food ingredient was conducted. The results revealed that the type of solvent, the solid-liquid ratio and extraction temperature were affected to the yield of curcuminoid content. The curcuminoid content ranged from 11.96% to 14.01% (for ethanolic 60% solvent extraction), ranged from 12.91% to 15.20% (ethanolic 80% solvent extraction), and ranged from 3.85% to 7.19% (ethanolic 50% solvent extraction). Results showed that the highest and the best value of total phenolic content was recorded in ethanolic extract (S/L ratio 1 : 50) and extraction temperature 60°C with value 148.99 mg GAE/100 g; while the lowest for a ethanolic 50% extract (S/L ratio 1 : 30) and extraction temperature 30°C with value 101.43 mg GAE/100 g. Results also showed that the highest value antioxidant activities were recorded in ethanolic 80% extract and 15.00 g ground dry turmeric used with value 47.65% ; while the lowest value of ethanolic 50% extract and 1.50 g ground dry turmeric used with value 20.04%..

Keywords : turmeric rhizome (*Curcuma longa domestica* Vahl), curcuminoid, extraction, characteristics, food ingredient

INTRODUCTION

Turmeric root (*Curcuma longa domestica*, Vahl) is a kind of spices that belongs to family *Zingiberaceae* and its usually used in house hold as food spices (Revathy *et al.*, 2011). Turmeric as an edible and herbaceous plant has been used in traditional medicines for a long time due to its many useful relating with human health. The dried and powdered rhizomes of *Curcuma longa* are used worldwide as a food-colouring agent because they are having a yellow color (Panlucci *et al.*, 2012).

Curcuminoid is the main natural coloring agent that recognized as a rich source of phenolic compound, consisting of three different compounds: curcumin, demethoxycurcumin, and bisdemethoxycurcumin (Montor *et al.*, 2016). The total of curcuminoids which is about 4 – 6% in wet turmeric rhizome, and turmeric also contains 2 – 4% essential oil and 2 – 3% of fixed oil and various volatile oils; including turmerone, atlantone, and zingiberone. Other constituents include sugars, proteins and resins (Revathy *et al.*, 2016).

The traditional uses of turmeric or natural curcuminoids are many in folk medicine, and some of these including antioxidant (Priyadarsini, 2009), anti-inflammatory properties (Jurenka, 2009), anti-carcinogenic effects or antitumor (Wilken *et al.*, 2011), antidiabetic (Wickenberg *et al.*, 2010) and imunomodulatory effects in humans (Rogers *et al.*, 2010). Turmeric has a healthy influence on digestive system and it also enhances the mucin secretion in the digestive tract (Nisar *et al.*, 2015). Although the chemical structure of curcumin was determined in the 19th century, the immense value of this molecule is being realized now with several extensive studies on its pharmaceutical and nutraceutical potential (Johnson and Mukthar, 2007).

Several *in vitro* and *in vivo* studies confirmed that turmeric extracts have

powerful biological activities, such as anti-inflammatory (Jurenka, 2009), anti-bacterial (De *et al.*, 2009), antidepressant (Kulkarni *et al.*, 2009), antidiabetic ((Wickenberg *et al.*, 2010), antitumor (Wilken *et al.*, 2011), immunomodulatory (Rogers *et al.*, 2010) and gastroprotective (Kim *et al.*, 2005) properties. Curcuminoid has been found to be an excellent scavenger of most reactive oxygen species (ROS), a property that bestows curcumin with antioxidant activity in normal cells (Priyadarsini, 2014).

The antioxidant activity of turmeric justifies its use in broad range of applications, including cosmetics (Thornfeldt, 2005), nutraceuticals (Anggarwal, 2010) and phytomedicines (Anggarwal and Harikumar, 2009; Priyadarsini, 2014). These medical and functional attributes can be related to turmeric's high content of curcuminoids, especially curcumin, while is considered a chemical marker of this species (Gupta *et al.*, 2012).

Developing a functional food ingredient or a phytomedicine requires the use of specific processing technologies, including preparation and extraction of spice active components or chemical markers (Rocha *et al.*, 2008). Extraction is the first step in the isolation of phenolic compounds from agro-industrial residues and plant materials, like curcumin or curcuminoids (Mussatto *et al.*, 2011). Different techniques have been applied to recover antioxidant phenolic compounds from natural sources including solid-liquid extraction with organic solvents, ultrasound-assisted extraction, microwave-assisted extraction, supercritical fluids extraction, and high pressure processes. Among these techniques, solid-liquid extraction is widely employed for phenolics extraction (like curcuminoid) from vegetable/spice sources (Markom *et al.*, 2007).

A number of studies are undertaken to separate curcuminoid pigments by thin layer chromatography

(TLC), high-performance thin layer chromatography (HPTLC) and column chromatography (CC) (Revanthy *et al.*, 2011; Pusphakumari *et al.*, 2014). Solvent extraction followed by column chromatography has been the most commonly employed method reported for separating curcumin/curcuminoid from turmeric, and several polar and non-polar organic solvents have been used, including hexane, acetone, ethylacetate, methanol, ethanol, etc. (Priyadarsini, 2014). Of the organic solvent employed, ethanol has been found to be the most preferred solvent for extracting curcumin/curcuminoid.

The stationary phase most commonly used is silica gel with different solvent system including benzene, ethyl acetate, ethanol, chloroform, hexane, and methanol for chromatographic separation (Waghmare *et al.*, 2015). Extraction time, temperature, liquid-to-solid ratio and the extraction-assisted methods are important concerns in the improvement of polyphenols (including curcuminoid) yield rate (Hadiyanto *et al.*, 2014). Therefore, even with the same technique of extraction, for different marker compounds in different plant materials; different operating conditions may be required (Noriega *et al.*, 2012; Gokhul *et al.*, 2015). Thereby, the method and processing conditions employed in the extraction of chemical markers from plant raw materials play important roles.

Carboxymethyl cellulose (CMC), a long chain polysaccharide, is a well-known polymer, which is used as a versatile, functional ingredient in a wide variety of processed foods, as a thickener, binding agent, stabilizer, protective colloid and suspending agent (Bar *et al.*, 1995). CMC can dissolve well in water and produce a translucent solution. Its safety has been confirmed (JECFA, 1990). Thus, it was selected to be used in curcuminoid powder preparation.

Based on these considerations, it is interesting to undertake studies in order to

investigate the relationship between extraction parameters and extract properties on the development of turmeric's functional food. The aim of this study was to extract the natural curcuminoid from turmeric by varying parameters such as extraction solvent, solid/liquid (SL) ratio and extraction temperature. The curcuminoid content, as well as the antioxidant capacity of the extract was also investigated. The water-soluble curcuminoid powder was also studied by entrapment a curcuminoid with CMC, as a complex formation. The properties of the powder product have been extensively examined.

MATERIALS AND METHODS

Materials and Research Location

Turmeric roots were purchased from local market (Pasar Bogor and Pasar Anyar)-west Java province. Sodium carboxymethyl cellulose (CMC) 1500 cps was purchased from Setia Guna Chemicals grocery at Bogor.

The reference standard of purified curcuminoid was a product of Sigma Chemicals-USA (Sigma C1386) that obtained from PT Brataco Chemicals-Jakarta. Other chemicals used in this research were food grade except for the chemicals for analysis that were either analytical grade or HPLC grade.

The research was conducted in Center of Agro-Based Industry (CABI) – Bogor; Academy of Chemical Analysis Bogor (ACAB) and Institute for Research and Development of Post-Harvest of Agricultural – Bogor.

Methods

Dried Turmeric Preparation

Each of fresh turmeric roots from Pasar Bogor and Pasar Anyar was cleaned under running tap water in order to remove adherent sand and clay particles; afterward; turmeric rhizomes were steamed for 10 minutes and sliced into small pieces before drying in a hot air oven at 50°C for about 8 hours.

Dry turmeric was collected and ground into fine powder using a high-speed blender. The dry, ground turmeric was packed in a plastic bag (polypropylene), sealed and kept in the refrigerator (10°C) until used.

Preparation of Turmeric Extracts

Turmeric extracts were prepared by using two solvents; ethanol (at two different concentrations 60% and 80%) and a mixture of ethanol and water 1 : 1 (ethanol concentration 50%), according to the protocol as specified by Muhktar and Ghoni (2012) with some modifications.

Approximately 20 gm of the sample from the selected, ground, dry turmeric of curcuminoid variety were taken into a thimble and placed in a Soxhlet apparatus. The extraction conditions were performed by factorial design as follows : solid : liquid (S/L) ratio : 1 : 30, 1 : 40, and 1 : 50 at extraction temperature 30°C; 45°C and 60°C with extraction time for 3 hours. Further, the extraction solution obtained from each set of conditions were filtered through Whatman No. 1 filter paper and the clear supernatant was collected. Then the clear supernatant was concentrated on a rotary evaporator. Subsequently, the curcuminoid and total phenolic content were examined. The results of the extraction conditions that provided the highest curcuminoid and total phenolic content were selected for the further experiment.

Preparation of Curcuminoid Powder

Water-soluble curcuminoid powders with different curcuminoid content were prepared. In this study, various quantities of ground turmeric of 1,50; 3,00; 6,00; 7,50 and 15.00 grams respectively were used; and each of it was extracted individually under selected conditions of solid liquid ratio.

After extraction, the mixture was filtered through nylon cloth (320 mesh). The clear solution was adjusted with ethanol to obtain a final volume of 200 ml,

while any excess solvent from the extraction that exceeds 200 ml was removed using a vacuum rotary evaporator (Buchii, Switzerland). The obtained solution was gradually added into 100 ml of 2.5% (w/v) carboxymethylcellulose (CMC) solution at pH 8 -10, stirred for 30 minutes ; thereafter it was adjusted to pH 4.0 with 20% ascorbic acid solution.

Maltodextrin (DE = 11) 600 g was added and thoroughly mixed with the curcuminoid solution in a glass container. The viscous mixture was then subjected to drying using a double drum dryer. The drum dryer was operated at a surface temperature of 130°C , with clearances between the drum of 0.04 inch and a rotation speed of 2 rpm. Dried curcuminoid flakes from the drum dryer were then ground into fine powder and the yield was calculated.

Characteristics of Curcuminoid Powder

Physical Properties

The physical properties analysis were conducted in focused at color as L*; a* and b* values of the curcuminoid powder. At this point 1 gram curcuminoid powder/100 ml water (dissolved solution) was analyzed using a color instrument (Cronometer, Data color, Spectraflash SF 600 plus –USA).

Chemical Properties

Analysis for moisture content of turmeric powder was carried out according to its standard methods AOAC (2006); while aw was carried out using aw meter (Novasiana, Switzerland). All the tests were carried out in triplicates.

Determination of Curcuminoid Contents

Determination of curcuminoid content was modified from Thai Herbal Pharmacopoeia (Ministry of Public Health, 2011). Briefly, an amount of 200 mg of dry turmeric powder weighed accurately in a 15 ml screw-cap test and then was added

with 5 ml ethanol. The mixture was vortexed every 15 minutes for 3 hours and the mixture was centrifuged at 4.000 rpm/min for 15 minutes at room temperature.

The clear supernatant was collected in a 25 ml volumetric flask. The extraction was repeated and the supernatant was deposited until a pale yellow solution was observed. The collected solution was then adjusted to volume 25 ml with ethanol.

The curcuminoid content in the extracted solution was tested and analysis using HPLC instrument (Agilent 1100 series) which is equipped with synergy 4 μ RP80A column. The column temperature was controlled at 35°C. The mobile phase consisted of 2% (v/v) acetic acid aqueous solution and acetonitrile in the ratio of 40 : 60 (v/v) with flow rate of 1 ml/min. The injection volume was 5 μ l and the quantitation wavelength was detected at 425 nm.

Total Phenolic Contents

The amount of total phenolic content (TPC) in turmeric powder was estimated and determined using Folin-Ciocalteu method as describe by Wojdylo *et al.*, (2007) with little modification to each samples without comparing one another. The mechanism is based on the reduction of phosphotungstic acid to phosphotungstic blue and as a result absorbance increase due to rise in the number of aromatic phenolic groups. For this purpose, 50 μ l of each prepared extract was separately added to test tubes, each containing 250 μ l of Folin-Ciocalteu's reagent and 750 μ l of 20% sodium carbonate solution and final volume was made up to 5 ml with distilled water. After 2 hours heated in water bath at 40°C, and absorbance was measured at 765 nm using UV/Visible Light Spectrophotometer (CECIL CE 7200). In this case, control having all reaction reagents except sample extract. Total polyphenols were estimated and values were expressed as gallic acid equivalent

(GAE; mg gallic acid/100 g) using the following formula : $C = c \times V/m$; where:

C = Total phenolic content (mg/g plant extraction, in GAE)

c = Concentration of gallic acid (mg/ml)

V = Volume of extract (mL)

m = Weight of turmeric extract (g).

Antioxidant Capacities

The turmeric extracts were analyzed for DPPH (1,1-diphenyl-2-picrylhydrazyl) free radical scavenging activity using the method as described by Maizura *et al.*, (2011) with some modifications. Sample solutions were prepared by dissolving 0.0025 mL of sample extract in 10 mL of ethanol. A fresh solution of DPPH mixed in ethanol (6×10^{-5} M) was prepared before measurements, 3 mL of this solutions was mixed with 77 μ l extract in 1 cm path length microcuvettes.

The mixture samples were vortexed and then placed in the dark at room temperature for about 20 minutes. Decreasing in absorbance was measured afterward, at 515 nm on UV/Visible light Spectrophotometer. Absorbance for a blank sample having the same amount of ethanol and DPPH solution as that for sample extract was also estimated at 515 nm on UV/Visible light Spectrophotometer. Butylated Hidroxy toluene (BHT) and Butylated Hydroxy Anisole (BHA) were used as a standard. Free radical scavenging activity was measured as :

Reduction of absorbance (%) = $[(AA - AB)/AA] \times 100$; where :

AA = Absorbance of blank sample at t = 0 minute

AB = Absorbance of tested extract solution at t = 20 minutes.

Statistical Analysis

Data collected from the experiments were analyzed by complete randomized design (CRD) using SPSS Version 12.00. Analysis of variance (ANOVA) and Duncan's Multiple Range test (DMRT) at p = 0.05 were used to determine the differences between treatments

RESULTS AND DISCUSSION

Effect of Extraction Conditions on the curcuminoid content

Different solvents with varying polarity have ever used in the study for extraction of curcuminoids from turmeric rhizome by some researchers. However, at this study, only two types of solvents were used, i.e. ethanol (concentration 60% & 80%) and a mixture of ethanol and water 1:1 (ethanol concentration 50%). The results of extraction are presented in Table 1. Under the established conditions, the results showed that the curcuminoid content from Pasar Bogor and Pasar Anyar (local market) ranged from 11.96 to 14.01% (ethanol solvent extraction concentration 60%), ranged from 12.91 to 15.20% (ethanol solvent concentration 80%), and ranged from 3.85 to 7.19% (ethanol - water 1 : 1 or ethanol extraction concentration 50%).

Results revealed that the type of solvent, the solid-liquid (S/L) ratio and the extraction temperature were affected the curcuminoid content. Ethanol extraction (60% and 80% concentration) produced

higher curcuminoid content than a mixture of ethanol and water. The highest curcuminoid content was obtained with the S/L ratio 1 : 50, an extraction temperature 60°C and extraction with ethanol solvent (80% concentration). Ethanol solvent (80% concentration) was resulted higher curcuminoid than other solvent concentration because it might be due to easier extract the curcuminoid content and more polarity. In addition, the expressive extraction of curcuminoid using ethanol solvent 80% may be due to the higher dielectric constant of this solvent, when compared to other proportion used (60% and 50%) (Jouyban *et al.*, 2004).

Mostly, the curcuminoid content was higher in the present study as compared to previous one (Sogi *et al.*, 2010), using ethanol solvent; in which were obtained curcuminoid yields ranging from 3.85 to 15.20%. This, it might be due to the different composition of Curcuma (different sources), extraction conditions and analytical technique employed in the curcuminoid quantification, since Sogi *et al.*, (2010) used spectrophotometry.

Table 1. Influence Of Extraction Conditions (Extraction Temperature And Solid-Liquid Ratio) On Total Curcuminoid Extraction Yield From Ground Dried Turmeric (*)

Solid/Liquid Ratio (g/ml)	Extraction temperature (°C)	Curcuminoid content (% w/w)		
		Ethanol 60%	Ethanol 80%	Ethanol-water
1 : 30	30	11.96 ^a	12.91 ^a	3.85 ^a
	45	12.31 ^{cd}	13.70 ^b	5.24 ^b
	60	13.92 ^{cd}	14.37 ^{bc}	5.27 ^b
1 : 40	30	12.19 ^{ab}	13.18 ^{ab}	5.36 ^b
	45	13.63 ^c	14.54 ^c	5.81 ^c
	60	13.97 ^{cd}	14.92 ^{cd}	5.98 ^c
1 : 50	30	12.28 ^b	13.05 ^{ab}	7.03 ^d
	45	12.87 ^{cd}	14.76 ^{cd}	7.10 ^d
	60	14.01 ^d	15.20 ^d	7.13 ^d

(*) repeated experiments (3x). Different alphabet in the same column indicate statistical differences ($p < 0.05$) by DMRT

Many factors such as the extraction method, solvent composition, extraction time, extraction temperature, the solvent to material extract ratio and extraction pressure, among others, are assumed to significantly influence the efficiency of

curcuminoid extraction (Wakte *et al.*, 2011). The order of curcuminoid content in the extract obtained by various S/L ratio were : 1 : 50 > 1 : 40 and > 1 : 30. As the extracted temperature was increased, the curcuminoid content also increased;

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although indicating that compound was heat stable. This phenomena can affected by with high temperature, so the molecule of curcuminoid was more extracted. According to Panlucci *et al* (2012), the optimum temperature for curcuminoid extraction was found to be at 70°C. The content of curcuminoids many vary in turmeric rhizome grown in different agro-climate zones (Revathy *et al.*, 2011).

The effect of extraction conditions on the phenolic contents can be seen in Table 2. The phenolic contents proved to be dependent on the type of solvent used at a significant level of 5% ($p < 0.05$).

Table 2 shows that the ethanol extraction of ground dry turmeric produced a greater total phenolic content than from the ethanol-water extraction. The Folin-Ciocateu method was reported to react not only with phenols but also any reductive substance present. According to Yang *et al.*, 2006, the high content of total phenols in the extracts might refer to the high antioxidant properties. The extract condition with the highest total phenolic content was found to be the same as the one that had the curcuminoid content.

Table 2. Total Phenolic Content Of Turmeric Extracted Under Various Condtions (*)

Solid/Liquid Ratio (g/ml)	Extraction temperature (°C)	Total phenolic content as mg gallic acid equivalent (GAE)/100 g sample		
		Ethanol 60%	Ethanol 80%	Ethanol-water
1 : 30	30	115.30 ^a	117.67 ^a	101.43 ^a
	45	116.75 ^b	119.05 ^a	110.34 ^b
	60	120.14 ^{ab}	122.37 ^{ab}	120.12 ^b
1 : 40	30	127.98 ^c	129.84 ^{bc}	101.87 ^b
	45	129.40 ^c	130.04 ^{bc}	102.40 ^c
	60	137.96 ^d	136.25 ^c	121.16 ^c
1 : 50	30	124.57 ^{bc}	127.36 ^b	108.67 ^d
	45	127.80 ^c	131.81 ^{bc}	110.19 ^d
	60	146.25 ^e	148.99 ^d	122.08 ^d

(*) repeated experiments (3x). Different letters in the same column indicate statistical differences ($p < 0.05$) by DMRT

Table 3. Properties of Curcuminoid powder

Ground dry turmeric used in the extract	Moisture (%)	Aw	Yield (%)	Curcuminionoid (µg/g)	Color Value		
					L *	b*	b*
1.50	3.01 ^a	0.24 ^b	67.51 ^c	164.95 ^a	97.20 ^a	-9.21 ^a	50.01 ^a
3.00	3.48 ^b	0.24 ^b	63.05 ^a	168.90 ^b	95.37 ^b	-7.46 ^b	63.70 ^b
6.00	3.06 ^a	0.20 ^a	64.60 ^{ab}	170.85 ^b	93.59 ^c	-5.01 ^c	69.55 ^c
7.50	3.05 ^a	0.28 ^b	65.52 ^{bc}	171.27 ^b	92.86 ^c	-4.09 ^d	70.38 ^{cd}
15.00	3.40 ^b	0.21 ^a	64.28 ^{ab}	172.50 ^c	89.50 ^d	1.18 ^e	71.89 ^d

Different letters in the same column indicate statistical differences ($p < 0.05$) by DMRT

Properties of Curcuminoid Powder

The character properties of curcuminoid powder were presented in Table 3. All the products had low Aw (0.21 – 0.27) and low moisture content (3.01 – 3.48%). If the data of moisture obtained

especially was comparable with the earlier results that conducted by Lim *et al.*, (2011), the moisture of curcuminoid powder is not agreement with their findings and is consistent with our results. According to Lim *et al.*, (2011), the

Curcuma longa (powder) contained moisture $14.8 \pm 0.12\%$, while our curcuminoid powder contained moisture 3.01 – 3.48%. The variations between our findings and their mentioned findings is may be due to the difference in varieties, type of materials and drying practice.

Color values L^* , a^* and b^* (Table 3) changed depending on the amount of ground, dry turmeric used. It can be seen also that the increasing the quantity of ground dry turmeric in the extract increased the curcuminoid content as well

as redness values (a^*) and yellowness values (b^*); while the lightness (L^*) value tended to decrease.

The properties of curcuminoid powder that dissolved in water were presented in Table 4. As shown in Table 4, dissolving the powder in distilled water produced acidic solutions with a range of pH from 3.68 – 3.75 that varied with their different color values. A deep yellow solution (high b^* values) was obtained from the powder with high curcuminoid content (Table 4).

Table 4. The Color Values of Dissolved Curcuminoid Powder In Water (g/ml water)

Ground turmeric used for extract (g)	Color Value		
	L^*	b^*	c^*
1.50	95.21 ^e	-4.01 ^c	13.93 ^a
3.00	93.35 ^d	-6.99 ^b	26.71 ^b
6.00	86.74 ^c	-9.03 ^a	45.82 ^c
7.50	84.78 ^b	-6.81 ^b	63.24 ^d
15.00	68.94 ^a	2.40 ^d	74.40 ^e

ns = not significance . Different letters in the same column indicate statistical differences ($p < 0.05$) by DMRT.

Total Phenolic Content

All products (Table 2) showed significant differences in total phenolic content. Results showed that the highest value of total phenolic content was recorded in the ethanolic extract (solid/liquid ratio 1 : 50 and extraction temperature 60°C) with value 148.99 mg GAE/100 g; while the lowest for a mixture of ethanol : water 1 : 1 (solid/liquid ratio 1 : 30 and extraction temperature 30°C) with value 101.43 mg GAE/100 g.

The results of our experiment has related the different method to research work of Kaur and Kapoor (2002), i.e. It have manner of acting the present research outcomes. They evaluated the bioactive phenolic compounds and antioxidant potential of Asian spices and vegetables including *Curcuma longa* for its application in different functional foods..

It was found that total phenolic content in dry powder of turmeric were 115.30 – 148.99 mg GAE/100 mg and our results are not consistent with their work (Wojdylo *et al.*, 2007). Different extraction methods and solvent used might have a

significant effect on extraction yield as well as their antioxidant potential (Nisar *et al.*, 2015). Kim *et al.*, (2011) studied the total phenolic content in the turmeric extract and they found that total phenolic content in turmeric extract was 582.8 mg GAE/100 g extract. This different results, it might be due to the different composition of curcuma (different source), extraction condition and analytical technique in the curcuminoid quantification.

Antioxidant Capacities of Curcuminoid powder (DPPH assay)

Results of antioxidant capacity regarding DPPH scavenging activity extracts are presented in Table 5. Mean values of DPPH showed has enough significant effect of solvent and their amount of ground dry turmeric used on free radical scavenging activity of turmeric powder extract.

Mean values free radical scavenging activities of the ethanol solvent at their different concentrations (50%, 60% and 80%) and at their different ground dry turmeric used for extract (1.50, 3.00, 6.00,

7.50, and 15.00 g) were 20.04 - 38.30%, 22.20 - 44.72% and 25.69 - 47.65% respectively. While for ascorbic acid (BHT/botylated hydroxy toluene or botylated hydroxy anisole/BHA) was 5.20%.

It was shown in Table 5 that indicated free radical scavenging activities were maximum for ethanol 80% and 60% extract follow by the mixture of ethanol and water 1 : 1 (ethanol 50%) extract.

Table 5. Means Values for DPPH Assay (%) of Turmeric Extracts

Ground dry turmeric used for extract (g)	Antioxidant capacity as mg DPPH/g sample		
	Ethanol 60%	Ethanol 80%	ethanol 50%
1.50	22.20 ^a	25.69 ^a	20.04 ^a
3.00	29.02 ^b	32.36 ^b	24.52 ^b
6.00	35.38 ^c	37.12 ^c	28.83 ^c
7.50	38.50 ^d	40.58 ^d	34.18 ^d
15.00	44.72 ^e	47.65 ^e	38.30 ^e
BHT/BHA as a standard	5.20	5,20	5,20

According to Kaur and Kapoor (2002), they assessed the free radical scavenging activity of turmeric powder by extracting it with water and ethanol. It was concluded that ethanol gave more extraction result content than a mixture of ethanol and water and measured the antioxidant potential by DPPH assay. According to them, ethanolic and the mixture of ethanolic and water (1 : 1) extracts of turmeric contained 62.45% and 41.30% antioxidant activity respectively.

Antioxidant activities were also determined by Tilak *et al.*, (2004) of some edible plants including turmeric. Plant materials extracted by using water and methanol as a solvent. According to them, it was mentioned that antioxidant potential of methanolic extract was higher than the water extract. The methanolic and water extracts of turmeric contained 52% and 38% antioxidant activity respectively.

Therefore, based on the above information can be stated that antioxidant activity our research was a little lower content than have been conducted by Kaur and Kapoor (2002) and Tilak *et al.* (2004). It might be due to the different composition of curcuma (different source), and extraction condition. The extraction temperature and ethanolic strength exerted

a strong impact on the soluble solid content (Panlucci *et al.*, 2012).

CONCLUSIONS

The type of extraction solvent and extraction condition (temperature and solid/liquid ratio) affected the curcuminoid and total phenolic content, as well as the antioxidant activity of several extracts from dry turmeric (*Curcuma longa domestica Vahl*).

The best solvent used for extraction of curcuminoid content was obtained with the S/L ratio 1.50 on extraction temperature 60°C and the ethanol solvent 80% concentration with curcuminoid content value 15.20 (% w/w); and the total phenolic content value 148.99 mg GAE/100 g. While the extract that has the highest value of an antioxidant capacity was recorded in the ethanolic extract with ethanol 80% concentration, and the amount of ground turmeric used for extract 15.00 mg with antioxidant capacity value as DPPH/g sample was 47.65%.

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