OPTIMIZATION OF KECOMBRANG FLOWER EXTRACT AND MALTODEXTRIN CONCENTRATION IN YOGURT POWDER PRODUCTION USING THE SIMPLEX LATTICE DESIGN METHOD

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Abstract. Yogurt has a short shelf life, but making yogurt powder can help it last longer. Adding kecombrang flower extract can improve the properties of yogurt. The aim of this study was to determine the individual effects, optimal conditions, and the physical, chemical, and sensory characteristics of yogurt powder with kecombrang flower extract and maltodextrin concentration. The research used a method called Completely Randomized Design (CRD) with the Simplex Lattice Design (SLD) optimization method. They looked at different levels of kecombrang flower extract (2.5-7.5%) and maltodextrin (15-20%). The best results came from using 7.5% kecombrang flower extract and 15% maltodextrin, with antioxidant activity of 87.46 ± 1.42%, moisture content of 3.39 ± 0.20%, pH of 3.37 ± 0.02, total LAB of 3.5 x 107 ± 0.58 cfu/g, and rehydration time of 20 ± 0.48 seconds. In sensory analysis, color had a significant effect, but taste, aroma, texture, and overall preference did not.

Keywords: yoghurt powder, kecombrang flower extract, maltodextrin, antioxidant activity, simplex lattice design

A. Introduction

Yogurt is a probiotic drink produced by fermenting milk using lactic acid bacteria (LAB). The types of bacteria commonly used in making yogurt are *Bifidobacterium* sp., *Lactobacillus* sp., *Streptococcus thermophilus*, and *Lactobacillus bulgaricus*. These bacteria trigger fermentation in milk and convert milk lactose into lactic acid. Fermentation is one of the milk preservation and processing technologies. During fermentation, organic acids are formed which create a distinctive flavor in yogurt [1]. Another effect of fermentation is the rupture of proteins in milk which causes the texture of milk to become thick [2].

Yogurt has functional properties that are further enhanced by the addition of antioxidant source materials, one of which is kecombrang flower extract. Chamomile flowers contain alkaloid compounds, flavonoids, polyphenols, steroids, saponins, and essential oils [3]. Yogurt is included in dairy products with a relatively short shelf life. One alternative to increase the shelf life of yogurt is to make it into powder form by drying it. Yogurt powder has a long shelf life and can be stored at room temperature [4]. Instant drinks in powder form have the characteristics of being easily soluble in water, practical in serving, and have a long shelf life because they have a lower water activity (aw) which can prevent microbial growth [5].

Foam mat drying is a process in which a liquid or semi-solid material is transformed into a stable foam by introducing a large volume of air or inert gas using a foaming agent, which serves as a foam inducer or stabilizer [6]. This method employs low temperatures and is suitable for heat-sensitive, viscous, and high sugar content materials, resulting in a powder that can be easily rehydrated while maintaining characteristics such as color, taste, texture, and nutritional

composition (including antioxidants) similar to the original material [7]. The production of yogurt powder necessitates the use of fillers and foaming agents. Fillers are essential for expediting the drying process, increasing yield, coating components, enhancing flavor, and preventing heat damage [8]. Maltodextrin is the filler used for this purpose. Maltodextrin was found to preserve the color stability of yogurt, aid in the rehydration of powdered soy milk yogurt, resulting in a smooth powder texture that does not clump upon rehydration [4]. The addition of maltodextrin can lead to increased yield (total solids and volume), accelerated drying, prevention of heat-related damage, and coating of flavor components of the ingredients [9].

An effective optimization method for obtaining the optimal formula is the simplex lattice design (SLD) method. The use of optimization models with SLD is relatively straightforward compared to other models [10]. The SLD method has been employed in various studies, such as determining the formula for steamed sponge cake with okra flour substitution by Rahayu [11], optimizing the formula for gluten-free white bread using breadfruit flour and xanthan gum by Firdaus [12], and determining the formula for red pomegranate powder beverage by Zulfiana [13]. The SLD method is suitable for producing products with the desired physical and chemical characteristics.

The objective of this study was to assess the independent effect on antioxidant activity, select the optimal conditions, and determine the physical, chemical, and sensory characteristics of yogurt powder with varying concentrations of kecombrang flower extract and maltodextrin.

B. Methods

1. Sample and materials

The sample utilized in this study comprised kecombrang flower extract powdered yogurt. The chemicals utilized were methanol, DPPH solution, phenolphthalein (PP) indicator, 0.1 N NaOH, and MRS agar.

2. Making a starter

Fresh cow's milk was obtained from the ex-farm of the Faculty of Animal Husbandry, Jenderal Soedirman University. To produce the yogurt working starter, 100 ml of cow's milk was pasteurized at 71-72^{0}C for 15 seconds. Then, 5 grams of Yogourmet dry yogurt starter (*L. bulgaricus, S. thermophilus, L. acidophilus*) was added when the temperature reached 45^{0}C. The mixture was incubated for 8 hours at 40-45^{0}C.

3. Preparation of kecombrang flower extract

The process commences with the meticulous sorting of fresh red kecombrang flowers sourced from Pasar Manis, West Purwokerto, Banyumas, to eliminate any damaged portions. Subsequently, the flowers undergo chopping using a chopper machine with a rotary system knife. Following the chopping process, the flowers are subjected to drying in a cabinet dryer at 50˚C for 4 hours until the moisture content is reduced to less than 10%. The dried kecombrang flower is then finely pulverized using a rotary-type hammer mill. The resulting powder is then combined with water in an extractor machine at a ratio of 1:14 and subjected to extraction for 3 hours at 60˚C. Post-extraction, the sample is carefully filtered using a filter cloth in a filter press machine to separate the filtrate and dregs. The remaining dregs undergo further drying in a cabinet dryer for 4 hours at 50˚C and are subsequently subjected to another round of extraction and filtration. The filtrates obtained from the initial and subsequent extractions are then consolidated for subsequent utilization.

4. Preparation of yogurt powder with kecombrang flower extract

Fresh cow's milk sourced from the exfarm of the Faculty of Animal Husbandry, Jenderal Soedirman University underwent pasteurization for 15 seconds at 71-72^{0}C. Subsequently, 8% skim milk, 10% HFS (High Fructose Syrup), and kecombrang flower extract were added to the milk. Upon reaching a temperature of 45^{0}C, 5% yogurt working starter was introduced, and the mixture was then incubated for 6 hours at 40-45^{0}C. The resulting yogurt drink was then converted into powder using the foam mat drying method or foaming technique along with a foam stabilizer. This process involved shaking tween 80, distilled water, and maltodextrin for 10 minutes until a stable foam was achieved, followed by the incorporation of the yogurt using a folding technique. The prepared mixture was poured into a 3 mm thick glass pan and dried using a cabinet dryer at 60^{0}C for 8 hours. Subsequent to the drying process, the resulting sheet form was pulverized using a chopper and filtered through a 60 mesh sieve to yield yogurt powder.

5. Research design

The study used a completely randomized design (CRD) and the Simplex Lattice Design (SLD) optimization method with Design Expert v.13 software. It focused on kecombrang flower extract and maltodextrin concentrations, with antioxidant concentration as the response variable. During the design phase, the lower and upper limits of the kecombrang flower extract concentration were set at 2.5% and 7.5%, respectively, while the maltodextrin concentration ranged from 15% to 20%. Experimental unit treatments comprised 11 combinations, detailed in Table 1.

Table 1. Experimental unit

Run	Space type	Kecombrang Flower Extract Concentration (%)	Maltodextrin Concentration (%)
1	AxialCB	3,75	18,75
2	Vertex	2,5	20
3	Center	5	17,5
4	ThirdEdge	4,17	18,33
5	Center	5	17,5
6	Vertex	7,5	15
7	Vertex	7,5	15
8	AxialCB	6,25	16,25
9	Vertex	7,5	15
10	ThirdEdge	5,83	16,67
11	Vertex	2,5	20

Source: Design expert v. 13.

6. Antioxidant activity analysis

The study used a method to test antioxidants developed by Sheikh *et al*. (2009). This method is based on capturing the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical. The test involved using a Thermo Scientific Genesys 150 UV-Vis spectrophotometer. A 10-fold sample dilution was mixed with 0.16 mM DPPH and left to sit in the dark for 30 minutes. After that, the absorbance was measured at a wavelength of 514 nm. The absorbance data was then used to calculate the inhibition using a specified equation (1).

$$\% \text{ inhibition} = \frac{\text{Blank absorbance-Sample absorbance}}{\text{Blank absorbance}} \times 100\% \quad (1)$$

7. Moisture content analysis

The water content analysis in this study follows Nielsen's method [14] using the AMTAST water content measuring instrument. A 1-gram sample is placed in the equipment, and the water content percentage is then displayed on the instrument's monitor after a few minutes.

8. pH value analysis

The pH measurement in this study was conducted using a pH meter based on the AOAC (1995) procedure. The pH meter underwent calibration with buffer solutions for pH 4.01, pH 6.86, and pH 9.18 prior to taking measurements by immersing the pH meter electrode into 10 ml of the sample.

9. Viscosity analysis

Viscosity measurements were conducted using an Ametek Brookfield DVE Digital Viscometer, following a method by Caesaron & Nintyas [15]. The measurements involved placing a 600 ml beaker containing the sample in the center and under the spindle. The spindle was then rotated to a specific depth into the sample, with the spindle number and speed set at 60 rpm. The resulting viscosity data was recorded.

10. Determination of total titratable acid

The determination of total titratable acid in this study is based on a method developed by Suhaeni [16]. It involves dissolving 10 grams of yogurt powder in distilled water to make 100 ml, filtering the mixture, adding phenolphthalein indicator, and titrating using 0.1 N NaOH solution to determine the total titrated acid. The end point of the titration is determined by the development of a stable pink color, which must persist for at least 30 seconds. The calculation of total titrated acid is performed using the subsequent formula.

$$\text{TTA (\%)} = \frac{\text{ml titration NaOH} \times \text{N NaOH} \times \text{df} \times \text{Dominan MW}}{\text{Sample weight (grams)} \times 1.000} \times 100\% \quad (2)$$

11. Determination lactic acid bacteria

Total lactic acid bacteria were quantified using the cup counting method by Hidayat *et al*. [17]. The enumeration process commenced with the dilution of samples in sterile 0.85% NaOH at a 1:9 ratio, with subsequent dilutions ranging from 10^{-1} to 10^{-7}.

The culturing procedure involved the use of MRS (De Man-Rogosa-Sharpe) Agar culture media. Preparation of 1,000 ml of MRS Agar entailed dissolving 68.2 grams of MRS Agar in 1,000 ml of distilled water, followed by sterilization using an autoclave at 121°C for 15 minutes. Inoculation was performed by applying 1 ml of the diluted sample onto a Petri dish containing approximately 10 ml of semi-solid MRS agar, followed by swirling for uniform distribution. Upon solidification, the Petri dish was inverted and incubated at 37℃ for 48 hours.

$$\text{Total cfu/gram} = \frac{\text{Colony count}}{\text{df} \times \text{number of inoculated samples}} \quad (3)$$

12. Determination of rehydration

In this study, rehydration determination is based on the method by Hashim *et al*. [18], involving brewing yogurt powder samples with water at 40°C.

13. Sensory analysis

The sensory test follows the method by Yansyah *et al*. [19] and includes color, aroma, texture, taste, and overall liking, scored on a 1-5 scale. The evaluation involved 25 semi-trained

panelists and included normality testing at the 5% significance level, followed by the Mann-Whitney test.

C. Results And Discussion

1. Effect of Kecombrang Flower Extract Concentration on Antioxidant Activity

The addition of kecombrang flower extract affects the antioxidant activity of yogurt powder. Research data on the effect of kecombrang flower extract concentration on antioxidant activity response are presented in Table 2.

Table 2. Average results of antioxidant activity test

Space type	Kecombrang Flower Extract Concentration (%)	Maltodextrin Concentration (%)	Antioxidant Activity (%)
Vertex	2,50	20,00	77,98
AxialCB	3,75	18,75	84,68
ThirdEdge	4,17	18,33	80,02
Center	5,00	17,50	85,35
ThirdEdge	5,83	16,67	80,46
AxialCB	6,25	16,25	87,11
Vertex	7,50	15,00	87,22

Source: Design Expert v.13

The study shows that as the concentration of kecombrang flower extract increases, so does the antioxidant activity. The highest antioxidant activity, with an average value of 87.22%, was observed with a 7.5% concentration of kecombrang flower extract, while the lowest, with an average value of 77.98%, was associated with a 2.5% concentration.

This increase in antioxidant activity is attributed to the presence of phytochemical compounds such as flavonoids, tannins, quinones, steroids, and triterpenoids in the extract. [20]. Additionally, Naufalin & Rukmini [21] reported antioxidant values of kecombrang flower extract ranging from 61.61% to 83.17%. Timoer's research (2017) further supported these findings by indicating average total phenol, total flavonoid, and vitamin C content of 5,782 mg TAE/100g, 2,015 mg QE/100g, and 50,688 mg/100g, respectively. Nurhopipah [22] asserted that yogurt enriched with 7.5% kecombrang flower extract exhibited the highest antioxidant activity compared to yogurt containing kecombrang leaf and stem extracts at 2.5% and 5% concentrations.

2. Effect of Maltodextrin Concentration on Antioxidant Activity

The addition of maltodextrin in yogurt powder affects its antioxidant activity. Research data detailing the impact of maltodextrin concentration on antioxidant activity response is outlined in Table 2. Research data shows that as the concentration of maltodextrin increases, there is a reduction in antioxidant activity. A 15% maltodextrin concentration resulted in the highest antioxidant activity at 87.22%, while a 20% concentration produced the lowest at 77.98%.

The decrease in antioxidant activity with higher maltodextrin concentration is due to its role as a filler, increasing total solids content in the material. This heightened totalsolids content is linked to a decrease in antioxidant activity [5]. This aligns with the findings of Dewi *et al*. [23], who observed a similar trend in the antioxidant activity of instant food containing tin leaf herbal tea extract. However, maltodextrin also helps preserve antioxidant compounds during high-temperature drying processes [24].

3. Optimization process

The concentration of kecombrang flower extract and maltodextrin significantly influences antioxidant activity. The graphical model illustrating treatment combinations on antioxidant activity response is presented in Figure 1.

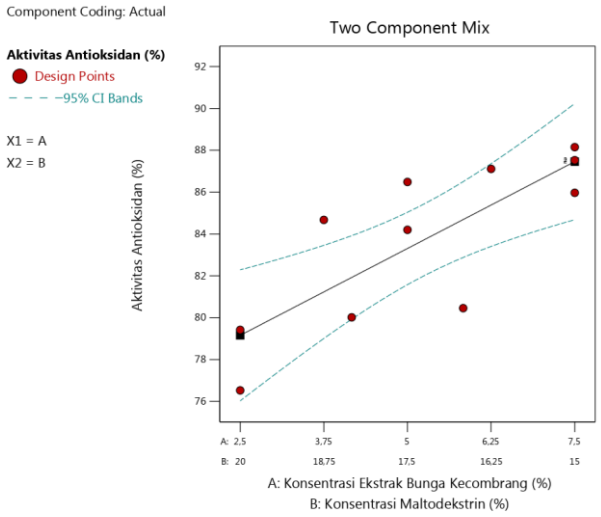

Figure 1. Response graph model of antioxidant activity

Source: Design Expert v.13 data processing.

Yogurt powder with 7.5% kecombrang flower extract and 15% maltodextrin shows the highest antioxidant activity at 87.22%, while yogurt powder with 2.5% kecombrang flower extract and 20% maltodextrin exhibits the lowest at 77.98%.

Table 3. Mathematical models and equations

Math Model	Optimum Model Equation	p-value
Linear	Y = 87.46A + 79.16B	0,0035

Source: Design Expert v.13 data processing.

Description:

Y = Antioxidant activity

A = Concentration of kecombrang flower extract

B = Maltodextrin concentration

Based on Table 3, the linear mathematical model is suitable and recommended by Design Expert v.13 software. The equation Y = 87.46A + 79.16B, indicating that every one unit increase in kecombrang flower extract raises antioxidant activity by 79.16. The linear model's p-value (0.0035) is <0.05, meeting the requirements for further ANOVA testing.

Table 4. Results of analysis of variance (ANOVA)

Response	p-value		Adjusted R^2	Predicted R^2	Adeq Precision	C.V (%)	VIF
	Model	Lack of Fit					
Antioxidant Activity (%)	0.0035	0.0985	0.5889	0.4837	7.7380	3.01	1.11

Source: Design Expert v.13 data processing.

Description:

If the p value < 0.05 then the model or lack of fit is significant.

If the p value > 0.05 then the model or lack of fit is not significant.

Based on Table 4, the ANOVA test results of antioxidant activity show that the treatment data of the model type has a p-value of 0.0035 which means that the model is significant. Then the lack of fit (deviation or inaccuracy against the model) has a p-value of 0.0985 which means that the lack of fit is not significant. Lack of *fit* which is not significant indicates the suitability of the response data with the resulting model [25].

Based on the analysis results, the adjusted R^2 value stands at 0.5889, signifying that 58.89% of the response is attributable to the specified factors, while 41.11% is influenced by unaccounted variables. As the adjusted R^2 value approaches 1, it indicates an increasing influence of the combined independent variables on the dependent variable. The predicted R^2 value, which aims to forecast the dependent variable with specific values, is determined to be 0.4837. The marginal difference of <0.2 between the adjusted R^2 and predicted R^2 values suggests that the antioxidant activity test results are within an acceptable range. Furthermore, the ANOVA assesses the precision adequacy, with a favorable ratio exceeding 4. In this instance, the adequacy precision value obtained is 7.738, denoting a high level of precision in the data.

The antioxidant activity response is associated with a VIF (Variance Inflation Factor) value of 1.11. The VIF value is utilized to assess the presence of multicollinearity within the study. A VIF of 1 indicates orthogonality, while a value exceeding 10 suggests the existence of multicollinearity. Furthermore, the diagnostic analysis of data normality is illustrated in Figure 2.

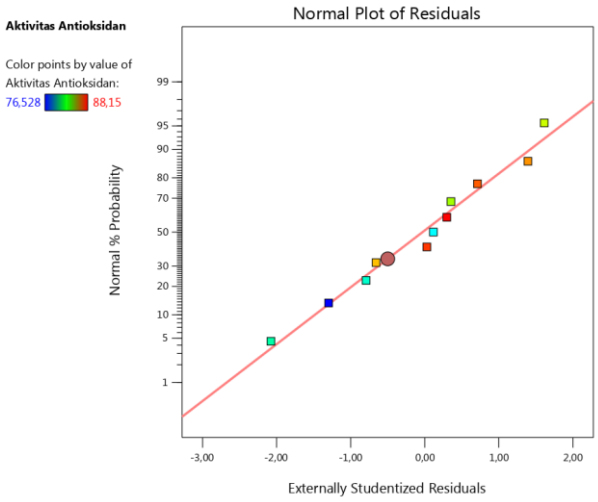

Figure 2. P-P plot

Source: Design Expert v.13 data processing.

The P-P plot graph depicted in Figure 2 serves to illustrate the normality of the data by showcasing the distribution of outliers along the diagonal line. Upon analysis, it is evident that the outliers closely align with the line and follow its direction, indicating the normality of the data and its suitability for further analysis.

In addition, a comprehensive optimization of the product formula was undertaken, with a specific focus on antioxidant activity and a maximum target setting of significant importance (***). The optimal formula was determined to comprise 7.5% kecombrang flower extract and 15% maltodextrin, resulting in an antioxidant activity of 87.459 and a desirability value of 0.941. Higher desirability values, in proximity to 1.0, signify an enhanced ability of the program to produce the desired product impeccably [25].

Subsequent to obtaining the optimal formula, a verification process was conducted, and the results of this verification are duly presented in Table 5.

Table 5. Optimum verification and validation results

Actual value (%)	Predicted value (%)	Standard deviation	95% Prediction interval	
			Low	High
85,372±1,42	87,459	2,52	83,158	91,760

Source: Design Expert v.13 data processing.

According to Table 5, the verification results demonstrate that the antioxidant activity response of 85.37 ± 21.42% falls within the range of the low and high Prediction Intervals (PI). This confirmation indicates that the verification is accepted, affirming the validity of the data. In summary, the effective utilization of Design Expert v.13 for optimization has yielded a highly successful formula.

4. Product characterization

The stage of product characterization entailed conducting tests on the physicochemical and sensory characteristics exclusively on the optimal formula. Subsequently, the results of the characterization were compared with those of the control sample, SNI 01-2981-2009 for yogurt subjected to heat treatment after fermentation, and SNI 01-2970-2006 for milk powder, as detailed in Table 6.

Table 6. Product characterization results

No.	Test Criteria	Unit	SNI	Best sample	Control
1.	Moisture content	%	max. 5,0	3,39±0,20	5,15±0,10
2.	pH value	-	3-4,5	3,37±0,02	3,44±0,03
3.	Total acid titrated	%	0,5-2,0	0,77±0,04	0,68±0,06
4.	Total LAB	cfu/g	-	$3,5 \times 10^7$±0,58	$6,2 \times 10^4$±0,23
5.	Yield	%	-	31,76±0,47	19,31±0,29
6.	Rehydration time	sec	-	20±0,48	30±0,39
7.	Viscosity	cP	-	83±0,91	78,5±0,93

Source: SNI and research data.

a. Moisture content

The water content of kecombrang flower extract powder yogurt was 3.39 ± 0.20%, meeting the SNI standard, while the control yogurt powder had a moisture content of 5.15 ± 0.10%, exceeding the limit. Excessive moisture content in the powder can lead to clumping as it affects the properties of the material particles [26].

Furthermore, research indicates that the addition of maltodextrin can effectively reduce the moisture in yogurt powder. Maltodextrin's ability to bind water results in lower water content as its concentration increases [23]. This aligns with previous research by Djali *et al*. [27], which demonstrated that higher maltodextrin addition led to decreased water content in koro sword nut yogurt powder.

b. pH value

The pH of kecombrang flower extract yogurt powder was 3.37 ± 0.02, complying with SNI standards. The best sample had a lower pH (3.44 ± 0.03) than the control, indicating a more our taste. Kecombrang extract addition reduced pH due to its organic acids. As reported by Rasyadi *et al*. [28], kecombrang extract preparations have pH values of 3.7-3.9, while those without it have a pH of 4.8. This finding aligns with the research conducted by Nurhopipah [22], which revealed that yogurt supplemented with kecombrang extract exhibited a pH value of 4.2, lower than the pH value of 4.3 observed in yogurt without the extract.

c. Total acid titrated

The yogurt powder with kecombrang flower extract had a total acid titration value of 0.77±0.04, meeting the Indonesian National Standard (SNI). The best sample showed higher acidity compared to the control (0.68±0.06). The addition of kecombrang flower extract increased the acidity of the yogurt powder. The acidic conditions in yogurt, in addition to the results of bacterial fermentation, are also influenced by the acidity of the added ingredients. The extract has a pH of 3.7-3.9, falling within the acidic range and contributing to the yoghurt acidity.

d. Total lactic acid bacteria

The yogurt produced from kecombrang flower extract powder exhibits a significantly higher total lactic acid bacteria (LAB) count of $3.5x10^7 \pm 0.58$ cfu/g compared to the control, which only has a total LAB of $6.2x10^4 \pm 0.23$ cfu/g. The addition of kecombrang flower extract and maltodextrin has been observed to positively impact the LAB count in the yogurt powder.

Carbohydrates and proteins play a crucial role in providing a conducive environment for the growth of lactic acid bacteria. Kecombrang flower contains 1.3g of protein and 4.4g of carbohydrates [8]. Furthermore, maltodextrin, rich in carbohydrates, undergoes hydrolysis by LAB to produce glucose, which serves as an energy source and raw material for bacterial metabolization. Masyhura *et al*. [2] reported that the higher maltodextrin concentrations result in increased total microbes in jackfruit seed yogurt powder. Lailiyah & Indrawati [4] also reported that the addition of 15% maltodextrin with a drying time of 14 hours has been found to yield the highest number of lactic acid bacteria colonies ($3.3x10^5$ cfu/gram) compared to other treatments.

The ethanol extract of kecombrang flower possesses antibacterial properties and can inhibit several bacteria such as Bacillus subtilis, Pseudomonas aeroginosa, Salmonella typhimurium, Escherichia coli, Listeria monocytogenes and Staphylococcus aureus. However, ethyl acetate and ethanol extracts of kecombrang flowers showed no inhibition against lactic acid bacteria, namely L. plantarum [21]. The resistant nature of L. plantarum is because on the surface of its cell wall there is lipoteichoic acid with a long glycerol phosphate chain so that it is polar [29]. L. bulgaricus and S. thermophilus are gram-positive bacteria which also have lipoteichoic acid on their cell wall surface. This causes the two bacteria to be resistant to kecombrang flower extract, so that LAB in the yogurt can still grow.

e. Rehydration time

The rehydration process of yogurt powder entails blending the powder with water at 40^0C for 20±0.48 seconds using a ratio of 1:3 (w/v). In comparison, the control yogurt powder necessitates a ratio of 1:5 (w/v) with a rehydration duration of 30±0.39 seconds. Several variables influence the rehydration of yogurt powder, including powder particle size, filler content, and water-to-powder ratio. Fillers, such as maltodextrin, can impact the stability and rehydration speed of yogurt powder. Furthermore, augmenting the filler concentration can expedite the rehydration process. Moreover, the addition of hydrocolloids can enhance the solubility of yogurt powder by increasing the number of hydroxyl groups, thereby facilitating easier and faster water binding [30,31].

f. Viscosity

The incorporation of kecombrang flower extract and maltodextrin into yogurt powder results in a viscosity of 83±0.91 cP, whereas the control yogurt powder exhibits a viscosity of only 78.5±0.93cP. A higher viscosity level signifies superior product quality. Notably, research by Segara [32] indicates that variations in extract concentration do not yield significant differences in viscosity. Maltodextrin serves the dual purpose of maintaining viscosity stability and acting as a filler, with higher concentrations further enhancing the viscosity of the resultant

yogurt powder. Furthermore, Yana *et al*. [30] observed that the inclusion of 5-15% maltodextrin can elevate the viscosity of cowpea-based yogurt powder.

g. Sensory analysis

The findings from the sensory evaluation of yogurt powder infused with kecombrang flower extract are depicted in Figure 3. Additionally, the outcomes of the sensory analysis, conducted using the Mann-Whitney test, are detailed in Table 7.

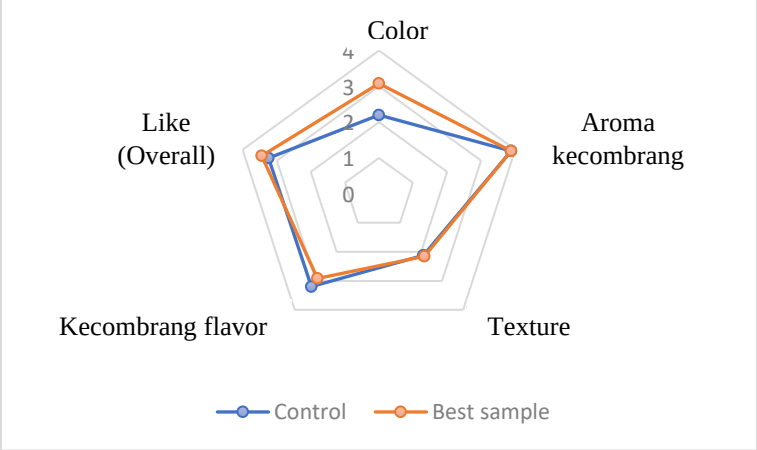

Figure 3. Sensory testing results of yoghurt powder with kecombrang flower extract

Source: Processed sensory data

Table 7. SPSS sensory testing data processing results

	Color	The aroma of kecombrang	Texture	The taste of chilies	Overall
Asymp. Sig. (2-tailed)	0.001*	0.913	0.951	0.348	0.168

Source: SPSS data.

Mann-Whitney decision basis

- If the value of Asymp. Sig. < 0.05, then H_0 is accepted
- If the value of Asymp. Sig. > 0.05, then H_0 is rejected.

Hypothesis: There is a difference in results between the best sample yogurt powder and the control yogurt powder.

1) Color

Based on the Mann-Whitney test, it is evident that the color parameter exhibits an Asymp. Sig. (2-tailed) of 0.001, which is less than the critical value of 0.05. Consequently, it can be inferred that the null hypothesis (H_0) is accepted, signifying a discernible difference in color between the best sample yogurt powder and the control yogurt powder. The best sample yogurt powder demonstrates a color value of 3.08 ± 0.76, presenting a yellowish-white hue, while the control product exhibits a color value of 2.20 ± 0.58, displaying a brownish yellow-yellow shade. Notably, during the drying process, non-enzymatic browning (Maillard reaction) occurs, a phenomenon influenced by heating temperature. The presence of vitamin C as an antioxidant plays a pivotal role in preventing browning reactions during the heating process and has been empirically proven to mitigate the browning index in salak fruit juice [33]. Furthermore, antioxidant compounds present in kecombrang flower extract, such as flavonoids and polyphenols, effectively inhibit oxidation reactions that induce discoloration, resulting in an enhanced visual appeal for the best sample yogurt.

The incorporation of maltodextrin serves to protect compounds sensitive to oxidation and heat, thereby preventing browning during the drying process. According to Badarudin's

research [8], the addition of high concentrations of maltodextrin (15-20%) facilitates the drying process without altering the color of the resulting powdered soy milk yogurt. Furthermore, in the study by Ansori *et al*. [34], the addition of 15% maltodextrin yielded a pumpkin instant cream soup with a color resembling that of pumpkin when processed into a product.

2) Aroma of kecombrang, texture, flavor of kecombrang, and *overall* liking.

The results of the Mann-Whitney test indicate that the parameters of kecombrang aroma, texture, kecombrang flavor, and overall liking exhibit Asymp. Sig. (2-tailed) > 0.05. Consequently, it can be inferred that the null hypothesis (H_0) is rejected, signifying no significant difference in the aroma of kecombrang, texture, taste of kecombrang, and overall liking between the best sample yogurt powder and control yogurt powder.

Alterations in aroma are attributed to the evaporation of volatile compounds, decomposition of fats and proteins, caramelization of carbohydrates, and coagulation of proteins caused by heating. The drying process can lead to the evaporation of volatile compounds in kecombrang flower extract, resulting in a reduction in the aroma and distinctive flavor of kecombrang in yogurt powder. During fermentation, lactic acid bacteria actively metabolize sugars and other components in milk, causing degradation of the kecombrang flower extract compound, and thus not significantly flavoring the aroma and flavor of kecombrang in yogurt powder [35]. The overall assessment was influenced by the panelists' level of liking for the color, aroma, texture, and taste of the yogurt produced, aligning with research by Wirawan *et al*. [36], which suggests that the sensory characteristics greatly influencing panelists' acceptance of stoic bamboo leaf herbal drinks are a combination of panelists assessment of the color, aroma, and taste of the brew.

D. Conclusion

The antioxidant activity of yogurt powder is significantly influenced by the concentration of kecombrang flower extract and maltodextrin. Optimal conditions for producing powdered yogurt involve the addition of 7.5% kecombrang flower extract and 15% maltodextrin, resulting in an antioxidant activity of 85.372±1.42%, moisture content 3.39±0.20%, pH 3.37±0.02, TAT 0.77±0.04%, total LAB 3.5 x 10^7±0.58 cfu/g, powder yield 31.76±0.47%, rehydration time 20±0.48 seconds, and viscosity 83±0.91 cP. The yogurt powder containing kecombrang flower extract exhibits a yellowish-white color, a slightly strong kecombrang aroma, a liquid-rather thick texture, a strong-rather strong kecombrang flavor, and an overall preference rating of slightly like.

E. References

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