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Optimization of Beverage Powder Formula Based on Defatted Tempe Flour

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Abstract Tempe is a fermented soybean product that is rich in antioxidants and has high protein bioavailability, so it is good for consumption for public health. However, tempe has a short shelf life of only two days at room temperature. One of the ways to extend the shelf-life of tempe is to process it into defatted tempe flour (DTF). DTF production began with milling process and continued with fat extraction using n-hexane as solvent. The resulting DTF contains a protein of 75.68±0.13%, thus meeting the Codex requirements regarding soy protein concentrates. Furthermore, DTF was formulated with maltodextrin, xanthan gum, and stevia sweetener using Mixture Design (MD) to produce tempe beverage powder (TBP). The composition of the TBP formula recommended by the MD consisted of DTF 64.65%, maltodextrin 21.16%, sweetener 13.50%, and xanthan gum 0.19%. TBP sensory test with the addition of various concentrations (0.4, 0.5, 0.6% w/w) of vanilla milk flavor showed that the panelists highly preferred the dose of 0.6%. The selected TBP optimum formula had good physical, chemical, microbiological, and sensory characteristics and met all of the Indonesian National Standard (SNI 7612, 2011) requirements, except for fat content.

Keywords Defatted Tempe Flour, Formulation, Optimization, Sensory, Beverage Powder

1. Introduction

Tempe is a traditional Indonesian food produced by fermenting soybean with *Rhizopus* spp. mold. The fermentation process will change the macromolecules composition in soybean into simpler compounds, which can increase protein digestibility [1]. According to Abdurrasyid et al. [2], the longer the soybean fermentation, the higher the *in vivo* protein digestibility of tempe. Tempe contains bioactive peptides which can prevent various degenerative diseases [3]. Tempe has s a short shelf-life of two days at room temperature [4]; thus, the processing of tempe into defatted tempe flour (DTF) is needed to increase the shelf-life of tempe. DTF has a relatively high protein content of 65-<90% but has its drawback, which is a slightly beany odor. DTF is produced by extracting fat using non-polar solvent in order to obtain the precipitates.

The application of tempe into beverage powder is an innovation in tempe consumption since, commonly, society consumes tempe in its food form. Tempe beverage powder (TBP) is processed foods produced from defatted tempe flour and other food additives in the form of powdered drinks. The TBP quality refers to Indonesian National Standard (SNI 7612:2011) regarding the soy beverage powder. TBP is designed to include 8 g of soy protein each serving (20 g), so that by drinking TBP three times per day, then someone can fulfill the daily soy protein need of 25 g. The development of DTF-based beverages requires additional food ingredients, namely stabilizer to stabilize the suspension [2], flavour-masking agent [5], and stevia sweetener to give a hint of sweet taste to the product [6]. All of these ingredients were then optimized using the Design Expert application with the Mixture Design feature to obtain the optimum formula of tempe beverage powder (TBP) from several parameters. This study also performed a sensory test to determine the flavor concentration which would be added to the TBP.

Some soy-based powder drinks are already available commercially, but TBP based on defatted tempe flour has not yet been commercially available and has not been studied previously. In addition, DTF also has several weaknesses, such as easy to form sediment, low solubility in water, and a distinctive beany odor. According to these conditions, this study was performed to determine the optimum formula of DTF-based TBP, which has good physical, chemical, microbiology, and sensory characteristics. This study is expected to provide valuable insight to the food industry, academics, and the public.

2. Materials and Methods

The main ingredient used in this study was tempe from non-GMO soybean, stabilizer (xanthan gum, arabic gum, CMC carrageenan, sodium alginate), maltodextrin, stevia sweetener, n-hexane food grade, vanilla milk flavor powder, and water. The procedure of this study consisted of several steps, namely DTF production and proximate analysis, stabilizer determination, TBP formula optimization, and TBP analysis of the physical, chemical, microbiology, and sensory characteristics.

2.1. Defatted Tempe Flour Production

The production process of defatted tempe flour (DTF) is referred to in a study by Puteri et al. [7]. Tempe was sliced to a thickness less than 0.5 cm by a slicer (ALEXANDERWERK, UC II, Montgomeryville, Pennsylvania) and blanched for 2 min before oven-dried (60°C, 6 hours). Dried tempe was milled by a disc mill with 60 mesh sieves. Tempe flour was suspended in n-hexane (1:3 w/v) and stirred using magnetic stirrer (Thermolyne Cimarec 3, Thermo Scientific, USA) for 1 hour at ambient temperature. The solvent was filtered to separate from the precipitate using Whattman no. 42 paper. Following two times of extraction, the precipitate was suspended in n-hexane (1:4 w/v) and placed in waterbath sonicator (JP Selecta model 3000839, 200 W, 50/60 Hz) at 35^{o}C and sonicated at 50% amplitude for 20 minutes The solvent was filtered to separate from the precipitate using Whattman no. 42 paper. The precipitate was left in the fume hood for 12 hours, to vaporize the solvent before oven-dried (50°C, 2 hours). The tested DTF was analyzed through proximate analysis to be compared with the Codex standard reference for the protein soy protein concentrate

2.2. Proximate Analysis

The proximate analysis of DTF, referred to as AOAC [8], consisted of water and ash content with the gravimetry method, fat content with the Soxhlet method, and protein content with the Kjeldahl method, and carbohydrate content which was calculated (by difference methods). Total carbohydrate by difference method is calculated by deducting the sum of percentage of moisture, crude protein, total fat, and ash from the total weight of the tested product.

2.3. Determination of Stabilizer

The tested stabilizers in the preliminary study were carboxymethyl cellulose (CMC), xanthan gum, carrageenan, Arabic gum, and sodium alginate. The stabilizer was determined through a sedimentation index test, which was mixing the stabilizer and DTF and then dissolved into 100 mL of water and visually observed for the sedimentation index. The determination of sedimentation index was done by diluting 10 g of powder sample into 100 mL of distilled water in 100 mL measuring glass, then the sedimentation height declining was observed for 30 minutes. Sedimentation index is calculated based on the ratio between transparent volume against total volume (mL/min).

2.4. Formula Optimization

TBP formula product consisted of DTF, chosen stabilizer, maltodextrin, and stevia sweetener. The mixture Design feature in the Design Expert 12 application requires upper and lower limits from the used variables. The free variable consisted of utilized DTF so that the TBP could have the protein content of 8 g per 20 g packaging. The limit of the stabilizer was determined with a trial-and-error test on the sedimentation index parameter. At the same time, for maltodextrin, the determined dose was 20% based on a study by Dewi et al. [9] on the production of instant soy drink powder. The limit for stevia sweetener as a control variable was determined through a descriptive trial-and-error test by tasting the aftertaste and sweetness level in various concentrations. The upper and lower limit from the variable were inserted into the Design Expert 12 application, then tested for their viscosity, sedimentation index (SI), and water absorption index (WAI) parameters.

Design Expert 12 Application will provide the TBP formula design based on the pre-determined parameters by choosing the criteria that have been optimized. The Design Expert 12 Application will choose the best TBP formula based on the highest desirability value, which is the value that is close to 1.0. As the final step of the optimization process, the optimum formula was verified with a repeated test on the previously-determined parameters three times. The result of the study is verified if the actual response test values were in the range value 95% prediction interval (PI) and 95% confidence interval (CI) [10].

2.5. Sensory Test

The sensory test was done by using diluted tempe beverage powder. The recommended optimum formula by Design Expert 12 was then assessed with a hedonic rating test by testing three different concentrations of milk vanilla flavor, namely 0.4, 0.5, and 0.6% (w/w). The test was done by 50 untrained panelists and scored on a 7-scale, from 1 (strongly dislike) to 7 (strongly like). Each panelist would score three samples based on aroma, taste, color, aftertaste, and overall attributes.

2.6. Chemical Analysis

The optimum TBP formula, which had been with flavor, was tested for its chemical characteristics, which consisted of water and ash content (gravimetry method), protein (Kjeldahl method), fat (Soxhlet method), and carbohydrate through by difference method [8]. The energy calculation was based on carbohydrate, protein, and fat content with the conversion of 4, 4, and 9 kcal per gram [11]. The acidity degree (pH) measurement was performed using a pH meter, and the total dietary fiber was analyzed with the enzymatic method [8]. The total TBP sugar analysis was based on the Luff Schoorl method by adding the reducing sugar and sucrose [12]. The mineral analysis, which consisted of Mg, Na, P, and Ca, was analyzed using an inductively coupled plasma-optical emission spectrophotometer (ICP-OES) [8]. The heavy metals consisting of Hg, Cd, As, Sn, and Pb on the tested formula were analyzed with inductively coupled plasma mass spectrometry (ICP-MS) based on the method by Kılıç Altun et al. [13]. The antioxidant capacity analysis was done with the DPPH method using standard ascorbic acid, with the result of antioxidant capacity stated as mg AEAC/100g.

2.7. Physical Analysis

TBP color and whiteness degree analysis were done using chromameter to obtain L (lightness), a (red-green), and b (yellow-blue) values. Then, the whiteness degree was calculated based on Yoon et al. [14]. The bulk density was measured by filling the sample into a bear glass and tapping more than 30 times. The analysis result was obtained by dividing the sample weight by the beaker glass volume (g/mL) [15]. The TBP viscosity was obtained by measuring the sample mixed with water using a Brookfield viscometer. The viscosity value is presented in the centipoise (cP) unit [16]

The water solubility index analysis (WSI) was initiated by mixing 1 gram of sample with 25 mL of distilled water, then homogenized for 5 minutes, centrifuged at 760 rpm for 10 minutes. The formed supernatant was separated and heated in an oven for 5 hours at 105°C. The calculation of the WSI value is referred to by Senanayake et al. [17].

TBP water activity (a_w) was measured with an a_w meter apparatus based on a method by Martins et al. [18]. The sedimentation index analysis was started by dissolving 10 grams of the sample with 100 mL of water, then observing the solution's height for 30 minutes [19]. The water absorption index (WAI) was started by mixing 1 gram of TBP with 15 mL water and then vortexed until evenly homogenized and centrifuged at 3000 rpm for 10 minutes. WAI calculation was based on the method by Senanayake et al. [17]. The measurement of total soluble solids was performed using the AOAC method [8].

2.8. Microbiology Analysis

Total plate count analysis was conducted based on SNI 4833-1:2015, which uses buffered peptone water solution for sample homogenization. Then, the sample was diluted and grown on a petri dish with acidified potato dextrose agar media. The incubation was done at 25-26°C for three days, and then the mold colonies would form mycelia-filled circles.

Total molds analysis was conducted based on SNI 4833-1:2015. Potato dextrose agar (PDA) media was weighed up and diluted in distilled water before being heated until dissolved. The media solution was sterilized for 15 min. Acidified potato dextrose agar (APDA) medium was made by adding 10% of tartaric acid to the media and homogenized with buffered peptone water (BPW). The solution was serially diluted in BPW at 1:9 (b:v) ratio before being grown in a petri dish with 1 mL of each solution. The plates were incubated for 2-3 days at 25-26^{o}C.

3. Results and Discussion

3.1. Defatted Tempe Flour Proximate

The defatted tempe flour criteria are referred to as the Codex standard criteria [20], as shown in Table 1. The DTF water content was sufficiently low and fulfilled the Codex standard reference. This was due to the tempe drying process with a certain temperature and time, which could evaporate most of the water contained in the tempe [21]. The ash content shows the total mineral inside of a certain sample. The defatting process with n-hexane solvent could dissolve minerals, reducing the ash content in DTF and meeting Codex standards. This was supported by Kang et al. [22] and Astawan et al. [23], which stated that minerals of soybean flour could dissolve in n-hexane, which resulted in low ash content.

The defatting process caused the low DTF fat content with n-hexane, which reduces its fat content. The fat extraction was related to the significant increase of protein content in DTF. This was due to n-hexane capability to aggregate protein, which increased protein content. Xing et al. [24] stated that the protein content of soybean flour would increase after defatting with an organic solvent.

DTF had a relatively high carbohydrate due to decreased fat content, which further increased the carbohydrate content. This was supported by Kang et al. [22] that the carbohydrate standard exceeded the Codex standard due to the fat content decline. Based on the analysis result, DTF had met the Codex criteria, except for carbohydrate content.

Table 1. Defatted Tempe Flour Proximate Composition

Parameter	Unit	Test Result	Codex Standard[1]
Moisture	%wb	9.52 ± 0.04	<10
Ash	%db	2.30 ± 0.13	<8
Fat	%db	0.70 ± 0.36	<5
Protein	%db	75.68 ± 0.13	65<N<90
Carbohydrate	%db	11.80 ± 0.32	<7

Description: wb=dry basis; db=dry basis. Source: [1]CAC [20].

Table 2. Test Result of Several Types of Stabilizers

Type of stabilizer	Sedimentation index (mL/min)
Xanthan gum	0.00 ± 0.00[a]
Arabic gum	0.17 ± 0.03[b]
CMC	0.21 ± 0.03[bc]
Carrageenan	0.25 ± 0.03[c]
Sodium alginate	0.37 ± 0.00[d]

Numbers followed by different letters in the same column show significantly different results ($p<0.05$)

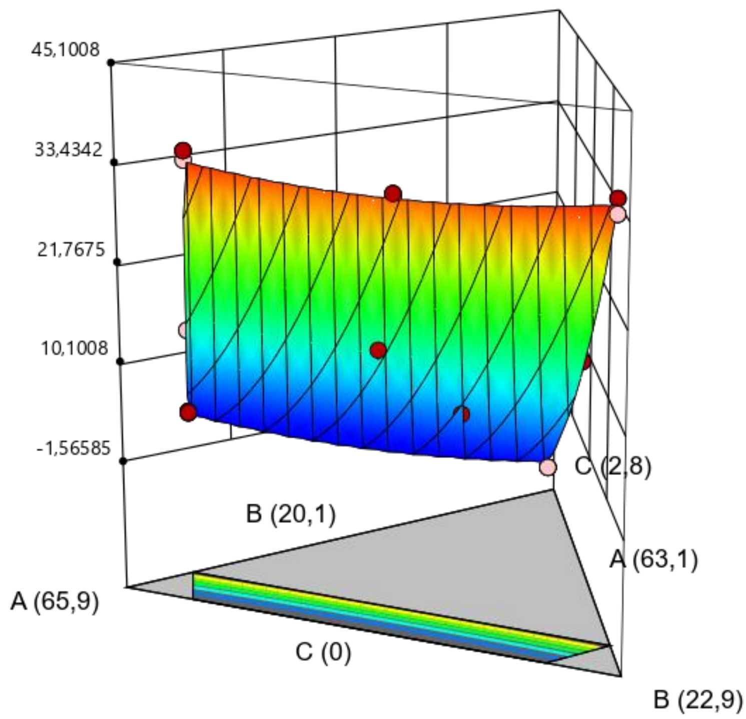
3.2. Determination of Stabilizer

The tested stabilizers in formula determination consisted of xanthan gum, Arabic gum, carboxymethyl cellulose (CMC), carrageenan, and sodium alginate. Based on Table 2, xanthan gum resulted in the lowest sedimentation index, and there was no sedimentation after the mixture was set. For that reason, xanthan gum was chosen as the stabilizer used in this study. Xanthan gum have a higher surface activity, making them better suited for use as emulsifiers than stabilizers, whereas the other hydrocolloid have a lower surface activity, making them better suited for use as stabilizers.

3.3. Formula Optimization

The TBP formula, which would be optimized with Design Expert 12, consisted of DTF, maltodextrin, and xanthan gum. Based on the calculation, the lower and upper limits of DTF were 63.10 and 65.50% to obtain a protein content of 8 g per 20 g of serving size. The xanthan gum concentration was determined based on the sedimentation index with the result of 0.10-0.40%. According to Dewi et al. [9], the limit of maltodextrin was 20%, then adjustment was made to obtain the range of 20.10-22.50%. Stevia sweetener as the fixed variable had the limitation of 13.50% based on trial-and-error descriptive observation.

The variable and parameter limits determined were inserted into Design Expert 12 and resulted in 16 formula designs (Table 3). Then, the testing on all formulas and the test results were inserted into the application to be analyzed. Based on the analysis result of all formulas, the optimum formula with the highest desirability was the formula that includes 64.65% DTF, 21.16% maltodextrin, 0.19% xanthan gum, and 13.50% stevia sweetener (Table 4). This formula met the verification due to the testing average, which was 95% CI and 95% PI (Table 5).



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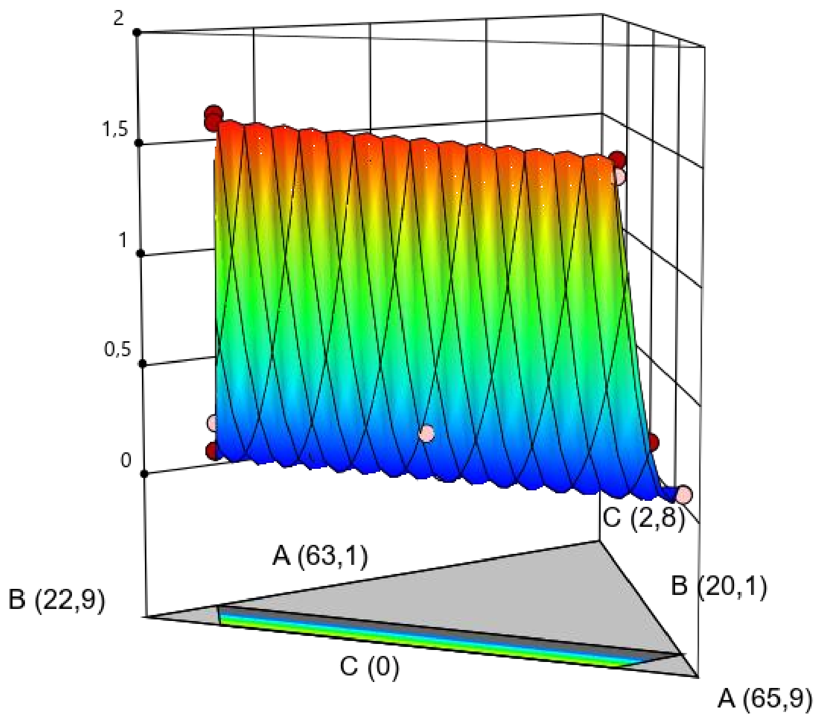
C (2,8)
B (20,1)
A (63,1)
A (65,9)
C (0)
B (22,9)

(a)



2
1,5
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C (2,8)
A (63,1)
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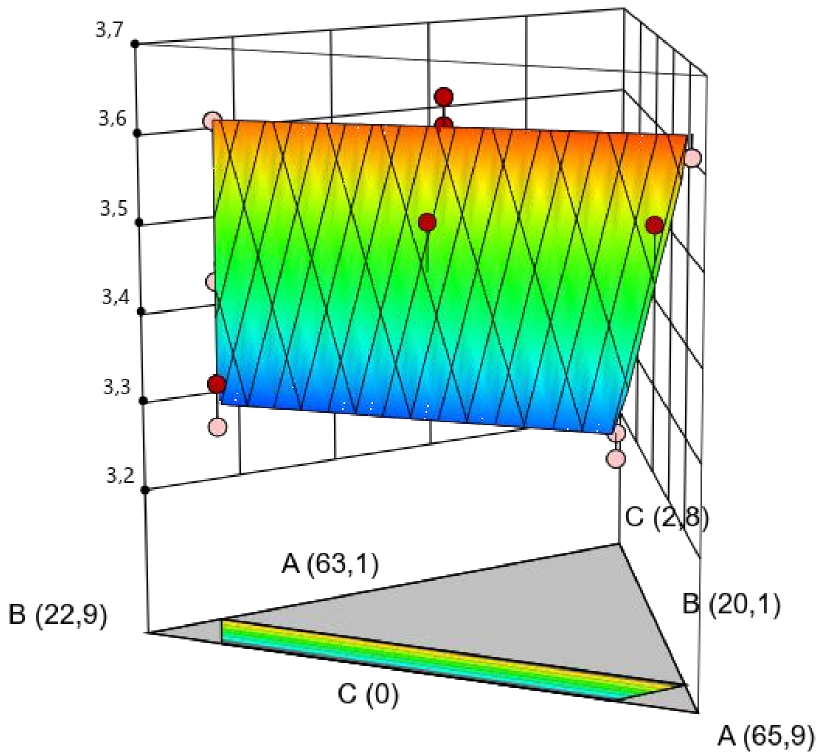
B (22,9)
C (0)
A (65,9)

(b)



(c)

Figure 1. 3D response curve of (a) viscosity, (b) sedimentation index, (c) WAI

Table 3. The Results of Optimization

Run	(a)	(b)	(c)	(d)	(e)	(f)
1	63.75	21.95	0.3	20.33	0.10	3.53
2	64.3	21.3	0.4	31.17	0.06	3.65
3	65.5	20.1	0.4	32.92	0.05	3.60
4	64.3	21.3	0.4	31.67	0.06	3.62
5	64.95	20.75	0.3	20	0.08	3.52
6	65.5	20.3	0.2	14	0.30	3.54
7	63.5	22.5	0	5,42	1.65	3.33
8	63.1	22.5	0.4	33.83	0.06	3.61
9	63.5	22.5	0	5.42	1.61	3.28
10	63.3	22.5	0.2	16.5	0.23	3.44
11	63.95	21.95	0.1	9.33	0.82	3.38
12	64.4	21.4	0.2	14.7	0.26	3.52
13	65.5	20.1	0.4	34	0.04	3.60
14	65.5	20.5	0	5.5	1.52	3.30
15	65.6	20.5	0	5.67	1.45	3.32
16	63.1	22.5	0.4	32.1	0.06	3.60

Description: a= defatted tempe flour, b= maltodextrin, c= xanthan gum, d= viscosity, e= sedimentation index, f= water absorption index

Table 4. Optimum Formula Solution Based on Design Expert 12

No.	(a)	(b)	(c)	(d)	(e)	(f)	Desirability
1	64.65	21.16	0.19	12.74	0.33	3.46	0.98

Description: a= defatted tempe flour, b= maltodextrin, c= xanthan gum, d= viscosity, e= sedimentation index, f= water absorption index.

Table 5. Verification of The Best Formula

Variable	(a)	(b)	95% CI		95% PI	
			Low	High	Low	High
Viscosity	12.78	12.80	11.44	14.16	10.79	14.82
SI	0.39	0.32	0.28	0.37	0.25	0.39
WAI	3.46	3.46	3.44	3.48	3.42	3.50

Description: SI=sedimentation index, WAI=water absorption index, a= verification value, b= prediction value

Table 6. Tempe Beverage Powder Hedonic Rating Sensory Test Result

Formula Type	Sensory Attributes				
	Aroma	Color	Taste	Aftertaste	Overall
Formula 1	5.68^{ab}	5.50^{a}	4.38^{a}	3.86^{a}	4.54^{a}
Formula 2	5.50^{a}	5.44^{a}	4.24^{a}	3.90^{a}	4.44^{a}
Formula 3	5.92^{b}	5.48^{a}	4.80^{b}	4.26^{b}	4.90^{b}

Description:

Formula 1: formula with 0.4% (w/w) flavor concentration

Formula 2: formula with 0.5% (w/w) flavor concentration

Formula 3: formula with 0.6% (w/w) flavor concentration

$^{a-b}$Numbers in the same column followed by different letters are significantly different ($p<0.05$)

3.4. Sensory Test Result

Sensory analysis was done by testing three different concentrations of vanilla milk flavor on TBP, namely 0.4, 0.5, and 0.6%. Panelists of 50 people assessed color, aroma, taste, aftertaste, and overall attributes. The test result is shown in Table 6. The test result showed significant differences ($p<0.05$) in aroma, taste, aftertaste, and overall attributes, but no difference was found in the color attribute. This was caused since vanilla milk flavor did not affect the TBP color. Based on the overall attribute, panelists scored the highest on Formula 3. It was easily understood that formula 3 had the highest concentration of vanilla milk flavor. Therefore, 0.6% vanilla milk flavor concentration was chosen and applied to the optimum TBP formula.

3.5. Chemical Properties

The TBP chemical analysis result can be seen in Table 7. Based on pH analysis, it is known that TBP was considered acidic due to the influence of tempe as the main ingredient of DTF. The hydrolysis of protein into amino acids during fermentation and ammonia production during extended fermentation of tempe will decrease the tempe pH [21]. Based on a study by Astawan et al. [26], TBP dietary fiber was higher than tempe. This was caused by the drying process, which reduces water content and automatically increases the dietary fiber content [27]. In addition, the increase of food fiber content is also affected by the addition of xanthan gum. The total sugar content is a total of reducing and non-reducing sugars. The addition of maltodextrin, which contains reducing sugar affected the increase of TBP total sugar [28].

Table 7. Chemical Properties of Tempe Beverage Powder

Parameter	Unit	Test Result	Standard*
Acidity (pH)	-	5.38 ± 0.02	-
Total dietary fiber	%	17.43 ± 0.41	-
Total sugar	%	13.18 ± 1.89	-
Magnesium (Mg)	mg/100 g	51.88 ± 2.37	-
Sodium (Na)	mg/100 g	45.37 ± 1.93	-
Phosphor (P)	mg/100 g	317.55 ± 1.69	-
Calcium (Ca)	mg/100 g	219.33 ± 2.46	-
Mercury (Hg)	mg/kg	nd	Max. 0.03
Cadmium (Cd)	mg/kg	nd	Max. 0.2
Arsenic (As)	mg/kg	nd	Max. 0.25
Tin (Sn)	mg/kg	nd	Max. 40
Lead (Pb)	mg/kg	nd	Max 0.25
Antioxidant capacity	mg AEAC/100 g	34.64 ± 0.68	-
Daidzein	mg/100 g	32.38 ± 0.51	-
Genistein	mg/100 g	89.81 ± 1.57	-

Description: nd= not detected, *=SNI 7612:2011 regarding soy drink powder

The mineral testing was done on Mg, Na, P, and Ca. The testing result was compared with daily Recommended Dietary Allowance based on Minister of Health Regulation No. 28 of 2019, then weighed as the contribution of daily mineral intake. Based on the calculation, consumption of one serving of TBP will fulfill the needs of Mg by 2.75-3.01%, Na by 0.51-0.60%, P by 9.02-9.12%, and Ca by 4.34-4.44%. According to Astawan et al. [21], the highest mineral content of tempe flour was phosphor, followed by calcium and magnesium. From that, the analysis result in this study had similarities. The heavy metal analysis of Hg, Cd, As, Sn, and Pb was done to determine the criteria fulfillment of powder drink based on SNI 7612:2011. The test result showed that Hg, Cd, As, Sn, and Pb was not detected in the TBP product. Thus, the result implies that TBP is safe for consumption.

Tempe contains phenolic compounds which have roles as an antioxidant, with one of them being aglycone isoflavone [21]. The antioxidant capacity is affected by the material building components, which can prevent the oxidation process. DTF contributed the highest antioxidant capacity in TBP products because of tempe. It is related to soybean fermentation which can increase phenolic content, so the antioxidant capacity in tempe is high. The fermentation process also converts the majority of the glycoside isoflavones in soybean into aglycon isoflavones, so its digestibility and absorption in the body increase [29]. Isoflavone is a flavonoid compound that acts as an antioxidant in food material. Examples of aglycone isoflavones are genistein and daidzein isoflavones. Heating with high temperature and defatting reduces the aglycone isoflavones content in TBP. This was due to the ability of isoflavones to dissolve in n-hexane solvent [30].

Table 8. Tempe Beverage Powder Proximate Composition

Parameter	Analysis result		Standard*
	%ww	%dw	
Moisture	8.03 ± 0.06	8.73 ± 0.06	Max. 10.0
Ash	1.68 ± 0.02	1.82 ± 0.02	Max. 6.0
Protein	42.48 ± 2.90	46.19 ± 3.15	Min. 30.0
Fat	0.608 ± 0.00	0.74 ± 0.00	Min. 17.0
Carbohydrate	47.14 ± 2.55	43.22 ± 3.19	-

Description *: SNI 7612:2011 regarding soy drink powder

The TBP proximate characteristics are shown in Table 8. If referring to SNI 7612:2011 regarding soy beverages, it is concluded that TBP water, ash, and protein contents have fulfilled the criteria, except for fat content. This was caused by defatting, which reduces the fat in DTF production. In addition, SNI also emphasizes soy powder drinks more, while TBP's main ingredient was DTF which has a low-fat content.

3.6. Physical Test Result

The physical analysis result is shown in Table 9. TBP is classified as a product with low a_w, so bacteria, yeast, and mold will be difficult to grow [31]. The a_w value can be associated with the shelf-life of a product, where a product with a lower a_w will most likely provide a long shelf-life.

Several factors, including particle size, influence the bulk density of TBP. The smaller the particle size, the higher its bulk density [15]. The size reduction of DTF to

100 mesh is suspected to increase the bulk density of TBP.

Table 9. Physical Characteristics of TBP

Parameter	Unit	Analysis result
a_w	-	0.41 ± 0.01
Bulk density	g/mL	0.40 ± 0.00
Solubility	g/mL	0.02 ± 0.00
Total soluble solids	ºBrix	4.76 ± 0.02
Color	L	92.23 ± 0.32
	a	0.16 ± 0.09
	b	11.44 ± 0.35
Whiteness Degree	-	86.17 ± 0.10

WSI is a crucial parameter because a higher WSI value shows a product's good solubility. TBP had higher solubility than Abdurrasyid et al. [2] regarding tempe flour-based powder drinks. It was caused by the utilization of maltodextrin in this study which increased the solubility of the product [25].

The total soluble solids indicate the solubility of organic and inorganic compounds. The total soluble solid in TBP was affected by several factors: maltodextrin and stevia sweetener. Both ingredients were easily dissolved and increased the total soluble solids [32]. The total soluble solid is also affected by free water content bound by the stabilizer.

The TBP color analysis was based on the Hunter Lab method, which showed that the product was yellow with a slight red hue and high lightness. The whiteness degree is a parameter that indicates the ability of a material to reflect the light that hits it. TBP had a relatively high whiteness degree due to the defatting process in DTF, which made the color even lighter. Maltodextrin and xanthan gum have white-yellowish color, which also affects the decrease of whiteness degree of TBP.

3.7. Microbiology Test Result

Table 10. TBP Microbiology Characteristics

Parameter	Unit	Result	Standard*
Total mold	colony/g	<1.00 x 10^1	5.0 x 10^1
Total plate count	colony/g	4.1 x 10^4	5.0 x 10^4

Description *: SNI 7612:2011 regarding soy drink powder

The analysis result on total mold and total plate count of TBP is shown in Table 10. Tempe is the main ingredient for DTF production, which contains *Rhizopus* spp. mold, which affects the high mold count. However, flouring and defatting processes, along with low a_w in TBP products, reduced the total mold count due to the unsustainable condition for growth. Mold grows well in a state with a_w 0.60-0.70, while TBP had far lower water activity. Total plate count is a parameter to calculate the total microbes within a food product. Both test results met the criteria from SNI 7612:2011 (Table 10), so it is safe for consumption.

4. Conclusions

The preliminary study showed that the application of xanthan gum resulted in tempe beverage powder (TBP) with the lowest sedimentation index, so it was chosen to be used in the product formula optimization test. The TBP formula composed of 64.65% defatted tempe flour (DTF), 21.16% maltodextrin, 13.50% stevia sweetener, and 0.19% xanthan gum. The formula had met the verification in the Design Expert 12 application. The vanilla milk flavor with 0.6% concentration achieved the highest score in the sensory test. DTF contributed to the high protein content in TBP. The applications of maltodextrin and xanthan gum were proven to contribute to the decent physical and sensory characteristics of TBP. The optimum TBP formula had good physical, chemical, microbiology, and sensory characteristics and met almost all the SNI 7612:2011 standard regarding soy beverage powder, except for fat content.

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