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Total phenol content of turmeric extract (*curcuma longa* L.) in vegetable oil using the ultrasonic method

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Total phenol content of turmeric extract (*curcuma longa* L.) in vegetable oil using the ultrasonic method

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Abstract. Turmeric extract (Curcuma longa L.) in vegetable oil is an herbal oil rich in antioxidants called phenolics. Vegetable oil has the potential to be utilized as a solvent in herb extraction because it can extract bioactive components in plants because it is stable, safe, and ecologically friendly. The purpose of this study is to determine the secondary metabolites and total phenolic content of turmeric extract in Extra Virgin Olive Oil (EVOO) and Virgin Coconut Oil (VCO) with the addition of a surfactant (tween 80). The extraction method utilized was ultrasonic, with variations in surfactant dosage (0 - 30 g) and extraction time (10 - 25 minutes). FTIR spectrophotometer used to identify functional groups in herbal oils. The qualitative test showed that phenolic components, flavonoids, terpenoids, and alkaloids were detected in turmeric extracts EVOO and VCO both without and with tween 80. Based on statistical study, the extraction time and the amount of surfactant used significantly affect the overall phenol content of herbal oils. The maximum total phenolic content of turmeric extract EVOO and VCO was achieved after a 25-minute extraction with 30 g surfactant, namely 44.11 0.43 mg GAE/g and 35.22 0.43 mg GAE/g. Identification of the functional groups of herbal oils with the addition of tween 80 obtained absorption patterns namely O-H, C=O, C=C aromatic, C-O-C, and C-H.

Keywords: EVOO, phytochemical, total phenol, turmeric, VCO

1. Introduction

Turmeric is being widely used effectively in various medical conditions [1]. The distinctive yellow color of turmeric is due to the curcuminoid content, which is the main component (Curcuma longa L.) and is included in the phenolic compound group [2][3]. Curcuminoids are divided into 3 components: 71.5% curcumin, 19.4% demethoxycurcumin, and 9.1% bisdemethoxycurcumin [4]. Curcumin is proven to have antibacterial, anti-inflammatory, and antioxidant activity, as an agent for healing wounds and acne on the skin [5][6]. Turmeric olive oil extract has an antibacterial ability to inhibit Staphylococcus aureus and Propionibacterium acne bacteria [7].

Herbal oils are called herbal extract oils and contain a combination of nutrients, antioxidants, and biostimulants. They are a great way to utilize the active compounds of the herbs and the oil itself [8]. Virgin coconut oil (VCO) is a type of vegetable oil with a main component of approximately 90% lauric acid (saturated fatty acid), of which 52% is medium-chain triacylglycerol (MCT). Curcumin in edible oil with MCT showed the highest solubility [9][10]. Olive oil (Olea europaea), contains mono-unsaturated fatty acids (MUFAs) and 30 phenolic compounds [11]. Oleic acid and phenolic compounds are useful for treating dry skin as daily use for the skin and skin disease therapy additives [12]. Curcumin in turmeric has a nonpolar part that allows curcumin in turmeric to dissolve in vegetable oil [13].

Tween 80 is a surfactant that provides the highest solubility of curcumin due to the high value of lipophilic hydrophilic balance (HLB) so that it can support a fast dispersion process [14]. Tween 80 shows good physical and chemical stability in curcumin-containing emulsions and is non-irritating due to its low toxicity [15][16]. Vegetable oil with the addition of tween 80 is effective for nanoemulsion formulations because it encapsulates curcumin [17]. Curcumin levels in turmeric virgin coconut oil extract with the addition of tween 80 have a greater value than without the addition of tween 80 [18]. Vegetable oil has the potential as an alternative solvent in green extraction from natural materials that have the advantages of not being volatile at high temperatures, safe, economical, and environmentally friendly [19][20]. Analysis of phenol content of Moringa leaves vegetable oil extract obtained the highest value of 15.78% GAE at hot maceration extraction temperature of 50 °C for 2 hours [21] Curcumin levels in turmeric virgin coconut oil extract by ultrasonic method have a greater value than the maceration extraction method [18]. The purpose of the study was to determine the phenol content in turmeric extract EVOO and VCO by ultrasonic extraction method. Because the content of compounds in turmeric and oil has good benefits for the skin, we can take the benefits of these 2 ingredients in the form of herbal oil. The results of turmeric vegetable oil extract can be used as an antioxidant product for skin health.

2. Materials and method

Research materials include extra virgin olive oil (Borges), virgin coconut oil (A&D), turmeric powder (Materia Medika Batu), tween 80 (Merck), and silica plate G60 F254 (Merck). The research equipment consists of a water bath sonicator (Branson 3510-DTH Ultrasonic cleaner), a 366 nm UV lamp (Camag UV Cabinet4), UV-Vis spectrophotometer (Cary 50 Conc UV-VIS Photometer variant), and Fourier transform infrared (FTIR) (Inc. Scimitar 1000 FT-IR variant).

2.1. Turmeric extraction in vegetable oil

3 gr of turmeric powder was dissolved in 10 ml of vegetable oil solvent (EVOO or VCO) then added tween 80 with variations of adding 0 µg, 10 µg, 20 µg, and 30 µg. Furthermore, it was extracted using a 40 kHz frequency water bath sonicator with variations in extraction duration of 10, 15, 20, and 25 min. The viscous extract is filtered using cheesecloth and the filtrate obtained is stored in a glass bottle with a dark state [18].

2.2. Qualitative phytochemical screening

The results of turmeric vegetable oil extract with and without the addition of 20 g tween 80 were carried out qualitatively in phytochemical tests to identify the content of alkaloids, terpenoids, steroids, phenolics, flavonoids, saponins, and tannins [21].

2.3. Analysis of total phenol levels of turmeric vegetable oil extract

2.5 mL of turmeric vegetable oil extract was put in a measuring flask and then added methanol solvent. 0.5 mL of the results obtained were added with 5 mL of Folin-Ciocalteu reagent and allowed to stand for 3 minutes then added 4 mL Na_2CO_3 10%. The mixture is incubated for 30 minutes at room temperature in the dark. Absorption is measured at maximum wavelength. The concentration of the oil solution is entered into the regression equation of the standard solution of gallic acid so that the total phenol content is obtained as indicated by milligrams of gallic acid equivalent per gram of oil (mg GAE/g oil). Calculation using the formula $y = ax + b$ [21].

2.4. Functional group identification with FTIR

Turmeric vegetable oil extract were dripped on one part of potassium bromide (KBr) pellets (Merck) and identified using FTIR (Varian Inc. Scimitar 1000 FT-IR) [22].

3. Results and Discussion

The process of extracting turmeric in vegetable oil with the addition of tween 80 surfactant affects the color of the extract, which is clearer yellow than the previous turbid yellow. The hydrophilic part of the surfactant will interact with secondary metabolite compounds present in curcumin by forming hydrogen bonds, while the hydrophobic part of the surfactant will interact with the oil to form van der Waals bonds, so the addition of surfactants helps emulsify the extract results.

Figure 1. Turmeric extract VCO without the addition of surfactants (a) turmeric extract oil with addition of 10, 20, 30 µg surfactants (b,c,d)

Table 1. Phytochemical test results of turmeric extract in vegetable oil

Phytochemical test	**Types of extracts**			
	Extra virgin olive oil		Virgin coconut oil	
	without surfactants	surfactants	without surfactants	surfactants
Alkaloids (Mayer)	+	+	+	+
Terpenoids	+	+	+	+
Steroids	-	-	-	-
Phenolic	+	+	+	+
Flavonoids	+	+	+	+
Saponins	-	+	-	+
Tannins	-	+	-	+

Note: Sign - : no color or foam is formed
Sign +: light color or slightly foamy

Based on the results of Table 1, turmeric extracts in VCO and EVOO with the addition of surfactants gave positive results containing alkaloids, terpenoids, steroids, tannins, phenolics, flavonoids, saponins, and tannins. Turmeric extracts in VCO and EVOO without surfactants were not identified as containing tannins and saponins. Based on the concept of like dissolves like, nonpolar compounds dissolve in nonpolar solvents. Tannins and saponins are polar compounds with hydroxy groups, so the presence of surfactants can increase the solubility of a polar compound in nonpolar solvents [23].

Table 2. Total phenol levels of turmeric extract in EVOO

Extraction duration (minute)	**Total phenol levels (mg GAE/g)**			
	surfactant (µg)			
	0	10	20	30
10	17,23 ± 0.28	20,17 ± 0.28	24,92 ± 0.75	22,07 ± 0.28
15	20,56 ± 0.43	23,59 ± 0.43	27,96 ± 0.71	35,66 ± 0.43
20	22,45 ± 0.43	28,63 ± 0.56	30,81 ± 0.43	42,30 ± 0.28
25	24,16 ± 0.43	31,19 ± 0.85	33,47 ± 0.28	44,11 ± 0.43

Table 3. Total phenol levels of turmeric extract in VCO

Extraction duration (minute)	Total phenol levels (mg GAE/g)			
	surfactant (µg)			
	0	10	20	30
10	13,91 ± 0,59	16,44 ± 0,16	21,03 ± 0,16	15,14 ± 0,16
15	15,43 ± 0.,43	20,56 ± 0,43	24,64 ± 1,30	28,25 ± 0,43
20	18,66 ± 0,85	24,54 ± 0,43	26,73 ± 0,43	29,86 ± 0,43
25	21,69 ± 0,43	26,25 ± 0,43	30,72 ± 0,43	35,28 ± 0,43

Based on Table 2 and Table 3, it can be observed that the total phenol content is directly proportional to the increase in surfactant volume and the length of extraction time, where the greater the tween 80 volume, the greater the total phenol content in turmeric extract in EVOO and VCO. Tween 80 surfactant as an emulsifying agent can reduce the surface tension of oil in water stably to increase the solubility process in phenolic compounds that are hydrophilic. The presence of a hydrophilic -OH group in surfactants causes interactions between H atoms and O atoms of secondary metabolite compounds to form hydrogen bonds, which can attract secondary metabolite compounds that have -OH groups. While the van der Waals force is formed due to the interaction between hydrophobic groups and oil.

Increasing the concentration of surfactants can reduce the surface tension between the organic phase and the water phase, whereas, at smaller particle sizes, the surface area of the sample to be extracted is larger and requires more surfactant to fill the surface area. An increase in surfactant volume can also lead to increased interaction and withdrawal of compounds that occur in the -OH (hydrophilic) group with the phenolic compounds of turmeric extract in oil. So it can be stated that the higher the addition of tween 80 surfactant volume, the more it increases the total phenol content in turmeric extract in VCO and EVOO. The addition of tween 80 2% surfactant can increase curcumin content compared to without the addition of tween 80 [18]. The total phenol content of turmeric extract EVOO is higher than that of turmeric extract VCO because the carbon chains tween 80 and EVOO in their unsaturated fatty acids (oleic acid) both have a double C bond at number 9, where both interactions occur π-π that overlap each other and produces strong attraction between the two compounds. This results in a strong van der Waals force between the two compounds to increase total phenol levels. In contrast to VCO which does not have a double C bond in its saturated fatty acid (lauric acid), the interaction between tween 80 and VCO is weaker, resulting in lower total phenol levels. The results of statistical tests showed that variations in the addition of surfactant volume and extraction duration to total phenol levels in the sonication results of turmeric extract in VCO and EVOO had a significant influence

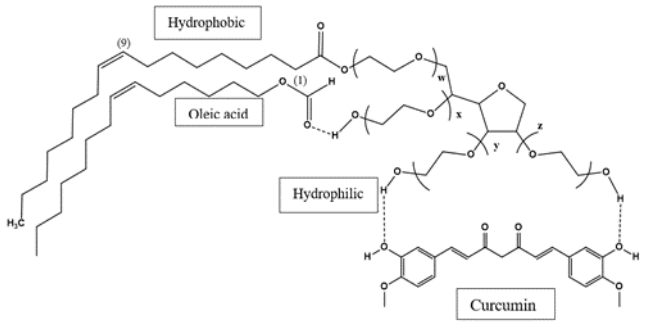

Figure a

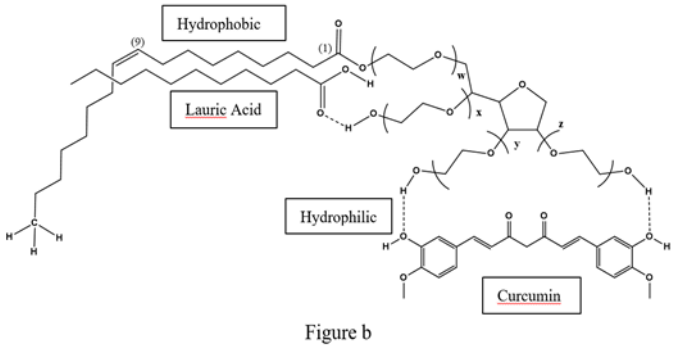

Figure 2. Interaction of tween 80 with turmeric extract EVOO (a), and interaction of tween 80 with turmeric extract VCO (b)

Table 4. Interpretation of FTIR spectral functional groups of turmeric extract in vegetable oil

No.	Range (cm^{-1})*	Vibration	Turmeric extract EVOO (cm^{-1})	Turmeric extract VCO (cm^{-1})	Tumeric (cm^{-1})	Tween 80 (cm^{-1})
1	3550-3250	O-H *Stretching*	3472	3472	3474	3495
2	3000-2800	C-H *Stretching*	2929	2925	-	2921
3	1870-1550	C=O *Stretching*	1628	1746	1628	1646
4	1600-1450	C=C *Streching*	1465	1466	1509	1463
5	1490-1150	O-H bending	1377	1377	1280	1350
6	1310-1020	C-O-C *Stretching*	1163	1161	1156	1118
7	995 - 650	C-H bending	967	722	962	949

Note: *(Socrates, 2001)

The turmeric spectra of vegetable oil extract with the addition of tween 80 showed the presence of a functional group with absorption wavenumber 3472 cm^{-1} which is an O-H group. The absorption of wavenumbers 2929 and 2925 cm^{-1} shows asymmetric stretching vibrations and symmetric CH2- (methylene) groups, indicating that EVOO has a linear carbon chain of fatty acids such as oleic acid. Meanwhile, the absorption of wavenumbers 1623 and 1746 cm^{-1} shows an absorption pattern of C=O stretching of the carbonyl group, which is characteristic of ester compounds, namely triglycerides. Wavenumbers 1465-1466 cm^{-1} show the absorption pattern of C=C aromatic bending which is the structure of the benzene ring. While the wavenumber 1377 cm^{-1} shows absorption caused by O-H bending vibrations. At wavenumbers 1163 and 1161 cm^{-1} there are vibrational absorption patterns C-O-C stretching and C-O stretching, while at wavenumbers 722 cm^{-1} is vibrational absorption C-H bending. Based on the description above, it can be concluded that in the turmeric extract herbal oil in VCO with the addition of Tween 80 typical functional groups belonging to curcumin compounds, namely O-H, C=O, C=C aromatic, CH2, C-O, and C-H.

4. Conclusion

The phytochemical test of turmeric vegetable oil extract with the addition of surfactants identified compounds containing phenolics, flavonoids, tannins, saponins, terpenoids, and alkaloids. The addition of surfactant and the length of ultrasonic extraction time to the total phenol content in the combination of turmeric extract in vegetable oil had a significant effect where 30 µg surfactant and extraction time

of 25 minutes were the best results with a total phenol content of 44.11 ± 0.43 mg GAE/ g in turmeric extract EVOO and 35.22 ± 0.43 mg GAE/g in turmeric extract VCO.

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