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Conference Paper

The Antioxidant Activity, Antibacterial Assay, and the Application of Turmeric (*Curcuma domestica*) Crude Extract with Various Solvents

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ABSTRACT

Turmeric (*Curcuma domestica*) was one of the herbal resources in Indonesia commonly applied as spices, herbal medicines also cosmetics. This study aimed to extract the chemicals from Turmeric using several solvents and then characterize each extract. The physicochemical and Biochemical characterization of each Turmeric extract showed that the crude extracts have a strong antibacterial effect against digestive bacteria and respiratory and skin bacteria. The antioxidant activity belongs to high levels also the Sun Protection Factor (SPF) ability of each extract showed belongs to Ultra Protection levels. Based on those results than concluded that Turmeric potentially applied as Herbal medicine and Cosmetics in Indonesia.

Keywords: Cosmetics, curcumin, pharmaceutical, turmeric

Introduction

Indonesia is a country rich in various herbal resources, those herbals have various chemical contains Because of that Indonesia there were claims said: "Biodiversity causing Chemodiversity" (A'yunin et al., 2019; Barki et al., 2017; Hanggoro et al., 2020). Those herbals were potentially to be applied for health like in cosmetics and/or medical (A'yunin et al., 2019; Barki et al., 2017). In medical applications, those herbals were claimed (or believed) can prevent or minimize the risk of degenerative diseases, and also can maintain the diseases caused by batteries (A'yunin et al., 2019; Hanggoro et al., 2020; Widyapuspa et al., 2022). Among those herbal resources were Turmeric (Hanggoro et al., 2020; Widyapuspa et al., 2022) (Curcuma domestica; synonym: Curcuma longa Linn.) (Bozkurt & Sanlier, 2015; Hewlings et al. 2017), in Indonesia the Turmeric very famous because already applied since ancestral era as herbal medicine, spice (seasoning) also as cosmetics (mix of Rice-Turmeric powders) (Hanggoro et al., 2020), the applications of Turmeric were inherited from generation to generation from simple ways in local wisdom until archived in library writing form (Hanggoro et al., 2020). The inheriting process the Turmeric was close to the Indonesian culture because almost all ethnics in Indonesia familiar with Turmeric although the applications are different from each other (A'yunin et al., 2019; Barki et al., 2017; Hanggoro et al., 2020).

In several ethnics, Turmeric is applied in an herbal drink called "Jamu" (A'yunin et al., 2019; Barki et al., 2017; Widyapuspa et al., 2022), this herbal drink is made from a mix of spices including Turmeric (Hanggoro et al., 2020). Jamu commonly looks cloudy with a yellow color from Turmeric (A'yunin et al., 2019; Hanggoro et al., 2020). Another ethnicity also knew about Turmeric but only applied it as a spice for foods not for herbal medicine, another ethnicity reported only knowing Turmeric as herbal medicine and consuming it in Phytopharmaca herbal drink. The differences

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between Jamu and Phytopharmaca herbal drinks are commonly based on 2 parameters (1) the color of Phytopharmaca herbal drinks is commonly more clean and transparent than Jamu because the spice materials including Turmeric in Phytopharmaca drinks mostly only macerated (marinated), but in Jamu those spices were ground then mix at once (Hanggoro et al., 2020; Widyapuspa et al., 2022). Another parameter (2) to make differences between Phytopharmaca herbal drink and Jamu comes from its composition, Jamu is commonly made from the mixing of more than 3 herbals but Phytopharmaca drinks commonly can made from single compounds. If it uses Turmeric as the main material then it only contains Turmeric crude extract, but Jamu sometimes mixes with Tamarin, Ginger, Rice, etc (Hanggoro et al., 2020; Widyapuspa et al., 2022). In another ethnicity, the Turmeric Phytopharmaca drinks are made from macerated Turmeric in local (traditional) Alcohol (estimated Bioetanol).

The Indonesian people have various applications for Turmeric causing Turmeric was become an object for medical or cosmetics science research several preliminary research reported that Turmeric is potentially applied (or suggested) as herbal medicine because it contains various organic chemical compounds beneficial for health ((A'yunin et al., 2019; Barki et al., 2017; Hanggoro et al., 2020; Widyapuspa et al., 2022; Bozkurt & Sanlier, 2015; Hewlings et al., 2017). The Turmeric extract reported has Biocompatibility, Strong Antioxidant, Strong antibacterial, Antiinflammatory, Low toxicity characteristics also minimum side effects if consumed as herbal medicine (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Larasati & Jusnita, 2020). The application in cosmetics also reported that the Turmeric crude extract has a Strong SPF (Sun Protection Factor) Ability and Anti-aging for skin especially face skin (Karina et al., 2015; Mutiana & Sopyan, 2018). Because of the benefits of Turmeric application then decided this study aimed to extract the chemicals from Turmeric using several solvents and then analyze the Physicochemical and biochemical properties of each extract (Larasati & Jusnita, 2020; Karina et al., 2015; Mutiana & Sopyan, 2018).

Material and Methods

Time and place

The research was conducted from September 2017 to October 2019 at the CARC laboratorium of Magister Biologi UKSW Salatiga.

Materials

The chemicals used in this research were equated / aquabides, Methanol, Ethanol, Acetic Acid, Aceton, Ethyl Acetate, n-hexane, Chloroform Petroleum Eter, Acetonitrile, Ascorbic Acid, $KFeCN_6$, $FeCl_2$, $FeSO_4$, Metilen Blue, Quercetin and Katekin, all materials standardized in Pro Analysis (PA) levels. The instruments used in this research were a sonicator, spectrophotometer UV-Vis, destination instruments (Erlenmeyer, Condensator, and Hotplate), oven, and incubator (biochemical incubator).

The samples / raw materials in this research, the turmeric were obtained from central market Pasar Raya Salatiga.

Preparation

The fresh turmeric was washed and peeled, then shredded. After shredded the turmeric dried at room temperature (Larasati & Jusnita, 2020; Karina et al., 2015). The fresh shredded turmeric was macerated in the next steps.

Extraction with maseration method

The chemicals from fresh turmeric were extracted by maceration method using various solvents, the universal solvents using water, and the polar solvents using Methanol, Ethanol, Acetic Acids, and Ethyl Acetate. The semipolar solvents use Acetone, Acetonitrile, and Chloroform, then the nonpolar solvents use n-Hexane and Petroleum Eter (Pratiwi & Wardaniati, 2022). The maseration combined with sonication along 45 minutes then continue (without sonication) until 24 hours (Kautsari et al., 2020). The maserated samples using 10.0055g of shredded turmeric, after macerating the turmeric extract were filtered before concentrated (Kautsari et al., 2020; Ihsan et al., 2018). The extract of turmeric was concentrated by dilation until the crude extract from each solvent (Pratiwi & Wardaniati, 2022; Kautsari et al., 2020; Ihsan et al., 2018).

Extract characterization

The crude extract (from each solvent) of turmeric was characterized by measuring density, and Viscosity (Hanggoro et al., 2020).

Moisture

The moisture of the Turmeric is measured automatically using an *Automatic Moisture Analyzer* with measurement intervals of 15 minutes (Gintu & Puspita, 2020).

Ash, organic compounds, and volatile carbons

The ash contained was measured by incinerating the Turmeric using a Furnace at 550^{o}C for 3 hours. The organic compounds obtained from the differences between the Turmeric mass against its ash mass (Pratiwi & Wardaniati, 2022). The volatile Carbons are obtained from the multiplying of organic compounds against 0,58 (Gintu & Puspita, 2020).

Organic fiber contains

The Organic fiber is measured by maceration methods, the dry shredded Turmeric was macerated sequentially in the 100ml NaOH 5% (w/v) and HCl 5% (v/v) to eliminate another material and leave the fibers. The Fiber's mass was weighed and noticed as crude fiber contains.

Density

The density of turmeric extract was measured by weighing the 1mL of turmeric extract (Hanggoro et al., 2020).

Viscosity

The viscosity of turmeric extract was measured using the rotary viscometer and noticed as absolute viscosity (Hanggoro et al., 2020).

Phytochemicals

Flavonoids

The 10mL extract (from each solvent) was diluted to 100mL (using its solvents) then added 1mL $FeCl_3$ 1% (w/v) and incubated for 10 minutes at room temperature. The absorbansion of the extract was measured using a spectrophotometer Uv-Vis at λ 435nm and then plotted in Quercetin: $AlCl_3$ standard curve (Pratiwi & Wardaniati, 2022; Hapsari et al., 2018; Septiani et al., 2018).

Saponin

The 10mL extract (from each solvent) was diluted to 100mL (using its solvents) then added 1mL NaCl 0,9% (w/v) and incubated for 10 minutes at room temperature. The absorbansion of the extract was measured using a spectrophotometer Uv-Vis at λ 650nm and then plotted in Metilen Blue standard curve (Pratiwi & Wardaniati, 2022; Hapsari et al., 2018; Septiani et al., 2018).

Tanin

The 10mL extract (from each solvent) was diluted to 100mL (using its solvents) then added 0,5mL $FeCl_3$ 1% (w/v) and incubated 10 minutes in room temperature. The absorbansion of the extract was measured using a spectrophotometer Uv-Vis at λ 235nm and then plotted in Catechin: $FeCl_3$ standard curve (Hapsari et al., 2018; Septiani et al., 2018).

Organic acids

The organic acid is measured using titration. Take 25mL of each extract and drop with 1mL Phenophtalein indicators then titrate with NaOH 0,1N (Hanggoro et al., 2020).

Antioxidant assay

The contents of antioxidants

The content of antioxidant were measured using Ascorbic Acids: $FeCl_3$ by spectrophotometer UV-Vis at λ 720nm. 1ml $FeCl_3$ 1% (w/v) was added to 10mL of the turmeric extract and then incubated for 10 minutes at room temperature. After incubation 1mL Ascorbic Acid 1% (w/v). The absorbansion of samples was measured and plotted to the Ascorbic Acids standard curve (Maesaroh et al., 2018; Maryam et al., 2015).

The inhibitory concentration 50% (IC_{50})

The IC_{50} of each extract was measured using 1mL DPPH (1,1-Diphenyl-2-Picrylhydrazyl) 0,5M by spectrophotometer UV-Vis at λ 517nm (Barki et al., 2017; Widyapuspa et al., 2022; Mutiana & Sopyan, 2018; Pratiwi & Wardaniati, 2022; Pratiwi & Wardaniati, 2022; Kedare & Singh, 2011; Lung & Destiani et al., 2017; Puspita & Gintu, 2020).

The reduction ability (Chelating ability)

The reduction ability of each extract was measured using $KFeCN_6$ by spectrophotometer UV-Vis at λ 700nm (Septiani et al., 2018; Maesaroh et al., 2018; Lung & Destiani, 2017; Septiana & Simanjuntak, 2015).

Antibacterial assay

The antibacterial assay treated against digestive bacteria *E. coli* and *Bacillus sp*; oral and respiratory bacteria *Streptococcus mutans, Lactobacillus acidophyllus, Nocardia asteroides* and *Nocardie erythropolys*; also skin bacteria *Propionibacterium acnes, Streptococcus epidermidis* and *Streptococcus aureus*. The antibacterial assay was treated by disch methods with Tetracycline, Streptomycine, Clindamycine, and Erythromycin as comparisons (Control Positive) (Gintu & Puspita, 2020; Septiana & Simanjuntak, 2015).

The batteries rejuvenation

The batteries used as test batteries were the 1st rejuvenated from the bacterial host. The batteries rejuvenated in an NA medium and incubated for 24 hours before being applied (Gintu & Puspita, 2020; Puspita & Gintu, 2020).

The standardization of batteries

The test batteries were standardized by McFarland Method, the McFarland solutions were made from the mix of $BaCl_2$ 1% (w/v) and H_2SO_4 1% (v/v) and measured those solution's absorption at λ 620nm by UV-Vis Spectrophotometer (Gintu & Puspita, 2020; Puspita & Gintu, 2020). The McFarland standardization is shown in Table 1.

The Sun Protection Factor (SPF) ability test

The SPF ability of each extract was measured using Mansur Method, the extracts were scanned along λ 290, 295, 300, 305, 310, 315, and 320nm by spectrophotometer UV-Vis (Karina et al., 2015; Mutiana & Sopyan, 2018; Susanti et al., 2015).

Table 1. The battery standardization using the McFarland method

McFarland series		0,5	1	2	3	4
$BaCl_2$ 1% w/v (ml)		0,05	0,10	0,20	0,30	0,4
H_2SO_4 1% v/v (ml)		9,95	9,90	9,80	9,70	9,6
Ab-sorbtion	Standard	0,08-0,1	0,257	0,451	0,582	0,669
	Results	0,170	0,229	0,421	0,579	0,776
	L. acidophilus	-	-	0,423	-	-
		-	-	0,417	-	-
		-	-	0,415	-	-
	N. asteroides	-	-	-	-	0,724
		-	-	-	-	0,729
		-	-	-	-	0,732
	N. erytropolis	-	-	0,346	-	-
		-	-	0,324	-	-
		-	-	0,299	-	-
	S. mutans	-	0,255	-	-	-
		-	0,243	-	-	-
		-	0,259	-	-	-
	E. coli	-	-	0,433	-	-
		-	-	0,419	-	-
		-	-	0,426	-	-
	Bacillus sp	0,150	-	-	-	-
		0,155	-	-	-	-
		0,148	-	-	-	-
	P. acnes	-	-	-	0,559	-
		-	-	-	0,572	-
		-	-	-	0,555	-
	S. aureus	-	0,222	-	-	-
		-	0,225	-	-	-
		-	0,219	-	-	-
	S. epidermidis	-	0,229	-	-	-
		-	0,231	-	-	-
		-	0,234	-	-	-
Equivalent Bacterial Concentration (x 10^6CFU/ml)		< 300	300	600	900	1200

Results and Discussion

Turmeric is one of the famous spices in Indonesia but is also applied as an herbal medicine (A'yunin et al., 2019; Hanggoro et al., 2020; Pratiwi & Wardaniati, 2022). The applications of Turmeric have already been proved since the ancestral era but now the use of Turmeric is considered and claimed as an "*Old Method*" or "*Old Culture*" by the young generation even it benefits affect the body it is claimed only relevant to the old generations (parents and elders) not for teenagers (Hanggoro et al., 2020). Because of this the application of Turmeric consumption slowly disappeared (Hanggoro et al., 2020). The consumption of herbals including Turmeric initiated later because many consumers realized that the consumption of (inorganic) synthetic chemicals in medicine commonly caused bad side effects on the body's healthiness (A'yunin et al., 2019; Barki et al., 2017; Hanggoro et al., 2020; Widyapuspa et al., 2022; Bozkurt & Sanlier, 2015) then the consumption of herbals like Turmeric initiated again (A'yunin et al., 2019; Barki et al., 2017; Hanggoro et al., 2020). To prove the medical benefits of Turmeric consumption need the Physicochemical and Biochemical analyzation (Pratiwi & Wardaniati, 2022), and the 1th step of analyzation was measuring the physical and chemical properties, the results showed at Table 2.

Table 2. Physical characterization of 1,0055g Turmeric

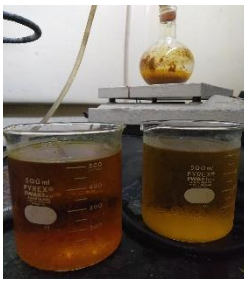
Parameters	Turmeric
Water (%)	20,80 ± 1,0198
Ash (g/g)	0,2993 ± 0,0034
Organic Volatiles (g/g)	0,7024 ± 0,0034
Carbon Volatiles (g/g)	0,4074 ± 0,0020
Organic Fiber (g/g)	0,5020 ± 0,0038
Crude Fat (g/g)	0,2194 ± 0,0010
SiO (g/g)	0,0748 ± 0,0009
Si (g/g)	0,0374 ± 0,0004

Table 2 shows that Turmeric has a high content of water (moisture) and organic fibers because the extraction of Turmeric suggested not only using a single method (Pratiwi & Wardaniati, 2022; Ihsan et al., 2018), maceration methods but also combining with sonication using middle-level frequency (30-50Hz) (Kautsari et al., 2020). The sonication aims to break the fibers and cell walls and build the Turmeric so the chemicals inside the Turmeric can push out of the fibers and bond with the solvents (Kautsari et al., 2020; Ihsan et al., 2018). The appearance of all extracts from each solvent looks orange-yellow, the extraction and extracts are shown in Figure 1.

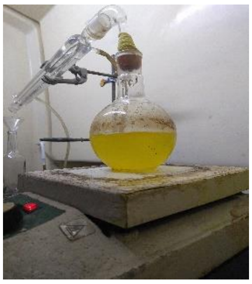
1a. The Preparation, the Turmeric were Peeling (Author's Documentation)

1b. The Turmeric Weighed to Measure the Wet mass (Author's Documentation)

1c. The Turmeric Shredded and Extracted using Aquades (Author's Documentation)



1d. Methanol and Ethanol Extracts Ready to Purification (Author's Documentation)



1e. Purification Process by Destination Method (Author's Documentation)

1f. The CrudeExtract from Each Solvent (Author's Documentation)

Each extract of Turmeric looks orange-yellow because of the existence of Curcumin, Bis-Demetoksi Curcumin, and Demetoksi Curcumin containing as pigments in Turmeric (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kautsari et al., 2020; Ihsan et al., 2018). Those pigments are also reported as strong antioxidants and strong antibacterial because Turmeric many used in herbal medicine and cosmetics (Pratiwi & Wardaniati, 2022; Septiana & Simanjuntak, 2015; Aprilia & Heviana, 2018). The Physicochemical of each extract is shown in Table 3.

Table 3. Extraction results of 10,0055g shredded turmeric

Sample		Concent rate Extract (mL)	Rende ment (% v/v)	Density (g/mL)	Mass Extract (g/g)	Mass Extract Rendement (% g/g)	Viscosity		
Fraction	Solvents						Absolute (P.A)	Kinetic (CTs)	Dinamic (CPs)
Universal	Water / Aquades	49,50 ± 0,50	19,80 ± 0,20	1,2495 ± 0,0015	1,5454 ± 0,0145	15,46 ± 0,1453	0,24 ± 0,00	0,1921 ± 0,0002	0,0192 ± 0,0002
Polar	Methanol	19,83 ± 0,73	7,93 ± 0,29	0,8517 ± 0,0003	0,4221 ± 0,0156	4,22 ± 0,1561	0,26 ± 0,00	0,3053 ± 0,0001	0,0305 ± 0,0001
	Etanol	24,27 ± 0,73	9,71 ± 0,29	0,9496 ± 0,0011	0,5758 ± 0,0181	5,76 ± 0,1808	0,26 ± 0,00	0,2738 ± 0,0003	0,0274 ± 0,0003
	Acetic Acid	13,67 ± 0,88	5,45 ± 0,35	0,9746 ± 0,0106	0,3332 ± 0,0247	3,33 ± 0,2476	0,26 ± 0,00	0,2668 ± 0,0029	0,0267 ± 0,0003
	Ethyl Acetate	12,17 ± 0,17	4,87 ± 0,07	0,8060 ± 0,0010	0,2450 ± 0,0037	2,45 ± 0,0037	0,26 ± 0,00	0,3226 ± 0,0004	0,0323 ± 0,0004
Semi Polar	Acetone	11,90 ± 0,10	4,76 ± 0,04	0,8018 ± 0,0002	0,2384 ± 0,0021	2,39 ± 0,0205	0,26 ± 0,00	0,3243 ± 0,0007	0,0324 ± 0,0007
	Acetonitrile	19,40 ± 0,27	7,76 ± 0,11	1,0045 ± 0,0041	0,4870 ± 0,0086	4,87 ± 0,0861	0,25 ± 0,00	0,2489 ± 0,0010	0,0249 ± 0,0011
	Chloroform	13,03 ± 0,38	5,21 ± 0,15	0,9703 ± 0,0007	0,3160 ± 0,0093	3,16 ± 0,0932	0,26 ± 0,00	0,2680 ± 0,0019	0,0268 ± 0,0002
Non Polar	n-Hexane	20,10 ± 0,10	8,04 ± 0,04	1,0011 ± 0,0002	0,5028 ± 0,0030	5,03 ± 0,0260	0,27 ± 0,00	0,2697 ± 0,0055	0,0270 ± 0,0006
	Eter	10,23 ± 0,27	4,09 ± 0,11	0,8816 ± 0,0016	0,2254 ± 0,0063	2,26 ± 0,0626	0,26 ± 0,00	0,2949 ± 0,0005	0,0295 ± 0,0005

Based on Table 3 shows that each crude extract has low density and viscosity which means that the extracts will be easy to absorb by bodies and easy to reach biochemically in the body (Larasati & Jusnita, 2020; Gintu & Puspita, 2020; Simanjuntak et al., 2021). The low density and viscosity will increase the opportunity for reaction biochemically because with low viscosity, the extracts can be easily mixed and homogeny with another biochemical compound (Larasati & Jusnita, 2020; Gintu & Puspita, 2020; Simanjuntak et al., 2021), and along the digestive system the chemicals in the extracts will be optimally absorbed (A'yunin et al., 2019; Widyapuspa et al., 2022; Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Larasari & Jusnita, 2020).

The extracts of Turmeric claim as a strong antioxidant because it also contains another phytochemical besides its pigments than the phytochemicals need to measure (A'yunin et al., 2019; Pratiwi & Wardaniati, 2022; Septiana & Simanjuntak, 2015; Aprilia & Heviana, 2018). The Results of Phytochemicals measurements are shown in Table 4.

Table 4. Phytochemicals contained in each turmeric extract

Extracts		Tanin (g/g)	Flavonoid (g/g)	Saponin (g/g)	Organic Acid (g/g)
Fraction	Solvents				
Universal	Water / Aquades	0,0471 ± 0,0008	0,0352 ± 0,0005	0,0532 ± 0,0014	0,0248 ± 0,0007
Polar	Methanol	0,0479 ± 0,0003	0,0368 ± 0,0002	0,0486 ± 0,0006	0,0193 ± 0,0006
	Etanol	0,0485 ± 0,0002	0,0376 ± 0,0003	0,0488 ± 0,0011	0,0195 ± 0,0002
	Acetic Acid	0,0470 ± 0,0007	0,0381 ± 0,0002	0,0525 ± 0,0009	0,0043 ± 0,0002
	Ethyl Acetate	0,0482 ± 0,0006	0,0376 ± 0,0002	0,0473 ± 0,0013	0,0217 ± 0,0009
Semi Polar	Acetone	0,0477 ± 0,0008	0,0354 ± 0,0011	0,0484 ± 0,0014	0,0321 ± 0,0010
	Acetonitrile	0,0463 ± 0,0011	0,0322 ± 0,0004	0,0468 ± 0,0012	0,0320 ± 0,0011
	Chloroform	0,0478 ± 0,0004	0,0314 ± 0,0004	0,0475 ± 0,0004	0,0323 ± 0,0012
Non Polar	n-Hexane	0,0494 ± 0,0004	0,0371 ± 0,0010	0,0602 ± 0,0008	0,0291 ± 0,0016
	Eter	0,0439 ± 0,0013	0,0339 ± 0,0008	0,0485 ± 0,0015	0,0350 ± 0,0011

Table 4 shows that the phytochemicals in Turmeric (besides its pigments) such as Tanin, Flavonoid, Saponin, and Organic Acids belong to middle levels (Pratiwi & Wardaniati, 2022; Kautsari et al., 2020; Ihsan et al., 2018; Septiana & Simanjuntak, 2015). Besides the Demetoxi Curcumin, those chemicals also contribute to the bitter taste (on the tongue) because of the bitter taste then the young generation in Indonesia commonly does not like the taste when consuming it as herbal medicine or herbal drink (Hanggoro et al., 2020; Widyapuspa et al., 2022; Nugroho et al., 2021), the teenagers commonly prefer using it as natural cosmetics and/or spices for food rather than consuming it as medicines because it taste (Hanggoro et al., 2020; Apriliana & Heviana, 2018; Nugroho et al., 2021; Megayanti & Wrasiati, 2021). So the local wisdom or local methods of processing Turmeric became herbal medicine, how to consume it (rules), also the benefits of consuming Turmeric almost no longer known among teenagers (Hanggoro et al., 2020; Nugroho et al., 2021), but the processing and applications in cosmetics still famous for the teenagers especially girls (Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022). The existence of those phytochemicals and the pigments of Turmerics caused the Turmeric extracts to become strong antioxidant agents (Setyowati & Suryani, 2013; Suena et al., 2021; Suprihatin et al., 2020), the results of antioxidant measurements using 3 methods against the Turmeric extracts showed at Table 5.

Table 5. Antioxidant activity of each turmeric extract

Extracts		Contains (g/g) (Fe – Ascorbic)	IC_{50} (%) (DPPH)	Inhibition (KFeCN)	
Fraction	Solvents			Contain (g/g)	Inhibisi (%)
Universal	Water / Aquades	0,2223 ± 0,0007	1,4500	0,0398 ± 0,0005	87,4829 ± 0,1628
Polar	Methanol	0,0609 ± 0,0008	0,7008	0,0357 ± 0,0005	88,7761 ± 0,1608

To be continued…

	Etanol	0,0591 ± 0,0010	0,0437	0,0335 ± 0,0003	89,4627 ± 0,0991
	Acetic Acid	0,0613 ± 0,0012	1,3904	0,0347 ± 0,0005	89,0955 ± 0,1686
	Ethyl Acetate	0,0593 ± 0,0010	0,8703	0,0356 ± 0,0007	88,2440 ± 0,2319
Semi Polar	Acetone	0,0570 ± 0,0015	0,5363	0,0333 ± 0,0002	89,5425 ± 0,0687
	Acetonitrile	0,0556 ± 0,0008	1,4768	0,0384 ± 0,0003	87,9140 ± 0,0924
	Chloroform	0,0576 ± 0,0007	1,7053	0,0550 ± 0,0004	82,7092 ± 0,1326
Non Polar	n-Hexane	0,0606 ± 0,0004	0,6751	0,0504 ± 0,0013	84,1621 ± 0,3971
	Eter	0,0525 ± 0,0006	1,2985	0,0442 ± 0,0008	86,1099 ± 0,2360

The biochemical reaction inside the human body produces the *Reactive Oxygen Species (ROS)* or called Radical Oxygen or Free Radical (Hanggoro et al., 2020; Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). This ROS claimed as reactive because it brings large energy (on atomic and molecule scales) strong enough to break and interfere with the biochemical reactions and cause unbalanced conditions inside the human body (Hanggoro et al., 2020; Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). In the case of ROS overproduction, the ROS can trigger and accelerate the aging effect and degenerative diseases then to balance and suppress the ROS production the human body need to supply antioxidant from food and beverages or herbal medicals (Hanggoro et al., 2020; Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). In Indonesian culture, one of the antioxidants recommended to consume is Turmeric because it is believed can become a strong antioxidant (A'yunin et al., 2019; Suena et al., 2021; Suprihatin et al., 2020). Table 5 proved that the turmeric extract can become an antioxidant because it has low IC_{50} and strong inhibition (reducing ability / Fe-Ascorbic) so it is recommended to be consumed as an antioxidant in the "herbal medicine" form. Consuming turmeric crude extract expected can suppress the production of ROS inside the body (A'yunin et al., 2019; Suena et al., 2021; Suprihatin et al., 2020). The antioxidant ability of Turmeric extract came from the Curcumin pigments (and its isomers) also from the phytochemicals contained in Turmeric (showed in Table 4) (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). Those phytochemicals are also categorized into "strong levels" of antioxidants (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). The pigments and phytochemical compounds in Turmeric extract can dampen the ROS reaction by donoring the proton (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017(. After the proton bonds with the ROS, the ROS becomes stable chemically. After the ROS stabilized the reactive levels decreased. The pigments and phytochemicals in Turmeric extracts can donate proton because the Organic Chemicals (including Curcumin from Turmeric extracts) are mostly good proton donors which mean Curcumin can donate its protons without experiencing proton deficiency (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). The Curcumin will still be stable chemically after donating a proton to the ROS (Bozkurt & Sanlier, 2015; Hewlings et al., 2017; Kocaadam & Sanlier, 2017). In the case of Table 5, the IC_{50} showed a small amount with 0,04-1,7%, which means that this IC was the minimum IC to inhibit radicals, simply described as from the total extract 100% of Turmeric, only need 0,04-1,7% from total concentrate to inhibit the radical oxygen or free radical depend on the solvents used to extract the Turmeric. Lower (or smaller) IC means the stronger antioxidant ability of Turmeric extract (Setyowati & Suryani, 2013). Besides being applied as an antioxidant in medical cases, in

Indonesia Turmeric and its extracts are also used as an antibiotic (Pratiwi & Wardaniati, 2022; Septiana & Simanjuntak, 2015), the local wisdom teaching (indirectly) the application of Turmeric extract can manage the infection of bacteria in oral and respiratory system also in digestive systems (Pratiwi & Wardaniati, 2022; Septiana & Simanjuntak, 2015). This local wisdom needs to be proven by measuring antibacterial effects, the results of antibacterial measurements are shown in Tables 6 and 7.

Table 6. Antibacterial assay of turmeric extracts against oral and respiratory batteries

Extracts		Oral Batteries		Respiratory Batteries	
Fraction	Solvents	*L. acydophylus* (mm)	*S. mutans* (mm)	*N. asteroides* (mm)	*N. erythropolys* (mm)
Universal	Water / Aquades	24,64 ± 0,1835	17,17 ± 0,0822	15,47 ± 0,2333	12,73 ± 0,3383
Polar	Methanol	25,43 ± 0,2333	25,07 ± 0,0667	24,77 ± 0,1453	21,73 ± 0,1202
	Etanol	25,93 ± 0,0882	25,00 ± 0,0000	25,10 ± 0,1000	22,07 ± 0,2186
	Acetic Acid	26,10 ± 0,1528	24,97 ± 0,0333	25,90 ± 0,0577	23,77 ± 0,1453
	Ethyl Acetate	26,13 ± 0,1202	24,97 ± 0,0882	26,00 ± 0,0577	24,10 ± 0,1000
Semi Polar	Acetone	26,20 ± 0,1528	24,90 ± 0,0577	26,00 ± 0,1155	25,03 ± 0,1764
	Acetonitrile	25,07 ± 0,2603	20,17 ± 0,1209	20,03 ± 0,2186	19,57 ± 0,1202
	Chloroform	23,90 ± 0,0577	21,10 ± 0,1000	20,07 ± 0,0882	19,70 ± 0,2000
Non Polar	n-Hexane	24,30 ± 0,2082	25,03 ± 0,2603	25,17 ± 0,1453	24,77 ± 0,1764
	Eter	23,67 ± 0,1856	21,10 ± 0,2082	19,97 ± 0,0333	17,27 ± 0,1453
Control (+) Standard Antibacterials	Tetracycline	26,47 ± 0,0333	25,10 ± 0,0577	26,00 ± 0,0000	25,07 ± 0,0667
	Streptomycin	26,50 ± 0,1155	25,00 ± 0,0000	25,97 ± 0,0333	24,87 ± 0,1333
	Erythromycin	25,00 ± 0,2082	24,90 ± 0,1528	26,03 ± 0,1202	25,97 ± 0,0882
	Clindamycin	25,90 ± 0,1155	25,80 ± 0,1528	26,10 ± 0,2646	25,93 ± 0,1202

One of the local wisdom from Indonesia teaches about the application of Turmeric crude extracts to manage the respiratory problems caused by bacteria causing "dry throat" sensation or heat (A'yunin et al., 2019; Hanggoro et al., 2020), this condition will trigger the activity of *S. mutans* bacteria and causing sprue in the month. These conditions are managed with herbal medicine made from Turmeric or Ginger (Hanggoro et al., 2020); Widyapuspa et al., 2020). Table 7 shows that the antibacterial effect of Turmeric extracts against oral and respiratory batteries belongs to the "Very Strong" effect and almost matches the standard antibacterial. If related to the data in Table 5, the Turmeric extracts produce strong antioxidant activity by donating protons, the process of donating protons causing acid conditions (Setyowati & Suryani, 2013). These acid conditions cause a side effect that the hydrolyzing of bacteria cell membranes, and the hydrolyzing of cell membranes causes the death of the batteries. Besides the hydrolysis, proton donors also cause another "way" of dead cells, the donated proton absorbed by the cells causes the abundance of H^+ inside the cells. The abundance of H ions causes the formation of H_2O_2 in the cells (Simanjuntak et al., 2021). The increase of H_2O_2 in the cells triggered the apoptosis mechanism because H_2O_2 was the signal of the beginning of apoptosis and killing the cells of bacteria (Gintu & Puspita, 2020; Septiana & Simanjuntak, 2015; Simanjuntak et al., 2021). Table 6 proved that the local wisdom matches with the antibacterial test results. In the same case shown in Table 7, the antibacterial activity against Digestive batteries has to strong effect.

Table 7. Antibacterial assay of turmeric extracts against digestive batteries

Sample		Inhibitory Area (mm) against Batteries:	
Fraction	Solvents	*E. colli*	*Bacillus*
Universal	Water / Aquades	17,93 ± 0,1764	20,47 ± 0,5239
Polar	Methanol	25,10 ± 0,0577	26,00 ± 0,1155
	Etanol	25,17 ± 0,0333	26,20 ± 0,0577
	Acetic Acid	25,77 ± 0,2186	26,33 ± 0,0882
	Ethyl Acetate	25,33 ± 0,1202	25,93 ± 0,0882
Semi Polar	Acetone	25,20 ± 0,1155	24,90 ± 0,1000
	Acetonitrile	23,97 ± 0,1856	25,03 ± 0,1333
	Chloroform	24,93 ± 0,0667	24,83 ± 0,1667
Non Polar	n-Hexane	24,57 ± 0,4096	24,33 ± 0,2186
	Eter	23,30 ± 0,1000	25,07 ± 0,0882
Control (+)	Tetracycline	26,07 ± 0,0667	25,93 ± 0,0667
Standard	Streptomycin	25,90 ± 0,2082	25,17 ± 0,1667
Antibacterials	Erythromycin	24,97 ± 0,1202	25,27 ± 0,2603
	Clindamycin	25,07 ± 0,1856	24,87 ± 0,1333

Another local wisdom from Indonesia also teaches about the application of Turmeric extract to manage the digestive problems caused by bacteria (Hanggoro et al., 2020; Septiana & Simanjuntak, 2015). Based on Table 7 shows that Turmeric extracts produce strong activity against bacteria that commonly cause digestive problems such as *E. coli* and *Bacillus sp* (Septiana & Simanjuntak, 2015). Tables 6 and 7 show that the Turmeric extracts are recommended to be applied as antibacterial agents to manage the respiratory and digestive problems caused by bacteria.

Besides traditional herbal medicine, the local wisdom also teaches about the application of Turmeric extract in cosmetics (Mutiana & Sopyan, 2018; Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022), but this methods also need to prove then the Turmeric extract was tested in the parameters of cosmetics. The results of the test showed in Table 8.

Table 8. Turmeric extract for skin application

Sample		SPF Protection		Inhibitory Area (mm) against Skin Bacteries		
Fraction	Solvents	SPF	Type of SPF	*P. acnes* (mm)	*S. epidermidis* (mm)	*S. aureus* (mm)
Universal	Water / Aquades	75,62	Ultra Protection	20,37 ± 0,1856	21,73 ± 0,5897	20,10 ± 0,1000
Polar	Methanol	71,80	Ultra Protec-tion	24,97 ± 0,2186	25,87 ± 0,3667	25,50 ± 0,2309

To be continued...

	Etanol	80,24	Ultra Protection	26,00 ± 0,1528	25,90 ± 0,2517	25,93 ± 0,1453
	Acetic Acid	46,92	Ultra Protection	26,03 ± 0,5696	26,50 ± 0,1528	26,13 ± 0,2333
	Ethyl Acetate	68,56	Ultra Protection	26,60 ± 0,2082	25,93 ± 0,1856	22,03 ± 0,1453
Semi Polar	Acetone	53,56	Ultra Protection	26,30 ± 0,2646	25,63 ± 0,3283	22,30 ± 0,5568
	Acetonitrile	56,86	Ultra Protection	26,40 ± 0,3215	26,20 ± 0,2517	23,03 ± 0,2848
	Chloroform	50,70	Ultra Protection	25,03 ± 0,0882	26,20 ± 0,2646	20,80 ± 0,1732
Non Polar	n-Hexane	52,34	Ultra Protection	26,07 ± 0,1764	26,23 ± 0,2333	25,70 ± 0,2082
	Eter	51,96	Ultra Protection	24,43 ± 0,5840	25,83 ± 0,1667	23,23 ± 0,3844
Control (+) Standard Anti bacteries	Tetracycline	-	-	26,03 ± 0,1856	26,50 ± 0,1155	25,93 ± 0,0667
	Streptomycin			25,53 ± 0,3180	25,93 ± 0,0667	25,07 ± 0,0667
	Erythromycin			24,87 ± 0,1333	25,97 ± 0,0333	24,97 ± 0,0333
	Clindamycin			25,43 ± 0,2963	26,27 ± 0,1764	25,30 ± 0,5033

The results of Table 8 showed that the Turmeric extracts producing Sun Protection Factor (SPF) in "Ultra Protection" levels also caused a strong antibacterial effect against skin bacteria. The SPF of Turmeric extracts is claimed to be protection because all of the extract produces an SPF of more than 30% (Karina et al., 2015). The SPF means the protection ability of Turmeric extracts against the burn of Radical Photon from the Sun (UV light) (Karina et al., 2015; Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022). The radical Photon can damage the skin during the lysis of skin tissues called sun burning then to inhibit the burning need the sunscreen ability called SPF to protect the skin (Karina et al., 2015; Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022). If related to antioxidant ability in Table 6, the data of Table 8 matched because the ROS inside the body and Radical Photon from outside have a similar way of damping it, the antioxidant showed strong levels and the SPF showed ultra protection (Karina et al., 2015; Mutiana & Sopyan, 2018; Suprihatin et al., 2020). On another side, the Turmeric extracts also cause strong antibacterial activity against skin bacteria, those 3 batteries mostly infect and cause skin damage like pimples (Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022; Erlinawati & Dewiyanti, 2018). The *P. acnes* bacteria decompose the Carbons from sweat, the decomposition happens in the porous skin (Imasari & Emasari, 2021; Pariury et al., 2021; Wardani et al., 2020). The side product of decomposition became substrates for *S. epidermidis* and *S. aureus* (Imasari & Emasari, 2021; Wardani et al., 2020). The activity of those 3 bacteries causing infection showed by pimples (Imasari & Emasari, 2021; Pariury et al., 2021; Wardani et al., 2020).. And the infection needs to manage (Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022; Erlinawati & Dewiyanti, 2018). when initiated to apply the (crude) extracts of Turmeric the consumers will get 2 benefits SPF protection and the antibacterial effect (Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022). But not like the application in medical herbal, the application of Turmeric in cosmetics still exist in the daily culture of the young generation because many products of modern cosmetics promote the application of Turmeric extract as an active compound in product formulation like Turmeric Lotions, Turmeric Soap, etc (Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022). so the applications of Turmeric in cosmetics are still famous among teenagers, especially girls (Megayanti & Wrasiati, 2021; Raihanna et al., 2023; Azizah & Marwiyah, 2022; Erlinawati & Dewiyanti, 2018). Based on the cultural case and the research results of applications of Turmeric then recommended that the application of turmeric as an active (main) compound in herbal medicine and cosmetic formulation.

Conclusion

1. Turmeric extract in this research contains high phytochemical compounds contributing to its antioxidant activity showed belongs to the strong range.
2. The phytochemicals contained in Turmeric extract also contribute the high antibacterial activity because those phytochemicals also rule as natural antibacterial agents.
3. In the skin application, the phytochemicals contained in Turmeric extract cause SPF in high range activity and strong antibacterial effect on the skin bacteria.

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