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Preparation of *Curcuma xanthorrizha* Roxb. with pressure blanching on the antioxidant activity and preference level of cookies

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Abstract

Curcuma xanthorrizha Roxb. (CX) contains curcuminoids which are natural antioxidants to fight free radicals. Blanching can increase the antioxidant activity of a product. One blanching method is pressure blanching using an autoclave. The type of solvent determines the antioxidants extracted in a food. The purpose of this study was to determine the appropriate time to maintain the bioactive compounds in CX from the appropriate blanching for the preparation of cookies with the addition of CX powder. This study used a two factorial Completely Randomised Design (CRD), namely the length of time of pressure blanching (0, 2.5, 5, 7.5 and 10 min) and the type of solvent (80% methanol, 80% ethanol, and 80% acetone) for CX powder and the best results were used to make CX cookies with variation of selected CX powder (1.5, 3 and 4.5 g) and baking temperature (130, 140 and 150 °C). The results showed that CX powder with a pressure blanching time of 5 min had the highest antioxidant activity 2,2-diphenyl-1-picrylhidrazyl (DPPH), antioxidant activity Ferric Reducing Antioxidant Power (FRAP), total phenol content (TPC), flavonoids, β-carotene and condensed tannins. The addition of CX powder and variations in baking temperature had a significant effect on the chemical properties, and the preference level of the cookies produced. The selected cookies product is the addition of 1.5 g CX powder and baking temperature of 130 °C which has a moisture content of 3.17%, protein content of 10.81%, DPPH antioxidant activity of 32.10% RSA, TPC 9.08 mg GAE/g, and total flavonoids 0.61 mg QE/g.

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1. Introduction

Antioxidants are bioactive compounds that can prevent various diseases (1). There are two types of antioxidants: synthetic and natural. Synthetic antioxidants work better, but they are harmful to the body if used beyond recommended limits (2). *Curcuma longa* is a source of natural antioxidants containing curcuminoids that can function as anticancer, anti-inflammatory, and able to ward off free radicals (3). While *Curcuma longa* is widely recognized for its curcuminoids, *C. xanthorrhiza* contains xanthorrhizol, curcumin, and demethoxycurcumin with stronger antioxidant and hepatoprotective effects, making it a promising functional ingredient.

CX belongs to the tuber-producing *Zingiberaceae* family (4), which is easy to grow and is found in many tropical areas, especially in loose soil (5). CX rhizomes have long been used as herbal medicine, with yellowish rhizome flesh colour (6) with dark yellow flowers and

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clusters. Curcuminoids, alkaloids, flavonoids, terpenoids, glycosides, saponins, and essential oils (kamfer, borneol, xanthorrhizol, tumerol, and sineal) are the main components of CX rhizomes (7). Curcuminoids contain curcumin, which is yellow in color, and is an antibacterial, anticancer, antitumor, anti-inflammatory, antioxidant, hypocholesterolemic, and to regulate the immune system (8).

Blanching is a preliminary heating process that serves to inactivate enzymes, remove air from tissues, and kill microorganisms (9). Blanching has the potential to increase the antioxidant activity of food ingredients. The type of antioxidant and phenolic components in the ingredients determines the level of antioxidant activity during the blanching process (10,11).

Blanching can be done in three ways: namely hot water blanching, steaming, and vacuum-steam pulsed blanching (2). Pressure blanching using an autoclave allows enzyme inactivation under controlled high-pressure conditions. In previous research, pressure blanching was shown to reduce blood levels of MDA, total cholesterol, LDL, and triglycerides, increase levels of SOD, Vitamin E, and HDL. The ideal white turmeric blanching, using a temperature of 120 °C for 7.5 min, is equivalent to a pressure of 28.81 psia (12).

The type of antioxidant to be extracted determines the extraction method of a material. The type of solvent depends on the polarity of the extracted compound (13). Types of solvents include methanol, ethanol, and acetone. Methanol has OH groups, which function as hydrogen bond donors and acceptors. Methanol is a semi-polar solvent compared to (14) ethanol is a polar solvent with the alcohol class, easily dissolving organic compounds with medium polarity and easy to evaporates (15). Acetone is a simple ketone used to attract organic compounds and is a semi-polar solvent (16).

Cookies or pastries are one type of biscuit made from wet dough that is high in fat, relatively crunchy, and the cross-section of the cut has a solid texture when broken (17). In demand, it is necessary to increase the nutritional value of cookies. Given the public's demand for cookies, it is also necessary to increase the diversity of cookie products. Research related to cookies with the addition of CX has never been studied before.

Based on this description, this research aims to determine the optimal pressure blanching time to retain bioactive compounds in CX, enabling CX powder to be processed into finished products, such as cookies, when added to the batter. Therefore, this study is the first to evaluate the effect of pressure blanching time and solvent type on the antioxidant activity of *Curcuma xanthorrhiza* and its application in cookies, providing insight into optimizing CX as a functional ingredient.

2. Materials and Methods

2.1. Materials

2.1.1. CX Powder Making Materials

The main material was the main rhizome of 8-10 months CX obtained from CV Windra Mekar in Sedayu, Bantul.

2.1.2. Cookies Making Materials

The materials used in making cookies are arrowroot flour, wheat flour (Segitiga Biru), CX powder, butter (Blue Band), powdered sugar (Rose Brand), skim milk powder (Indoprima), baking powder (Koepoe-koepoe), vanilla (Koepoe-koepoe), eggs purchased at the market, and salt.

2.1.3. Chemicals

Chemicals used for analysis included distilled water, pure ethanol (Merck), BHT (2[6]-Di-tert-Butyl-P-cresol, Sigma), 0.1 mM DPPH (Sigma-Aldric), solution, pure Folin-Ciocalteu (Merck), Na_2CO_3 (Sodium Carbonate, Merck), $NaNO_2$ (Sodium Nitrite, Merck), $AlCl_3$, $6H_2O$ (Aluminium Chloride Hexahydrate, Merck) NaOH (Sodium Hydroxide, Merck), CH_3COOH (Acetic Acid, Glacial), CH_3COO-Na (Sodium Acetate, Merck), TPTZ (Tris Pyridyl Triazine, Merck), HCl (Hydrochloric Acid), $FeCl_3$, $6H_2O$ (Ferric chloride hexahydrate, Merck), methanol (Merck), ethanol (Merck), acetone (Merck), Whatman filter paper no. 42 and petroleum benzene.

2.2. Equipment

Equipment for making CX powder includes an autoclave, a knife, and a basin. Equipment used in the study included analytical scales (Ohaus Pioneer PA214), measuring cup (pyrex Iwaki), beaker glass (pyrex Iwaki), test tube (pyrex Iwaki), micropipette (Acura 825 autoclavable), volumetric flask (pyrex Iwaki), dropper, measuring pipette (pyrex Iwaki), spatula, stirring rod, funnel, filter paper, vortex (Maxi Mix II type 37600), separatory funnel, centrifuge and UV-Vis spectrophotometer (Genesys).

2.3. Methods

2.3.1. Preparation of CX Powder

The rhizomes must be cleaned, washed, drained, peeled, and sorted to produce CX powder. The rhizomes were treated with pressure blanching with an autoclave (12) using distilled water at 120 °C with a time variation of 0, 2.5, 5, 7.5 and 10 min. The CX rhizomes were reduced in size to accelerate the drying process because the surface became wider. The drying process was carried out under direct sunlight for 24 h. Next, the rhizomes were ground using a 60 mesh sieve for chemical analysis. Pressure blanching was carried out in an autoclave at 120 °C, corresponding to approximately 0.1 MPa (1 atm gauge pressure or 28.81 psia) based on previous reports (12). The blanching durations of 0–10 min were selected to evaluate enzyme inactivation and phenolic stability under pressure treatment.

2.3.2. The process of Making Cookies

The first step in making cookies is 40 g of powdered sugar, 15 g egg yolk, and 60 g of butter until pale in color with a medium speed mixer. Next step, CX powder (1.5, 3.0 and 4.5 g), 20 g skim milk powder, 1 g salt, 1 g vanilla, then 65 g arrowroot flour, and 35 g flour, and stirred until smooth with a spatula. Flatten the dough with a rolling pin and mold it using a cookie cutter, then put it in a baking tray lined with baking paper and bake it using an oven at temperatures (130, 140 and 150 ^oC) for 25 min. Cookies were produced using a 3 × 3 factorial design: three CX powder levels (1.5, 3.0, 4.5 g) and three baking temperatures (130, 140, 150 °C). A control cookie (0 g CX powder, baked at 140 °C) was prepared under identical conditions.

2.3.3. Sample Extraction for Chemical Analysis

CX powder was extracted using a modified maceration method (18). CX powder was weighed 1 g, and 10 ml of methanol, ethanol, and acetone solvents were added, each with a concentration of 80%, vortexed, and incubated for 18 h. The powder was then filtered and

subjected to chemical analyses such as DPPH and FRAP antioxidants, phenols, flavonoids, β-carotene, curcumin, and condensed tannins.

2.3.4. Antioxidant Activity Analysis of 2.2-diphenyl-1-picrylhydrazyl (DPPH) Method

A 0.2 ml sample was added to 3.8 ml of 0.1 mM DPPH solution, vortexed for a minute, and incubated at room temperature (27 °C) under conditions for 30 min. The absorbance was measured at λ 517 nm with a UV-Vis Spectrophotometer (Genesys). Blank using ethanol (19).

2.3.5. Ferric Reducing Antioxidant Power (FRAP) Antioxidant Analysis

A total of 3 ml FRAP reagent was heated at 37 °C for 10 min, 100 µl sample and 300 µl distilled water were added, then vortexed for a minute and left for 4 min. The absorbance was measured at λ 593 nm. FRAP was calculated as mg FE (Ferro Equivalent)/g (mg Ferro equivalent) per g of dry extract using the Fe^{2+} calibration curve (4.3-137.5 mg/L) with r = 0.99 (20).

2.3.6. Total Phenolic Content Analysis using Folin-Ciocalteu Method

A total of 50 µl CX extract sample, 250 µl Folin-Ciocalteu solution was added, then allowed to stand for a minute, and 750 µl Na_2CO_3 20%, vortexed, and distilled water to a volume of 5 ml. After that, it was incubated for 2 h at room temperature. The absorbance was measured at λ 760 nm (21).

2.3.7. Flavonoid Analysis

A total of 50 µl of CX extract sample was added with 4 ml of distilled water and 0.3 ml of 10% $NaNO_2$ let stand for 6 min. Add 0.3 ml $AlCl_3.6H_2O$ 10%, allowed to stand for 5 min, then add 4 ml NaOH 10%. The mixture was added with distilled water up to 10 ml, vortexed for a min, and left for 15 min. The absorbance was measured at λ 510 nm, and the blank was distilled water. Flavonoid content using quercetin standard and calculated as mg Equivalent of Quercetin (QE)/g (22).

2.3.8. β-carotene Analysis

A total of 1 g of sample was put into a test tube, and then 5 ml of 95% ethanol was added and homogenised. Then, added 20 ml of petroleum benzine and homogenised again. The homogeneous sample was separated the precipitate and solution with a separating funnel, and then 1 ml of the yellow solution layer containing β-carotene was taken into a sealed test tube. The sample in the test tube was then added to a separatory funnel, and then 1 ml of the yellow solution layer containing β-carotene was taken into a sealed test tube. The sample in the test tube was added 3 ml of petroleum benzine and vortexed. The homogenised sample was then assayed with a UV-Vis spectrophotometer, and the absorbance of the β-carotene standard was measured at λ 450 nm.

2.3.9. Curcumin Analysis

A total of 1 g sample and 10 ml pure ethanol were added, vortexed, and then incubated for 18 h, and filtered. The extract was centrifuged for 10 min at 8000 rpm. The absorbance of the sample was measured using a spectrophotometer with λ 431 nm (23) with modifications.

2.3.10. Analysis of Condensed Tannins

A 50 µl sample was added with 3 ml of 4% methanol-vanillin, 1.5 ml of concentrated HCl, and vortexed for 2 min and measured at λ 500 nm. Condensed tannins were calculated as mg Catechin equivalent (CE)/g dry extract with a calibration curve (8.9-44.4 mg/l) with r=0.99 (24).

2.3.11. Moisture Content

Determination of moisture content is carried out by weighing 1 g of material carefully in a weighing bottle that had been dried and whose weight was known. The bottle was then dried in an oven at 105-110 ^{o}C for 3 h. The bottle was removed and cooled in a desiccator, then weighed. Drying was continued again and every half hour was cooled and weighed until a constant weight was obtained (25).

2.3.12. Protein Content

Total protein content was measured using the Kjeldahl method (25). The mashed samples weighed 200-500 mg and were then put into the Kjeldahl flask. Next, 10 mL of concentrated sulfuric acid and 5 g of catalyst (a mixture of K_2SO_4 and $CuSO_4.5H_2O_8$: 1) were added and then deconstructed (in a fume hood) until the liquid was clear. After cooling, the solution was diluted with distilled water to 100 mL in a volumetric flask. The solution was pipetted 10 mL and put into the Kjeldahl distillation device, and then 10 mL of 30% NaOH was added, which has been standardised by oxalic acid solution. The distillation was run for about 20 minutes, and then the distillate was collected in an Erlenmeyer containing 25 mL of 0.1 N HCl solution that had been standardised by borax (the tip of the condenser must be immersed in the HCl solution). Then, the excess HCl was titrated with 0.1 N NaOH solution with a mixture of bromine, cresol green, and metal red indicators.

2.3.13. Preference Level Test

All cookie formulations were hedonic tested for color, aroma, taste, texture, flavor, and overall attributes. The scale used was: 1 (strongly dislike); 2 (dislike); 3 (rather like); 4 (like); 5 (strongly like). The panelists used were semi-trained panelists, as many as 20 panelists.

2.3.14. Statistical Analysis

The study used a 2-factorial Completely Randomised Design (CRD), namely variations in the length of time of pressure blanching (0, 2.5, 5, 7.5 and 10 min) and variations in solvents (80% methanol, 80% ethanol and 80% acetone). The 0 min blanching treatment served as the control. Both solvent types (methanol, ethanol, acetone) were applied across all blanching durations including the control. For CX powder, the best results were used to make CX cookies with variation (1.5, 3.0, and 4.5 g) and baking temperature (130, 140 and 150 ^{o}C). The results were analysed using Analysis of Variance (ANOVA), and if there was a significant difference, followed by Duncan Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Analysis of CX Powder

3.1.1. Antioxidant Activity (DPPH)

The antioxidant activity (DPPH) of CX powder with variation of pressure blanching time and solvent type is presented in Table 1.

Table 1. Results of DPPH antioxidant activity analysis of CX powder

Time of pressure blanching (min)	Antioxidant Activity (%RSA)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	59.90±0.85^{abc}	58.23±0.83^{a}	58.99±1.08^{ab}
2.5	64.07±1.16^{ef}	60.74±0.35^{bc}	61.65±0.37^{cd}
5	65.35±0.63^{f}	67.61±0.00^{g}	63.10±0.40^{de}
7.5	65.44±0.07^{f}	65.15±0.00^{f}	60.13±1.89^{bc}
10	63.38±0.28^{de}	62.98±0.00^{de}	60.68±0.52^{bc}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

Table 1 shows the analysis of the antioxidant activity in CX powder with the 2,2-diphenyl-1-picrylhydrazyl (DPPH) method, which shows significant differences. CX with pressure blanching treatment has a higher free radical capture power than without pressure blanching for all types of solvents. The 5-minute pressure blanching produced the highest antioxidant activity because blanching can inactivate the enzyme polyphenol oxidase. According to previous research, thermal treatments, including blanching, can inactivate potato polyphenol oxidase efficiently in less than 5 min (26). It is suspected that pressure blanching converts phenolic compounds from less active to more active ones, increasing the radical scavenging activity of CX powder. The release of phenolic compounds can make antioxidants easily separated from cell tissue, so pressure blanching increases the antioxidant activity of white turmeric, which increases the extraction yield (12). Table 1 shows that the use of ethanol (67.61% RSA), methanol (65.35% RSA), and acetone solvent (63.10% RSA) at a pressure blanching duration of 5 min gave the highest %RSA.

3.1.2. Antioxidant Activity (FRAP)

The antioxidant activity of the FRAP method of CX powder is presented in Table 2.

Table 2. FRAP antioxidant activity analysis results of CX powder

Time of pressure blanching (min)	FRAP Antioxidant Activity (mg FE/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	5.72±0.08^{d}	4.17±0.03^{a}	5.02±0.04^{c}
2.5	7.01±0.01^{h}	6.10±0.09^{e}	6.82±0.06^{g}
5	7.76±0.13^{j}	7.30±0.11^{i}	8.78±0.01^{k}
7.5	6.79±0.04^{g}	5.86±0.03^{d}	6.72±0.24^{fg}
10	6.57±0.09^{f}	4.66±0.01^{b}	6.25±0.05^{e}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

The data showed that CX powder with pressure blanching treatment showed higher antioxidant activity than CX powder without blanching treatment. Apricot fruits also produced higher FRAP antioxidant activity after blanching than fresh (27). FRAP antioxidant activity values ranged from 4.17 - 8.78 mg FE/g. The antioxidant activity of the FRAP method of CX powder was strongly influenced by the variation of pressure blanching time and solvent type. The highest value was found in CX powder treated with 5 min pressure blanching and extracted with 80% acetone solvent at 8.78 mg FE/g. Research on sesame seeds extracted using various solvents, namely 70% methanol, 70% acetone and 70% ethanol, showed the highest FRAP antioxidant activity results with the acetone solvent of 0.408 (28). FRAP antioxidant activity increased in CX pressure blanching 0-5 min. After 5 minutes, there was a decrease in antioxidant activity. Sugarcane (*Saccharum officinarum* L.) blanching with autoclaving increased antioxidant activity when blanching for 0-5 min (29).

3.1.3. TPC

The results of the analysis of the total phenol content of CX powder with variation of pressure blanching time and solvent type are presented in Table 3.

Table 3. Results of analysis of total phenol content of CX powder

Time of pressure blanching (min)	Total Phenol Content (mg GAE/g (b/k)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	48.89 ± 0.07 ^{b}	45.79 ± 0.11 ^{a}	52.87 ± 0.32 ^{f}
2.5	52.07 ± 0.05 ^{ef}	50.42 ± 0.39 ^{cd}	56.61 ± 1.21 ^{g}
5	52.97 ± 0.23 ^{f}	51.05 ± 0.14 ^{de}	63.33 ± 0.06 ^{i}
7.5	50.70 ± 0.14 ^{d}	49.03 ± 0.81 ^{b}	60.23 ± 0.23 ^{h}
10	49.35 ± 0.31 ^{bc}	45.56 ± 1.27 ^{a}	52.46 ± 0.69 ^{f}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

The total phenol content of CX powder was influenced by pressure blanching time treatment and solvent type, as shown in Table 3, after pressure blanching treatment. CX had a total phenol content of 45.56-63.33 mg GAE/g db. higher than without blanching treatment. This is thought to be due to the pressure blanching process breaking down complex phenol compounds into simple phenol compounds that do not undergo enzymatic oxidation, so the amount of phenols does not decrease. Previous research states that the rate of solvent heating is faster with blanching in beans, thus causing thermal degradation of phenolics (30). Blanching can activate enzymes in the material and the extraction process can be optimised (21,31). The highest value of total phenol content is CX powder with 80% acetone solvent and a pressure blanching time of 5 min. During the extraction process, the solvent will dissolve with the active ingredients according to their polarity; one of the polar compounds is phenolic (32). Ethanol, methanol, and acetone are solvents that are often used to extract phenolic compounds in herbal plants (33). The study showed that the total phenol content had polar compounds equivalent to acetone. Compared to ethanol or methanol solvents CX powder extracted with acetone solvent had higher total phenol content. Acetone, being semi-polar, efficiently extracts both polar phenolics and less-polar curcuminoids and xanthorrhizol. This explains why 80% acetone yielded higher antioxidant activity than 80% ethanol or methanol, which are more polar and may be less efficient in solubilizing hydrophobic phenolic fractions.

3.1.4. Flavonoid content

The results of flavonoid content analysis of CX powder with variations in pressure blanching time and solvent type are presented in Table 4.

Table 4. Flavonoid content analysis results of CX powder

Time of pressure blanching (min)	Flavonoids Content (mg QE/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	6.32±0.09^{cd}	5.60±0.04^{a}	6.96±0.02^{f}
2.5	6.49±0.02^{de}	5.89±0.02^{b}	7.17±0.02^{g}
5	6.60±0.12^{e}	6.69±0.01^{e}	7.58±0.19^{h}
7.5	6.27±0.09^{c}	5.61±0.06^{a}	6.58±0.17^{e}
10	6.28±0.01^{cd}	5.54±0.15^{a}	6.56±0.06^{e}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

Table 4 shows flavonoid levels that show significant differences. Pressure blanching time of 5 min and 80% acetone solvent, produced CX with the highest flavonoid content (4.25-6.28 mg QE/g). Research by (21) stated that white turmeric treated with blanching increased flavonoid levels. White turmeric after blanching has higher flavonoid levels that support

antioxidant activity compared to fresh white turmeric. Blanching with ultrasonic extraction showed a significant increase in total flavonoids in galangal (34) and improved the extractability of phenolic compounds in broccoli (35).

The use of solvents (ethanol, methanol and acetone) for extraction also affects flavonoid levels in CX powder. This is because solvents can dissolve various flavonoid compounds, depending on the solubility of the solvent and the extracted compound. The solvent mixture of methanol (0.445) and ethanol (0.555) produced a flavonoid content of 144.665 mg QE/g bk. This solvent mixture can be used to extract active compounds (especially flavonoids) in large quantities in *C. xanthorrhiza* (36). A compound will dissolve in a solvent with the same polarity according to the principle of polarization (37).

3.1.5. β-carotene Content

The results of β-carotene analysis of CX powder with variation of pressure blanching time and solvent type can be seen in Table 5.

Table 5. Results of analysis of β-carotene content of CX powder

Time of pressure blanching (min)	β-Carotene Content (ug/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	205.03±0.98^{a}	202.43±1.82^{a}	251.71±3.56^{ef}
2.5	217.26±4.72^{bc}	211.89±1.02^{b}	276.98±2.54^{g}
5	230.75±0.51^{d}	227.43±4.52^{d}	292.94±1.01^{h}
7.5	219.34±2.11^{c}	213.38±1.77^{b}	256.91±3.04^{f}
10	214.16±2.99^{bc}	201.01±0.74^{a}	250.99±1.53^{e}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

β-carotene is a potent pigment that gives vegetables and fruits their yellow color; it also functions as provitamin A and an antioxidant. Both of which are essential for health (38). Table 5 shows the β-carotene content of CX powder ranged from 201.01-292.94 ug/g which showed a significant difference. The highest result of β-carotene was obtained in the treatment of CX blanching for 5 min with acetone solvent. This is thought to be because the 5-minute pressure blanching time is an effective time to produce high levels of β-carotene. In agreement with previous research, that blanching with Pulsed Electric Fields-ohmic increased β-carotene bioavailability by 3.9% (39). Pressure blanching after 5 min decreased the β-carotene content of CX. This is thought to be because the long heating process can damage β-carotene in CX. The results of (40) stated that there was a significant decrease in the β-carotene content of sweet potato-corn paste samples after extrusion cooking due to exposure to light, oxygen, and high temperature conditions. β-carotene is a labile compound and can be lost through mechanisms such as cis-trans isomerization, fragmentation and oxidation (41).

3.1.6. Curcumin content

The results of the analysis of curcumin content of CX powder with variations in the length of time of pressure blanching and type of solvent can be seen in Table 6. Table 6 shows that the curcumin content of CX powder with various solvents ranged from 3.80-10.01 mg/g, which showed significant differences. The highest curcumin content was found in CX powder without blanching with 80% acetone solvent. The data showed that the longer the blanching time, the lower the curcumin content. This is thought to be because during the blanching process, curcumin degradation occurs.

Table 6. Analysis results of curcumin content of CX powder

Time of pressure blanching (min)	Curcumin Content (mg/g)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	8.49±0.04^{m}	8.17±0.04^{l}	10.01±0.04^{n}
2.5	5.83±0.03^{g}	6.48±0.04^{j}	6.90±0.04^{k}
5	5.67±0.02^{f}	4.29±0.02^{c}	6.30±0.04^{i}
7.5	5.42±0.04^{e}	4.08±0.04^{b}	5.92±0.03^{h}
10	4.59±0.04^{d}	3.80±0.05^{a}	5.85±0.04^{g}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

Curcumin is easily damaged by heat. Previous research stated that prolonged drying resulted in the degradation of curcumin in *C. longa* (42). The higher the temperature that hits the material, the greater the damage to curcumin content, so that the antioxidative properties of the material are getting smaller (43). Although curcumin content decreased with increasing blanching time, total antioxidant capacity increased up to 5 min. This suggests that while heat-labile curcumin degraded, other phenolic compounds and flavonoids were released or formed through thermal transformation, contributing to the overall antioxidant activity. Thus, a 5-minute pressure blanching represents an optimal balance between curcumin preservation and phenolic enhancement.

3.1.7. Condensed Tannin Content

The results of the analysis of condensed tannin content of CX powder with variation of pressure blanching time and solvent type are presented in Table 7.

Table 7. Results of condensed tannin content analysis of CX powder

Time of pressure blanching (min)	Condensed Tannin Content (ppm)		
	Methanol 80%	Ethanol 80%	Acetone 80%
0	1.38±0.01^{a}	1.36±0.02^{a}	1.76±0.01^{c}
2.5	3.09±0.01^{i}	1.66±0.03^{b}	2.24±0.01^{f}
5	3.10±0.01^{i}	3.00±0.07^{h}	3.24±0.01^{j}
7.5	2.11±0.01^{e}	2.48±0.04^{g}	2.24±0.01^{f}
10	2.08±0.01^{e}	2.02±0.01^{d}	2.22±0.01^{f}

Notes: Numbers followed by different letters indicate a significant difference (P<0.05)

Table 7 shows that the CX powder from pressure blanching with various solvents is significantly different. The condensed tannin content of CX powder ranged from 1.36 - 3.24 ppm. Tannin levels in CX extract with pressure blanching were higher than CX without blanching. Optimal condensed tannin levels were found in CX powder with a blanching time of 5 min and 80% acetone solvent at 3.24 ppm. The increase in condensed tannins is in accordance with the research of (21) that condensed tannins in white turmeric after blanching remain high compared to fresh white turmeric because they are not damaged by oxidation. In addition, it is suspected that condensed tannins in white turmeric after blanching are easier to extract than those in fresh white turmeric.

3.2. Analysis of Cookies

Based on the data analysis of CX powder, the best result is CX powder with a pressure blanching time of 5 min which has high antioxidant activity so that it is added to cookies with the following results.

3.2.1. Preference Level

The preference test is a hedonic test used to determine the sensory acceptability of food products. The results of the cookie preference level are presented in Table 8.

Table 8. Preference level test results

Treatment		Parameters				
CX Powder (g)	Baking Temperature (°C)	Colour	Aroma	Taste	Texture	Overall
0	140	2.70±1.03^{a}	3.95±1.05^{c}	4.15±1.04^{d}	4.00±1.03^{b}	4.00±0.92^{d}
1.5	**130**	**3.35±0.88^{bc}**	**3.95±0.67^{c}**	**4.00±0.92^{cd}**	**3.90±0.55^{b}**	**3.80±0.83^{cd}**
1.5	140	3.60±095^{bc}	3.50±0.76^{abc}	3.20±0.89^{ab}	3.55±0.76^{ab}	3.35±0.88^{abc}
1.5	150	3.85±0.67^{c}	3.90±0.79^{bc}	3.50±0.69^{bc}	3.75±0.72^{ab}	3.65±0.59^{bcd}
3	130	3.35±0.88^{bc}	3.55±0.69^{abc}	3.05±0.95^{ab}	3.60±0.68^{ab}	3.10±0.64^{ab}
3	140	3.75±0.91^{c}	3.65±0.75^{abc}	3.20±0.89^{ab}	3.50±0.89^{ab}	3.30±0.80^{abc}
3	150	3.30±0.87^{bc}	3.95±0.69^{c}	3.50±0.95^{bc}	3.85±0.59^{b}	3.60±0.82^{bcd}
4.5	130	3.10±0.64^{ab}	3.35±0.81^{ab}	3.00±0.73^{ab}	3.25±0.79^{a}	2.80±0.70^{a}
4.5	140	3.75±0.79^{c}	3.35±0.81^{ab}	2.90±0.91^{ab}	3.70±0.66^{ab}	3.15±0.75^{ab}
4.5	150	3.35±0.59^{bc}	3.15±0.88^{a}	2.75±0.85^{a}	3.65±0.59^{ab}	2.85±0.93^{a}

Notes: Numbers followed by different letters in the column indicate a significant difference with a significance level of 0.05

Based on the hedonic test in Table 8 with color, aroma, taste, texture and overall parameters, the selected sample is cookies with the addition of 1.5 g of CX powder and a baking temperature of 130 °C. The color of the selected cookies has a value of 3.35, while the cookies with the addition of CX powder show a yellowish hue. Consistent with the research of (44), the curcumin content in CX rhizomes is 2.29% and causes a yellow coloring effect. CX has essential oil content that can provide a distinctive aroma in cookies. This is in accordance to (45) the essential oil content of 6-11% in CX can provide an aroma to cookies. The aroma score of the selected cookies was 3.95 ± 0.67 (Table 8), indicating that panelists 'liked' the aroma. The addition of CX powder gives a distinctive aroma to the cookies. CX is in the form of crystalline powder, with a slightly bitter taste and a distinctive aroma. It has an orange pigment (46). The texture of cookies is influenced by the additional ingredients used, such as butter, egg yolks, and milk powder. The use of cheese also affects the texture of cookie products because of the high fat content in these ingredients (47). The overall assessment of the parameters on the selected cookie sample was 3.80. The selection of the sample is based on the results of the flavor parameters and the efficiency of the baking temperature used has a good value.

3.2.2. Chemical Analysis

Chemical analyses were carried out on selected cookies and controls used as comparisons, namely moisture content, protein content, antioxidant activity DPPH method, TPC and total flavonoids. The results of chemical analysis on cookies are presented in Table 9.

Table 9. Results of chemical analysis of cookies

Chemical Analysis	Sample	
	Control	Selected
Antioxidant activity (%RSA)	18.94	32.1
TPC (mg GAE/g db)	5.02	9.08
Flavonoid (mg QE/g)	0.32	0.61
Protein content (%wb)	9.30	10.81
Moisture content (%wb)	3.58	3.17

3.2.2.1. Moisture Content

Moisture content in cookies products is a critical characteristic that will affect consumer acceptance of cookies, because this moisture content determines texture, especially in terms of softness or softness attributes (48). Based on Table 9 the moisture content of the selected cookies is not much different from the control cookies. The moisture content of both selected (3.17%) and control (3.58%) cookies met the SNI requirement (maximum 5%). Moisture content is influenced by the type of ingredients used, the thickness of the ingredients, the constituent components of the ingredients, conditions and baking time (49). Roasting time affects the moisture content, the higher the roasting time, the lower the moisture content (50).

3.2.2.2. Protein Content

A Based on Table 9 the protein content of the selected cookies is higher than the protein content of the control cookies, namely 10.81% and 9.30%, so that the protein content in the cookies has met the SNI cookie quality requirements of at least 9%. The protein contained in the cookies is thought to come from the composition of the constituent materials used (17).

During the baking process, proteins tend to denature, resulting in changes in the secondary, tertiary, and quaternary structures of protein molecules without breaking covalent bonds (51). Heat treatment, pH, physical, and chemical disturbances can trigger protein denaturation, the configuration of the original protein molecules and their specific immunological properties (52). The addition of baking powder which is alkaline causes protein denaturation to be inhibited so that the protein content of the selected cookies is higher (53).

3.2.2.3. Antioxidant Activity of DPPH

Based on Table 9 the antioxidant content of selected cookies is higher than the protein content of control cookies, namely 32.56% RSA and 23.41% RSA. The high antioxidant levels in cookies are caused by the addition of CX powder. In accordance with the research of (54) that CX powder has antioxidant activity of 87.01% which is classified as active so that CX has the potential to be a good natural antioxidant. While the high antioxidant activity in cookies without the addition of CX powder is thought to be due to the influence of the constituent materials such as the use of flour.

3.2.2.4. TPC

Based on Table 9 the total phenol content in the selected cookies is higher than the total phenol content of the control cookies, namely 9.08 mg GAE/g db and 5.02 mg GAE/g db. The high phenol content in cookies is thought to be due to the addition of CX powder to the

cookies. The increase in phenol content is strongly related to antioxidant activity; this is due to the presence of phenol hydrogen which can capture free radicals. The relationship shows that the higher the content of phenol compounds, the higher the antioxidant activity (21,55).

The results of total phenol content in cookies are also influenced by heating in the baking process. According to (57) an increase in heating time can cause a decrease in total phenol content in the material. This is thought to be the dissolution of phenols during heating.

3.2.2.5. Flavonoids Content

Based on Table 9, the flavonoid content in the selected cookies is higher than the flavonoid content of the control cookies, namely 0.64 mg QE/g and 0.55 mg QE/g. The flavonoid content in the cookies is thought to be due to the addition of CX powder. The content and total amount of flavonoids in natural ingredients are influenced by a variety of things. Including the type/variety of ingredients, besides that it is also influenced by the method of extraction, type of solvent, temperature, and even the length of storage.

Flavonoids, curcumin and phenols work by binding superoxide anions (O_2), hydroxyl radicals (OH), peroxyls (ROO), and alkoxyls (RO) formed as a result of phagocytosis activity (56). Flavonoids help the process of cell membrane stabilization and affect some accelerated metabolic processes and inhibit lipid peroxidase. In addition, flavonoids can also stimulate prostaglandin excretion in the mucosa and mucus secretion in the gastric mucosa by stimulating the formation of COX-1 enzymes (57).

4. Conclusions

The results showed that CX powder with a pressure blanching time of 5 min had the highest antioxidant activity (DPPH and FRAP), TPC, total flavonoid content, β-carotene and condensed tannins. The addition of CX powder and variations in baking temperature had a significant effect on the chemical properties, and preference level of the cookies produced. The selected cookies product is the addition of 1.5 g CX powder and baking temperature of 130 ^{o}C which has a moisture content of 3.17%, protein content of 10.81%, DPPH antioxidant activity of 32.10% RSA, TPC 9.08 mg GAE/g and total flavonoids 0.61 mg QE/g.

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Author Contributions

D.P. and S.W. conceived and designed the experiments; D.P. and B.K. performed the experiments and analyzed the data; D.A.R made the product and product analysis; S.W. and A.A.C wrote the paper

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Conflicts of Interest

Authors may declare no conflict of interest.
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