

Effect of Pressurized Blanching Time on Antioxidation Properties of *Curcuma xanthorrhiza* Roxb. Powder with Various Solvents

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ABSTRACT

Javanese turmeric (JT) or *Curcuma xanthorrhiza* Roxb. is rhizome possessing bioactive components such as curcuminoids and xanthorrhizol that are soluble in various solvents. Therefore, this study aimed to evaluate the antioxidation properties of JT extract with various solvents for extraction. The method used was a Completely Randomized Design (CRD), with variations of pressure blanching time (0, 2.5, 5; 7.5, and 10 minutes) and solvents (80% methanol, 80% ethanol, and 80% acetone). Antioxidation properties were determined comprising antioxidant activity (DPPH (2,2-diphenyl-1-picrylhydrazyl) and FRAP (Ferric Reducing Antioxidant Power), phenol, flavonoid, β -carotene, curcumin, and tannin. The results showed that at a pressurized blanching time of 5 minutes, JT extract had the highest antioxidant activity. By using DPPH and FRAP methods with 57.31% RSA and 7.91 mg Ferro E/g, the highest antioxidant activity was also obtained in 80% ethanol solvent. Furthermore, phenol, flavonoid, β -carotene, tannin, and curcumin contents were 48.70 mg GAE/g, 7.28 mg QE/g, 243.83 μ g/g, 2.44 ppm and 1.81%, respectively. This study showed that JT subjected to pressurized blanching had higher antioxidant activity than the fresh sample.

Keywords: Antioxidant activity; curcumin; pressurized blanching; solvent for extraction

INTRODUCTION

Consumption of herbal products is experiencing a significant increase since the COVID-19 pandemic. The preference for herbal products is based on the perception that herbs are safer than synthetic materials with adverse side effects. One major factor contributing to the shift is the increasing awareness of oxidative stress, which plays a role in the development of cancer,

cardiovascular, and neurodegenerative diseases. Among the widely distributed herbs, javanese turmeric (JT) or *Curcuma xanthorrhiza* Roxb. is used in medicine because its rhizome is easily found in tropical areas such as Indonesia and the price is affordable. Many people routinely consume JT to maintain a healthy body. Previous studies showed that people who had not consumed herbs often felt unhealthy and unfit (Mahawikan et al., 2022).

Indonesia has many indigenous medicinal herbs and spices, including JT, a rhizome-junction with pharmacological activities and antibacterial potential (Rahman et al., 2022). JT belongs to the *Zingiberaceae* family and is widely found in the tropics (Rahmat et al., 2021). The part of JT that is commonly used is rhizome, which contains curcuminoids and xanthorrhizol with various health benefits. The benefits of curcumin, besides being antibacterial, are antidiplidemia, antioxidant, antiviral, anti-inflammatory, antifungal, and hepatoprotective (Vikri et al., 2022). Curcumin extract of JT encapsulated in water in oil (w/o/w) nanoemulsion was most stable with oil phase separation of at least 5% consisting of w/o emulsion (15%) and Tween 80 (1.5%) (Harimurti et al., 2021). During JT production process, there is often a decrease in antioxidant levels. This phenomenon can be addressed by retaining bioactive compounds through the selection of solvent which depends on the compound's polarity. Different solvents have various abilities in dissolving and extracting bioactive compounds. Therefore, using a suitable solvent is crucial to ensure the effectiveness of extraction process.

A potential method that can further antioxidant activity of food ingredients is blanching. Moreover, blanching has the potential to increase the antioxidant activity of food ingredients. The level of antioxidant activity during the blanching process is determined by the type of antioxidant and phenolic components in the ingredients (Kaseke et al., 2020; Magangana et al., 2021). Blanching can be done in three ways: namely boiling, steam, and vacuum (Wang et al., 2021). Pressure blanching is a vacuum blanching process using an autoclave. In previous research, pressure blanching was shown to reduce blood levels of MDA, total cholesterol, LDL, and triglycerides and increase levels of SOD, Vitamin E, and HDL in white turmeric. The ideal white turmeric blanching, using a temperature of 120 °C for 7.5 min, is equivalent to a pressure of 28.81 psia (Pujimulyani et al., 2020). Blanching can effectively overcome the decline in antioxidant levels during the JT powder production process. This study used the pressurized blanching method because this treatment has never been done on JT.

Extraction is the process of separating bioactive compounds from a natural material matrix using a specific solvent. Several extraction methods have been identified including conventional solvent, Soxhlet, microwave, ultrasonic, and liquid-liquid. Each method has its advantages and is selected based on the nature of the bioactive compounds and the characteristics of the natural material. Selecting extraction methods is based on solvents such as methanol, ethanol, and acetone

due to suitability for different bioactive compounds regarding polarity and solubility. Physical and chemical properties are factors that affect extraction process, including solvent, extraction time, and temperature, as well as the ratio of material to solvent. To ensure maximum yield and purity of bioactive compounds, these factors should be enhanced for producing high-quality herbal products. Yasacaxena et al. (2023) stated that using the maceration method is the best extraction process for JT rhizome. Extraction with ethanol solvent also created a 12 mm inhibition zone against pyogenic bacteria, showing antibacterial properties (Ulfah, 2021). By using 95% ethanol solvent, curcuminoid content was obtained to be 16.07 mg CE/g extract, which was more active against *Propionibacterium acne* bacteria (Marliani et al., 2021). Furthermore, 144.126 ppm of antioxidant content was found in JT instant powder extracted with ethanol solvent (Sholikhah et al., 2023).

Secondary metabolites have been extracted using methanol solvent because of the ability to dissolve polar and non-polar compounds. It has also been used to extract red galangal and ginger, which show antimicrobial properties (Nugraha et al., 2021). Furthermore, red ginger rhizome extracted with methanol showed a high activity value of 10.35 µg/mL (Munadi, 2020). *Curcuma longa* L. extracted using microwave-assisted extraction (MAE) method showed a yield of 66.86% and contained alkaloid compounds (Luviana et al., 2023).

Acetone can dissolve polar and semi-polar compounds. The carboxyl group causes acetone to be used as a suitable solvent. The yield of turmeric extract using the sonication extraction method with acetone solvent was 26.44% (Haryani et al., 2021). The results of research by Lezoul et al. (2020) show that acetone is the best extraction solvent, with an average extraction yield of *Passiflora* (20.43%), *Physalis* (20.95%), and *Solanum muricatum* (20.01%).

The antioxidative properties of *Curcuma mangga* Val. were most significant in samples with ethanol solvent and the smallest antioxidative properties in acetone solvent. Antioxidant values are well extracted in methanol, ethanol, and acetone solvents. This results in *Curcuma mangga* extract with ethanol solvent and methanol solvent having the ability to inhibit the oxidation. *Curcuma mangga* contains curcuminoids which have the ability to inhibit oxidation (Pujimulyani, 2006).

The use of 80% methanol, 80% ethanol, and 80% acetone solvents is based on previous research that using these three types of solvents can attract more polyphenol content in tea (Paramita et al., 2020). Previous studies have shown that the 80% methanol extract of propolis has excellent potential as an effective

adjunct therapy for the treatment of periodontal disease (Lisbona-González et al., 2021). However, 80% methanol, 80% ethanol, and 80% acetone have not been used for JT extraction. This shows the need for antioxidant analyses of DPPH (2,2-diphenyl-1-picrylhydrazyl) and FRAP (Ferric Reducing Antioxidant Power), flavonoid, phenol, β -carotene, curcumin, and tannin to determine the antioxidation properties of the various solvents used for analysis.

Various solvents with the right concentration are needed to obtain an optimal JT extract because each bioactive compound's chemical properties and polarity differ. Based on this description, the antioxidation properties of JT extract with various solvent pressure blanching time treatments were investigated. Therefore, this study aimed to determine the effect of pressurized blanching time and various extraction solvents on the antioxidation properties of JT powder.

METHODS

Materials

The main ingredient was JT rhizome in fresh condition and a dark yellow color aged 8-11 months obtained from CV Windra Mekar, Sedayu, Bantul. Chemicals used for analysis included pure ethanol pro analysis (Merck, 96%), BHT (2[6]-Di-tert-Butyl-P-cresol, Sigma), DPPH solution (Sigma-Aldric) 0.1 mM, pure Folin-cioalteau (Merck), Na_2CO_3 (Merck, 20%), NaNO_2 (Merck, 10%), $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ (Merck, 10%) NaOH (Merck, 10%), TPTZ (Tris Pyridyl Triazine) (Merck), HCl (Merck) $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ (Merck), methanol (Merck), ethanol (Merck), acetone (Merck), and petroleum benzine (Merck). The leading equipment used is micropipette (Acura 825 autoclavable, Germany), analytical balance (Ohaus Pioneer PA214, USA), vortex (Maxi Mix II type 37600, Germany), centrifuge (Ohaus, USA), and UV-Vis spectrophotometer (Genesys, USA).

Preparation of JT Powder

The main stage of making JT powder is the sorting process to separate damaged samples and obtain quality JT rhizome. Subsequently, JT rhizome is peeled, washed, and drained to dry. JT rhizome is blanched using the pressurized blasting method using distilled water at 120°C. In this blanching process, the treatments used are variations in blanching time namely 0, 2.5, 5, 7.5, and 10 minutes. The pressurized blanching method is based on studies by Pujimulyani et al. (2020) on *Curcuma mangga* Val.

Samples of JT rhizome were sliced to a thickness of 1-2 mm to facilitate drying and grinding. A cabinet dryer at 50-55°C was used for drying for 8 hours reducing

water content to 10-12%. JT rhizome was ground and sieved using a 60 mesh sieve. The powder form was analyzed using the maceration method with 80% methanol, 80% ethanol, and 80% acetone.

Sample Extraction for Chemical Analysis

Maceration method by Siahaan et al. (2021) was used for JT rhizome extraction, with modifications in time and solvent. Initially, 1 g dried JT was added with 10 mL of 80% methanol, 80% ethanol, and 80% acetone, followed by vortexing to incubate for 18 hours. The results were filtered for chemical analysis, such as antioxidant activity (DPPH and FRAP), β -carotene, curcumin, phenol, flavonoid, and tannin.

Antioxidant Activity Analysis of DPPH Method

To measure DPPH free radical capture capacity, 0.2 mL of the sample was added to 3.8 mL of 0.1 mM DPPH solution. This is followed by vortexing for a minute and incubating for 30 minutes in a dark room at a room temperature of 27°C. UV-Vis spectrophotometer was used for absorbance determination at λ 517 nm—the blank used ethanol (Xu & Chang, 2008). DPPH count was calculated using Equation 1.

$$\% \text{ RSA (Radical Scavenging Activity)} = 1 - \frac{\text{Absorbance of sample}}{\text{Absorbance of control}} \times 100\% \quad (1)$$

Antioxidant Analysis of FRAP

FRAP reagent of 3 mL was heated at 37°C for 10 minutes, added with 100 μl of sample and 300 μl of distilled water homogenized for a minute, and left for 4 minutes. The absorbance was measured at λ 593 nm with UV-Vis Spectrophotometer. Fe^{2+} calibration curve (4.3-137.5 mg/L) and $r=0.99$, FRAP value was estimated by calculating mg Ferro E/g (mg Ferro equivalent) per g of dry extract (de Faria Cardoso et al., 2023).

Total Phenolic Analysis by Folin-Cioalteau Method

A total of 50 μl JT extract sample was added to 250 μl Folin-Cioalteau solution and allowed to stand for a minute. Subsequently, 750 μl NaCO_3 20% was added, vortexed for a minute, and distilled water was added to a volume of 5 mL. After incubating it for 2 hours at room temperature (27°C), the absorbance was measured at λ 760 nm with UV-Vis Spectrophotometer (Pujimulyani et al., 2010a).

Flavonoid Analysis

A 50 μl of JT extract was added with 4 mL of distilled water and 0.3 mL of 10% NaNO_2 . After standing for 6 minutes, the mixture was added 0.3 mL $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ 10%, allowed to stand for 5 minutes, then 4 mL NaOH

10%. The mixture was added with distilled water up to 10 mL, vortexed for a minute, and left for 15 minutes. The absorbance was measured at λ 510 nm with UV-Vis Spectrophotometer and the blank was distilled water. Quercetin standard was used, and the total flavonoid content can be calculated as mg Quercetin Equivalent (QE)/g (Dewanto et al., 2002).

β -carotene analysis

β -carotene analysis was performed using the method by (Nielsen, 1995) with slight modification of total homogenization time of 10 minutes on JT extract sample. Approximately 1 g of sample was put into a large test tube and 5 mL of 95% ethanol was added and homogenized. A total of 20 mL of petroleum benzene was homogenized, and separated into precipitate, and solution using a separatory funnel. Subsequently, 1 mL of the yellow solution layer containing β -carotene was put into a small test tube with a lid. The sample in the test tube was separated with a separatory funnel. Then 1 mL of the yellow solution layer containing β -carotene was taken and put into a sealed test tube. The sample was added 3 mL petroleum benzene and vortexed. The homogenized sample was then assayed with a UV-Vis spectrophotometer and the absorbance of the β -carotene standard at a wavelength of 450 nm.

Curcumin Analysis

A total of 1 g of sample was collected and added with 80% methanol, 80% ethanol, and 80% acetone solvents as much as 10 mL separately. The mixing process was done with a vortex for 1 minute, followed by incubation for 18 hours. Next, the mixture was filtered with filter paper and sonication was performed for 10 minutes. The mixture was allowed to stand for 1 hour and vortexed for 30 seconds. The mixture was centrifuged at 8000 rpm for 15 minutes using a

centrifugation (Heraeus Biofuge 15). The absorbance of the sample was measured using a spectrophotometer with λ 431 nm Sujarwo et al. (2015) with modifications. The modification used in this study was sonication for 10 minutes and solvent.

Condensed Tannin Analysis

Condensed tannin content was performed by adding 50 μ l of sample with 3 mL of 4% methanol-vanillin, 1.5 mL of concentrated HCl, and vortexed for 2 min, followed by measuring at λ 500 nm using UV-VIS spectrophotometer. Furthermore, condensed tannin was calculated as mg Catechin equivalent (CE)/g dry basis with a calibration curve (8.9-44.4 mg/L) with $r=0.99$ (Xu & Chang, 2007).

Statistical Analysis

This study used Completely Randomized Design (CRD), namely variations in the length of time of pressurized blanching (0; 2.5; 5; 7.5; and 10 minutes) and solvents (80% methanol, 80% ethanol, and 80% acetone) with two replication. The analysis results were calculated using One Way Analysis of Variance (ANOVA) when a significant difference was followed by Duncan Multiple Range Test (DMRT) with significant levels of 95%.

RESULTS AND DISCUSSION

Antioxidant Activity of DPPH Method

Antioxidant activity of JT powder with variations of pressurized blanching time and solvent type is presented in Table 1.

Based on Table 1, antioxidant activity of JT powder with blanching preparation was significantly higher than non-blanching or fresh. Similarly, Pujimulyani et al. (2010) reported that *Curcuma mangga* possessed

Table 1. Antioxidant activity of JT powder from pressurized blanching time with 3 solvent extraction

Pressurized blanching time (minutes)	Antioxidant value of DPPH (% RSA)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	49.25 \pm 0.26 ^a	53.01 \pm 0.06 ^{bc}	52.53 \pm 0.27 ^b
2.5	53.86 \pm 0.33 ^{de}	55.89 \pm 0.13 ⁱ	54.89 \pm 0.11 ^{fgh}
5	56.98 \pm 0.84 ^j	57.31 \pm 0.57 ^j	57.22 \pm 0.13 ^j
7.5	54.24 \pm 0.19 ^{ef}	55.08 \pm 0.18 ^{gh}	55.25 \pm 0.27 ^{hi}
10	53.07 \pm 0.39 ^{bcd}	53.68 \pm 0.19 ^{cde}	54.38 \pm 0.50 ^{efg}

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

higher antioxidant activity with blanching preparation. In this study, JT powder with pressurized blanching treatment for 5 minutes in each solvent showed the highest antioxidant value. This increase was caused by high-temperature heating leading to a rise in phenol (Pujimulyani et al., 2010b). Although antioxidant activity ranged from 49.25-57.31% RSA, a decrease was observed following pressurized blanching preparation for more than 5 minutes. This was due to heating treatment that accelerated oxidation to varying degrees depending on the ingredients (Amanto et al., 2020). Previous studies stated that the % RSA value of temu mangga under blanching at 100°C, 0.05% citric acid media, and distilled water for 5 and 10 minutes showed higher antioxidant activity than white saffron as control (Pujimulyani et al., 2010b).

JT antioxidant activity is influenced by bioactive compounds such as phenol, tannin, flavonoid, and β -carotene. Prasetya et al. (2020) obtained higher antioxidant capacity of cocoa bean skin due to the polyphenol content. Because of oxygen, light, heat, and drying, there can be variation in antioxidant levels (Hikmah et al., 2022). Therefore, antioxidant activity of JT extract in cabinet dryer is important due to high polyphenol and flavonoid content. Sudirman et al. (2022) stated that high content of polyphenol and flavonoid in *apu-apu* (*Pistia stratiotes*) leaves caused oven drying to have an elevated antioxidant activity value than sun drying.

Compared to others, 80% ethanol is a polar solvent capable of producing high antioxidant values. The blanching results for 5 minutes showed antioxidant activity values that were not significantly different in each solvent. It is suspected that the polar phenolic components are more dissolved in samples pressurized using blanching preparation for 5 minutes. Previous studies stated that polar protic solvents provided better extraction results, with hydro-ethanol achieving

significantly higher values. Furthermore, 80% ethanol is a suitable solvent to optimize extraction results in strict fruit compared to methanol and acetone solvents (El Mannoubi, 2023).

Antioxidant Activity of FRAP Method

Antioxidant activity of FRAP of JT powder with a variation of pressurized blanching time and solvent type is presented in Table 2.

Table 2 shows that JT powder from pressurized blanching increased compared to non-blanching. Antioxidant activity of JT powder by solvent extraction ranged from 4.79 to 7.91 mg Ferro E/g and was significantly different. The highest antioxidant activity was shown in JT extract with 5 min blanching. Extraction of JT with 80% ethanol solvent showed antioxidant activity of 7.91 mg Ferro E/g which was the highest result. Based on previous studies, JT powder that was boiled for 5 min and processed into snack bars had FRAP antioxidant activity of 5.15 mg Ferro E/g (Saputra et al., 2023). This difference is likely due to the variation in method, namely hot water and pressurized blanching. FRAP antioxidant content of turmeric rhizome processed into sticks is 7.06 μ g/g (Andriyani et al., 2023). *Rhizopora stylosa* ethanol extract has FRAP antioxidant activity of 24.64 mg AAE/g (Raharjo et al., 2022). The difference in results is due to variations in materials and extraction methods. Similar to DPPH results, FRAP antioxidant activity showed the highest values in JT powder extracted with 80% ethanol solvent after pressurized blanching for 5 minutes. The comparison of DPPH and FRAP results showed consistency in the trend that ethanol solvent and pressurized blanching for 5 minutes obtained the highest antioxidant activities.

Total Phenolic Content

Total phenolic was analyzed to understand the correlation between phenolic content and antioxidants.

Table 2. FRAP antioxidant levels of JT powder from pressurized blanching with 3 solvent extraction

Pressurized blanching time (minutes)	Antioxidant activity of FRAP (mg Ferro E/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	4.79±0.28 ^a	4.88±0.18 ^a	5.07±0.02 ^{ab}
2.5	6.53±0.00 ^{ef}	7.34±0.06 ^g	5.48±0.02 ^c
5	7.63±0.26 ^h	7.91±0.03 ⁱ	5.99±0.00 ^d
7.5	7.10±0.12 ^g	6.78±0.27 ^f	5.33±0.037 ^{bc}
10	6.63±0.15 ^{ef}	6.40±0.09 ^e	5.16±0.05 ^b

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

Table 3. Total phenolic content of JT powder from pressurized blanching with 3 solvent extraction

Pressurized blanching (minutes)	Total phenolic content (mg GAE/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	32.87±0.28 ^a	32.28±0.69 ^a	34.84±0.42 ^b
2.5	37.53±0.73 ^{cd}	36.94±0.39 ^c	38.55±0.08 ^d
5	44.11±0.36 ^{ef}	46.80±1.10 ^g	48.70±0.27 ^h
7.5	33.69±0.87 ^{ab}	42.74±0.92 ^e	44.55±0.36 ^f
10	33.78±1.30 ^{ab}	36.48±0.14 ^c	36.89±0.63 ^c

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

The higher the antioxidant activity, the higher the phenolic content. Total phenolic content of JT powder with variations in launch time and solvent type is presented in Table 3.

Based on Table 3, total phenolic content of JT powder from the preparation of pressurized blanching variation of time and solvent showed a significant difference with value ranging from 32.87-48.70 mg GAE/g. Total phenolic content of pressurized blanching JT extract with a cabinet dryer increased compared to non-blanching JT extract. The pressurized blanching process is assumed to break down complex phenol compounds into simple forms that do not undergo enzymatic oxidation, thereby preventing a decrease in value. Blanching can inactivate enzymes in the material to optimize the extraction (Pujimulyani et al., 2010a). The highest total phenolic content was found in JT powder from 5 minutes of blanching and showed a significant difference between each solvent. JT extract with 80% acetone solvent showed the highest value of 48.70 mg GAE/g b/w. This shows that in every gram of ethanol extract of JT powder, there are phenolic compounds equivalent to gallic acid. Pressure blanching for 5 minutes and extraction using polar solvents such as acetone and ethanol are effective ways to maximize the extraction of phenolic compounds, thereby increasing antioxidant potential of JT powder.

Total phenolic significantly affects antioxidant activity because phenol compounds have hydrogen donors and are antioxidants. A positive correlation between antioxidant activity and total phenolic occurs due to the presence of hydrogen donors in effective phenol compounds. Therefore, total phenolic content positively correlates with antioxidant activity and vice versa (Dwiloka et al., 2020). Total phenolic content in JT powder significantly influences its antioxidant activity due to phenolic compounds acting as hydrogen

donors and effective antioxidants. The levels of phenolic compounds in each solvent are different, presumably because the phenol extraction results are also different. According to Mulyanita (2019), the solubility of phenol compounds depends on the structure of the compounds, showing their availability in polar extracts. Cabinet dryer samples on fresh chrysanthemum flowers have the highest total phenolic content of 15.99%, which is the lowest compared to other samples due to storage factors (Hartanto et al., 2021).

Flavonoid Content

Flavonoid is a class of bioactive compounds known for their powerful antioxidant properties. The compound acts as free radical scavengers and is essential in reducing oxidative stress in the body. Flavonoid content of JT powder with variations of pressurized blanching time and solvent type is presented in Table 4.

Table 4 shows that the results of pressurized blanching JT powder and solvent variation differ significantly. The results of flavonoid content ranged from 5.05-7.28 mg QE/g. Flavonoid content of JT blanching extract up to 5 minutes showed an increase compared to fresh JT. The highest flavonoid levels were found in JT extracts with the results of 5 minutes of pressurized blanching in the 80% acetone solvent extraction treatment. Previous studies showed that turmeric had the highest flavonoid content value for 80% acetone extraction (Sepahpour et al., 2018). Flavonoid value of each extract is significantly different due to the solubility of the solvent. Based on these results, 80% acetone solvent is the best solvent for producing flavonoid content due to the potential to extract polar flavonoid compounds.

Flavonoid protects lipophilic antioxidants to increase cellular types (Susiloningrum & Sari, 2021). The results of this study differ from the report by

Table 4. Flavonoid content of JT powder from pressurized blanching with 3 solvent extraction

Pressurized blanching time (minutes)	Flavonoid content (mg QE/g)		
	Methanol 80%	Ethanol 80%	Aceton 80%
0	5.91±0,07 ^d	5.05±0.08 ^a	5.55±0.09 ^c
2.5	6.32±0,02 ^f	6.00±0.22 ^d	6.08±0.08 ^{de}
5	6.41±0,09 ^f	6.41±0.09 ^f	7.28±0.17 ^h
7.5	6.06±0,04 ^{de}	6.08±0.23 ^{de}	7.06±0.07 ^g
10	5.60±0,03 ^c	5.32±0.07 ^b	6.26±0.03 ^{ef}

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

Mubarokah & Kusumaningtyas (2023), where the levels of red galangal ethanol extract have fewer flavonoid in 96% methanol extract. The principle of total flavonoid content is that, $AlCl_3$ forms acid-stable complex compounds with ketone and flavonoid hydroxyl groups binding to curcuminoids through β -diketone groups (Sepahpour et al., 2018).

β -carotene Content

β -carotene content of JT powder with variations in pressurized blanching time and solvent type is presented in Table 5.

β -carotene is a compound that contains antioxidants and has great benefits for health (Mustikaningrum & Johar, 2023). Based on Table 5, β -carotene content of JT extracts from various solvents showed a significant difference. β -carotene content of blanched JT showed an increase compared to fresh JT. The highest β -carotene content was found in JT powder treated with pressurized blanching for 7.5 minutes but not significantly different from the 5-minute blanching treatment. This is probably because the carotenoids in

JT that underwent blanching for 5 minutes had not been damaged during the drying process. However, at 60°C, carotenoids showed no damage to heating (Mustofa & Wulandari, 2020). Highest results were found in JT extract using acetone solvent with β -carotene levels of 269.39 μ g/g but not significantly different from methanol. Cvitković et al. (2021) stated that drying temperatures below 60°C positively affected the carotenoid content in the extract. The results showed that higher polarity of acetone caused greater extraction of JT β -carotene. Materials and heating can influence fluctuations in β -carotene levels (Saeroji et al., 2023). Based on the results, β -carotene content of JT from pressurized blanching at 7.5 minutes tended to increase. However, longer drying process will reduce β -carotene levels, as reported by Ihns et al. (2011). As a natural pigment in the carotenoid group found in fruits, vegetables, and plants, β -carotene has strong antioxidant properties as a precursor to vitamin A. It protects cells from oxidative damage by capturing free radicals in the body, thereby preventing cancer and heart diseases.

Table 5. β -carotene content of JT powder from pressurized blanching with 3 solvent extraction

Pressurized blanching time (minutes)	β -carotene content (μ g/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	209.72±0.36 ^a	219.52±11.15 ^{ab}	219.17±11.08 ^{ab}
2.5	215.13±3.06 ^a	232.69±2.04 ^{cd}	234.19±6.12 ^{cd}
5	237.17±3.56 ^{cd}	243.83±1.02 ^d	277.55±1.77 ^{bc}
7.5	227.20±2.79 ^d	243.35±1.18 ^d	269.39±1.02 ^{ef}
10	217.45±1.48 ^{ab}	236.31±1.53 ^{cd}	264.92 6.39 ^e

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

Table 6. Curcumin content of JT powder from pressurized blanching with 3 solvent extraction

Pressurized blanching time (minutes)	Curcumin content (%)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	1.81±0.00 ⁱ	1.27±0.00 ⁱ	1.81±0.00 ⁱ
2.5	1.44±0.00 ^j	1.11±0.00 ^g	1.54±0.00 ^k
5	1.24±0.00 ^h	1.00±0.00 ^d	1.11±0.00 ^f
7.5	1.14±0.04 ^g	0.95±0.03 ^c	1.03±0.00 ^d
10	1.05±0.02 ^e	0.73±0.01 ^a	0.92±0.00 ^b

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

Table 7. The condensed tannin content of JT powder from pressurized blanching with 3 solvent extraction

Pressurized blanching time (minutes)	Condensed tannin content (ppm)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	1.52±0.00 ^a	1.54±0.02 ^a	1.74±0.08 ^b
2.5	2.01±0.00 ^d	2.01±0.00 ^d	2.14±0.00 ^e
5	2.49±0.00 ^f	2.44±0.00 ^f	2.58±0.00 ^g
7.5	2.00±0.00 ^d	2.01±0.01 ^d	2.02±0.19 ^d
10	1.81±0.00 ^{bc}	1.84±0.00 ^{bc}	1.85±0.01 ^c

Description: Numbers followed by different letters in columns and rows indicate significant differences at the 95% significance level.

Curcumin Content

Analysis of curcumin analysis is essential because it is the main active compound in JT with potent antioxidant properties. This compound protects the cells from oxidative damage by capturing free radicals and increasing body antioxidant system. The curcumin content of JT powder with variations of pressurized blanching time and solvent type is presented in Table 6.

Curcumin content of JT with variations in pressurized blanching time and 3 solvent extraction ranged from 0.73-1.81%, showing a significant difference between fresh and blanching JT. The results in previous studies showed that North Sulawesi local white JT powder contained curcumin in a sample with a weight of 0.10 g at a sample spotting volume of 20 µl, equivalent to 2040 nanograms. The curcumin levels were <0.10 nanograms/mg (Demmassabu et al., 2023). High-Performance Liquid Chromatography - Diode Array Detector - Electrospray Ionization Mass Spectrometry (HPLC-DAD-ESIMS) analysis showed

that JT contained curcumin, demethoxycurcumin, and bisdemethoxycurcumin (Ruslay et al., 2007). Curcumin consists of phytopharmaceuticals that protect the liver, antioxidants, and anti-inflammatory. The content of curcumin in turmeric has a protective effect on the histological picture of the kidneys of male Sprague Dawley rats induced with cooking oil (Liani, 2023). The data showed that longer blanching time caused a decrease in the curcumin content of JT due to the inability to resist heat. Therefore, the highest curcumin content results were obtained in fresh samples. Silvia et al. (2023) stated that curcumin in turmeric had poor resistance to heat and light. Curcumin is easily decomposed when heated and during cooking, such as boiling and roasting (Sun et al., 2021). JT powder with 80% methanol extraction showed the highest results compared to others. This is because methanol solvent is the most polar solvent compared to others. Meanwhile, the curcumin content of JT powder with ethanol solvent 3 produced the lowest value, causing less light for the solution to absorb (Syarifah et al., 2023).

Condensed Tannin Content

Tannin is a water-soluble polyphenolic compound that can precipitate proteins. The compound has a distinctive bitter or astringent flavor and is often found in many plants, including tea, wine, and fruits. Tannin content of JT powder with variations in pressurized blanching time and solvent type is presented in Table 7.

The effectiveness of compound extraction by a solvent largely depends on how soluble the compound is in the solvent and polarity of methanol, ethanol, and acetone. Table 7 shows that tannin value of JT with the 3 solvent extraction is significantly different, ranging from 1.52 to 2.58 ppm. This proves that JT contains tannin, which is polyphenol with a molecular weight of more than 1000 and can form complexes with proteins (Uday et al., 2022). The highest tannin content was obtained in acetone solvent. This is because tannin is more easily extracted using acetone solvent. The results of this study differ from previous reports, where tannin levels in coffee skin are higher using ethanol solvent than acetone (Kusumadewi et al., 2022). The volatile nature of the acetone solvent produced a more concentrated solution, which caused a higher tannin content of JT powder. Condensed tannin is more easily extracted because when blanching causes protein denaturation (Pujimulyani et al., 2010a). Optimal tannin levels were found in JT extract with a blanching time of 5 minutes, followed by a significant decrease because of the heat-resistant nature (Styawan et al., 2021). A blackish-green color indicates tannin levels in JT due to the addition of FeCl_3 (Shaleha & Daulay, 2023).

CONCLUSION

In conclusion, this study showed that JT extract had a high antioxidant value with a pressurized blanching time of 5 minutes. The antioxidant activity value of extraction results from high to low with acetone, ethanol, and methanol solvents, produced high antioxidation properties. By using DPPH and FRAP methods, the highest antioxidant activity with 80% ethanol showed 57.31% RSA and 7.91 mg Ferro E/g, respectively. Total phenolic and flavonoid contents were 48.70 mg GAE/g and 7.28 mg QE/g, while β -carotene, tannin, and curcumin had 243.83 $\mu\text{g/g}$, 2.44 ppm, and 1.81%, respectively.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in this study. This statement was made truthfully by the authors who are willing to face legal prosecution when found to be untrue.

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