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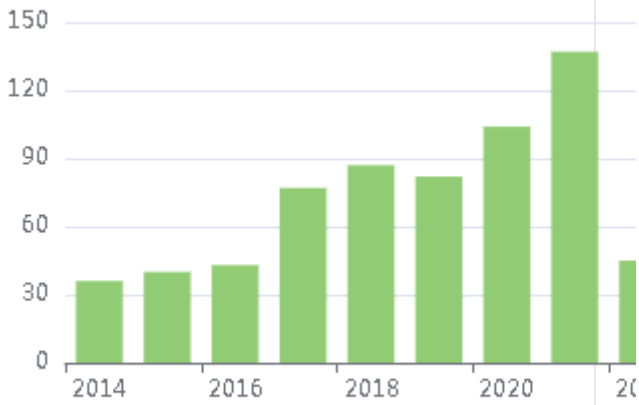
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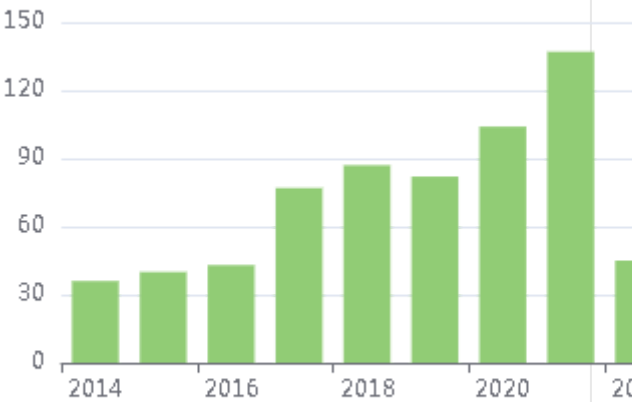
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Sensory, Physicochemical and Antioxidants Evaluation of Kecombrang (*Etlingera elatior*) Preservative Powder with Foam-mat Drying Method for Beef Meatballs Products

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Abstract. This study aims to determine the effect of the type and concentration of preservative powder with foam-mat drying method to produce optimal beef meatballs products seen from the chemical, sensory, and antioxidant evaluation. This study used an experimental method with a randomized block design with the factors being studied were the type of powder of kecombrang plant parts, namely flowers and stems with the concentrations used, namely 0%, 1%, 2%, and 3%. Physicochemical analysis was performed on moisture content, pH, and total protein hydrolyzed (Formol test). The sensory evaluation was carried out by 25 trained people using the descriptive and hedonic testing methods on a scale of 1-5 (very dislike to very much like). Meanwhile, the best treatment from the results of physicochemical and sensory evaluation was analyzed of bioactive compounds (antioxidants) was carried out on total flavonoids and total phenols. The results showed that the best treatment combination was the type of flower preservative with a concentration of 2% which had characteristics with an average moisture content of $57.19 \pm 5.71\%$, pH 7.1 ± 0.21 , hydrolyzed protein content (Formol) $1.40 \pm 0.35\%$, whitish-gray color (2.72 ± 1.40), scents of meat and kecombrang (3.64 ± 0.49), slightly chewy texture (3.52 ± 0.65), flavored with meat and kecombrang (3.68 ± 0.75), is rather preferred by panelists (3.12 ± 0.97), and results of antioxidants evaluation were total flavonoids 2.42 mg QE / 100 mg, total phenolic 179.53 mg QE / 100 mg. The concentration of kecombrang flower and stems powder suitable for adding to beef meatballs is seen from the physicochemical and sensory evaluation up to 2%.

Keywords: kecombrang, meatball, natural preservative, foam-mat drying method, sensory

Abstrak. Penelitian ini bertujuan untuk mengetahui pengaruh jenis dan konsentrasi serbuk pengawet dengan metode *foam-mat drying* untuk menghasilkan produk bakso sapi yang optimal dilihat dari evaluasi kimiawi, sensoris, dan antioksidan. Penelitian ini menggunakan metode eksperimen dengan Rancangan Acak Kelompok dengan faktor yang diteliti adalah jenis serbuk bagian tanaman kecombrang yaitu bunga dan batang dengan konsentrasi yang digunakan yaitu 0%, 1%, 2%, dan 3%. Analisis fisikokimia dilakukan terhadap kadar air, pH, dan protein total terhidrolisis (uji Formol). Evaluasi sensori dilakukan oleh 25 orang terlatih menggunakan metode pengujian deskriptif dan hedonik pada skala 1-5 (sangat tidak suka hingga sangat suka). Sedangkan perlakuan terbaik dari hasil evaluasi fisikokimia dan sensorik dilakukan analisis senyawa bioaktif (antioksidan) berupa total flavonoid dan total fenol. Hasil penelitian menunjukkan bahwa kombinasi perlakuan terbaik adalah jenis pengawet bunga dengan konsentrasi 2% yang mempunyai karakteristik dengan kadar air rata-rata $57,19 \pm 5,71\%$, pH $7,1 \pm 0,21$, kadar protein terhidrolisis (Formol) $1,40 \pm 0,35\%$, warna abu-abu keputihan ($2,72 \pm 1,40$), aroma daging dan kecombrang ($3,64 \pm 0,49$), tekstur agak kenyal ($3,52 \pm 0,65$), dibumbui dengan daging dan kecombrang ($3,68 \pm 0,75$), disukai oleh panelis ($3,12 \pm 0,97$), dan hasil evaluasi antioksidan didapatkan total flavonoid 2,42 mg QE / 100 mg, total fenolik 179,53 mg QE / 100 mg. Konsentrasi tepung bunga dan batang kecombrang yang sesuai untuk ditambahkan pada bakso sapi dilihat dari evaluasi fisikokimia dan sensoris sebesar 2%.

Kata kunci: kecombrang, bakso, pengawet alami, metode foam-mat drying, sensori

Introduction

The increased awareness of society to the importance of maintaining health goes in line with the consumer demand for foodstuffs. Consumers nowadays place importance not

only on economic factors but also on the health and nutritional value of the foodstuff they consume. In developed countries, consumers are concerned about the nutritional content and delicious taste of food as well as its effect on body health. The available foodstuffs which

contain harmful ingredients have made the consumers more selective about the foodstuffs they consume.

Meatballs is a processed meat product made from minced meat mixed with seasoning and flour, then made into small balls and boiled in hot water (Montolalu et al., 2017). Meatballs can be made from beef, chicken, fish, pork, and other meats. Meatballs in the market are mostly beef. The shelf life of meatballs is usually short, from 12 hours to a maximum of 1 day in room temperature (Widyaningsih and Murtini, 2006) or 4-5 days in cool storage of 5°C (Alishahi and Aider, 2012).

The short shelf life has inspired meatballs producers to use preservatives, such as acetic acid, benzoate acid, or nitrate and nitrite. However, the use of preservatives is restricted to a particular limit, and excessive dosage would impose detrimental effects on consumers' health (Latifasari et al., 2019). Therefore, it is necessary to extend the shelf life of meatballs using natural preservatives that exhibit antimicrobial and antioxidants properties.

A natural preservative for meatballs that can extend the shelf life without affecting the taste is kecombrang flower. Previous research (Naufalin, 2019) reported that kecombrang flower (*Etlingera elatior*) is a part of kecombrang plants with antimicrobial and antioxidants effects. Kecombrang plants contain bioactive compounds, such as alkaloid, saponin, phenolic, flavonoids, triterpenoid, steroid, and glycoside that are active antimicrobial or antioxidants agents. The other parts of the plant that can be harnessed to extend the shelf life of meatballs are kecombrang stem. (Naufalin and Rukmini, 2012) reported that incorporating 1% kecombrang powder stem into mackerel fish meatballs could decrease the total bacteria by 1.31 CFU/g and total mold and yeast by 1.18 CFU/g.

Accordingly, the higher concentrate of kecombrang powder stem would extend the shelf life of mackerel fish meatballs.

Kecombrang is a natural preservative for food that can be made into powder using the foam-mat drying method. This method can accelerate water evaporation process and performs at a low temperature, so it prevents the cell tissue from damage and preserves the nutritional values (Rajkumar et al., 2007). Kecombrang powder is easy to save and use. Preservatives must be used in a proper concentration to render an optimum effect on inhibiting microbes as well as exhibiting sensory qualities that the public can accept.

Accordingly, this research aimed to evaluate the effect of foam-mat-dried kecombrang flower and stem powder on the physiochemical, antioxidants, and sensory properties of beef meatballs.

Materials and Method

Materials and Research Design

The primary materials for this study were kecombrang kecombrang preservative powder and minced beef. The study was experimental in a Randomized Block Design (RBD) with factors including two types of preservatives, i.e., kecombrang flower and kecombrang stem, and the level of preservatives for beef meatballs, i.e., 1%, 2%, and 3%. A total of six treatments and four replicates made up 24 treatment units.

Producing kecombrang flower and stem powder

Fresh kecombrang flower and stem were sorted and chopped to bits and dried in a cabinet dryer at 50 - 60 °C for 4 hours. Kecombrang dried simplisia was pulverized using a disc mill and sifted using a 60-mesh sieve to obtain kecombrang flower and stem powder (Naufalin et al., 2019).

Producing liquid extract of kecombrang flower and stem

Kecombrang powder (flower and stem) and water with a ratio of 1: 14 (b/v) were incorporated in an extractor. The extraction process of kecombrang flower and stem was performed at 60 °C for 4 hours (Naufalin and Rukmini, 2018).

Producing kecombrang preservative powder with foam-mat drying method

Fifty ml of liquid extract was mixed with 10% maltodextrin and 1% Tween 80 using a mixer for 15 minutes until frothing, then poured on baking sheets and dried in a cabinet dryer for 4 hours at 50 °C.

Moisture content analysis

One gram of sample was weighed in a moisture analyzer cup and heated up to 120 °C. After that, the *moisture analyzer* was closed and let sit to read the result of moisture content. The result was recorded (AOAC, 1995).

pH analysis

A pH meter was calibrated with buffer pH 4 and pH 7 before measuring the sample pH. Ten grams of sample was mixed with 50ml Aquadest and homogenized. The pH was measured by placing electrodes on the sample, and the pH is read on the pH meter (Sudarmadji, 1997).

Analysis of hydrolyzed protein level (Formol Test)

Two grams of chicken sausage sample mashed with a porcelain cup was dissolve in 20ml of Aquadest, mixed with a stirrer for 15 minutes, and filtered to take 10ml of the filtrate. The filtrate was put into a 125ml Erlenmeyer, incorporated with 20ml Aquadest, 0.4ml calcium oxalate saturation (K-oxalate: water = 1:3), and 1ml of PP indicator, and let sit for 2 minutes. The sample solvent was titrated with NaOH 0.1N until it turned pink. The titrated sample was added with 2ml of 40% formaldehyde and re-titrated with NaOH 0.1N until it turned pink (titration II), then the NaOH volume was recorded and the protein level was calculated (Sudarmadji, 1997).

Sensory evaluation

The sensory evaluation of the beef meatball sample was performed using a descriptive and hedonic test. The descriptive test was performed by 25 trained panelists. The first step was preparing the test samples bearing a random three-digit number code, the second step was serving the sample on a styrofoam plate/tray simultaneously, and the last code was asking the panelists to fill out the evaluation form based on the scale. The hedonic test was performed to indicate the

Table 1. Description sensory of hedonic test

Skor	Color	Scent	Texture	Flavor	Preference
1	Gray blackish	Very scented kecombrang	Very not chewy	Very strong Kecombrang taste	Dislike
2	Gray whitish	Scented kecombrang	Not chewy	Kecombrang taste	Rather like
3	Gray brownish	Scented meat and kecombrang	Rather chewy	Kecombrang and meaty blended taste	Rather like
4		Scented meat	Chewy	Meaty taste	Like
5	Gray Gray redness	Scented meat Very scented meat	Chewy Very chewy	Very meaty taste	Like very much

level of food preference in general as instructed by the food server. The panelists gave their evaluation based on the 1-5 point hedonic scale. Description sensory of hedonic test can be seen in Table 1. To verify the preference on beef meatballs as well as standardize and evaluate each sensory attribute, the total acceptable factor (AF) was determined based on the formula below (Dutcosky, 1996):

$$AF = A \times 100 \times B^{-1}$$

Note: A = mean of each attribute; B = maximum mean of each attribute.

The determination of the selected preservatives was based on the highest average value of all attributes. Afterwards, flavanoids and total phenolic analysis were tested on the selected preservatives.

Flavonoids Analysis

Twenty-five milligrams of quercetin were dissolved in 96% ethanol for analysis up to 25ml as the mother liquor (1000 ppm). One ml of the mother liquor was dissolved in 10ml of 69% ethanol for analysis (100 ppm). The solvent was diluted in a series of 6 ppm, 8 ppm, 10 ppm, 12 ppm and 14 ppm to create a standard curve. Then, 1g sample was incorporated with 10ml of 96% ethanol in a shaker and shaken at a speed of 200 rpm for 2 hours. The supernatant yield was the extract to determine the sample. As much as 100 μ L or 0.1 ml supernatant sample was mixed with 1 ml $AlCl_3$ 2% (2 g $AlCl_3$ in 100 ml of glacial acetic acid 5%) and 1 ml of 120 mM potassium acetate (1.176 g potassium acetate in 100ml of Aquadest). The sample was incubated for one hour at room temperature and measured for the absorbability using a spectrophotometer at 435 nm wavelength (Sudarmadji, 1997).

Total phenolic analysis

Tannic acid was used as the standard. As much as 10mg tannic acid was diluted in 100ml

of 95% ethanol as the stock solvent solution and subjected to a series of dilution for 0.02 mg/ml, 0.04 mg/ml, 0.06 mg/ml, 0.08 mg/ml, and 0.1 mg/ml to create a standard curve. After that, a 0.01 g sample was mixed with 10ml of 70% ethanol, shaken with a vortex to prepare for the sample. The supernatant yield was the extract to determine the sample. A quantity of 0.4ml sample was added with 1.5ml of 10% Folin-Ciocalteu and let sit for five minutes at room temperature. Then, 1.5ml sodium bicarbonate ($NaHCO_3$) 0.556 M was shaken, let sit in a dark room for 90 minutes and measured for the absorbability at 725 nm wavelength (Singleton and Rossi, 1965).

Data analysis

The data of chemical test were subjected to Analysis of Variance (ANOVA) at 5% level of significance and any significant difference was analysed further using Duncan's Multiple Range Test (DMRT). Data of variable sensory were analysed with Friedman Test, and Effectivity Index was used to determine the best treatment combination.

Result and Discussion

Moisture content

The moisture content of the treatment combination for beef meatballs with kecombrang powder was 51.76 ± 6.65 to $64.82 \pm 1.65\%$. The moisture content of beef meatballs decreased with an increased level of kecombrang powder (Figure 1). It is presumably because kecombrang powder can absorb water, so it is a hydrophilic compound (Naufalin, 2020).

pH

The range pH of the treatment combination for meatballs with kecombrang powder was 7.0 to 7.3 (Figure 2). Beef meatballs with the best-combined treatment were A1B3 (addition of 2% kecombrang flower powder) with a pH of 7.10 ± 0.21 . The pH of beef meatballs tends to

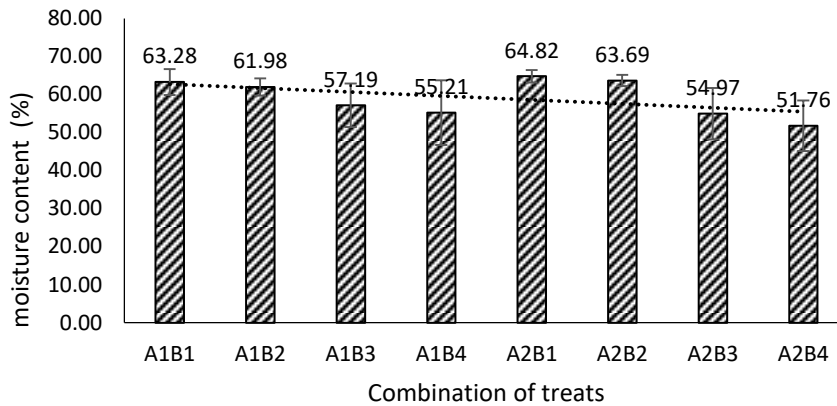


Figure 1. The effect of the combined treatments of the pulverized parts of kecombrang plants (A) with the level of kecombrang preservative powder (B) on the moisture content of beef meatballs. A1, kecombrang flower preservative powder; A2, kecombrang stem preservative powder; B1, 0%; B2, 1%; B3, 2%; B4, 3%.

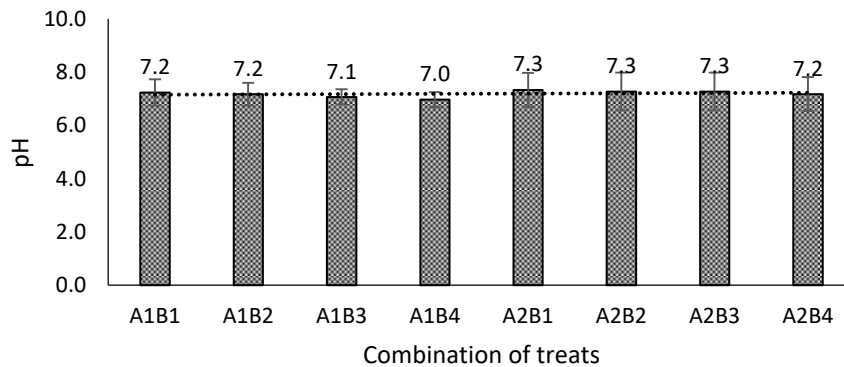


Figure 2. The effect of the combined treatments of the pulverized parts of kecombrang plants (A) with the level of kecombrang preservative powder (B) on the pH of beef meatballs. A1, kecombrang flower preservative powder; A2, kecombrang stem preservative powder; B1, 0%; B2, 1%; B3, 2%; B4, 3%.

decrease with the increased level of kecombrang preservative powder. It was presumably because the previous studies reported that the pH of 1-3% solvent from kecombrang stem powder was comparatively low, i.e., 3.0-3.2. The low pH could be attributed to the organic acids in kecombrang flower and stem powder (Naufalin et al., 2019). Organic acids could serve as antimicrobial agents or synergize with the flavonoid compounds because organic acids may damage the microbial cell wall so that the antimicrobial compounds easily enter the cells and render toxicity. As a result, it inhibits the growth of microbes (Naufalin, 2019).

Level of Hydrolyzed Protein (Formol Value)

Based on data analysis, 2% of kecombrang powder is sufficient to inhibit protein hydrolysis. The range formol value of the treatment combination for meatballs with kecombrang powder was 1.28% to 2.09% (Figure 3). Accordingly, beef meatballs with the best-combined treatment were A1B3 (addition of 2% kecombrang powder flower) that contained hydrolyzable protein (Formol value) $1.40 \pm 0.35\%$.

Figure 3 showed that the hydrolyzable protein (Formol value) of beef meatballs decrease with the increased level of kecombrang preservative powder.

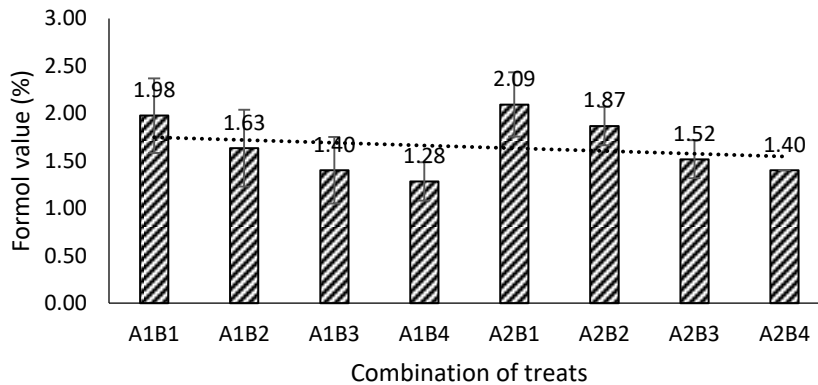


Figure 3. The effect of the combined treatments of the pulverized parts of kecombrang plants (A) with the level of kecombrang preservative powder (B) on the Formol value of beef meatballs. A1, kecombrang flower preservative powder; A2, kecombrang stem preservative powder; B1, 0%; B2, 1%; B3, 2%; B4, 3%.

The high concentration may contain more antimicrobial compounds, so it could inhibit the microbes from hydrolyzing the protein, hence lower the Formol value (Naufalin et al., 2019). Jay et al. (2008) reported that bacteria like *Clostridium*, *Bacillus*, and *Pseudomonas* hydrolyze protein into peptides and free amino acids that are subsequently subjected to enzymatic hydrolysis by proteolytic bacteria and produce stench odor.

Sensory evaluation

The result of sensory evaluation of beef meatballs on color, scents, texture, flavor and preference as presented in Table 2.

Colour

The result of the *Friedman* test showed that the types of powder of kecombrang plant parts, namely flowers and stems, together with the concentration of preservatives did not significantly affect the color of beef meatballs. The color spectrum of beef meatballs ranges from grey to blackish grey. The lowest color score of beef meatballs was 2.72 ± 1.4 (whitish-grey) found in 2% kecombrang flower powder

as the selected best treatment. Meanwhile, the highest acceptable factor (100) was 24 ± 1.30 (brownish-grey) produced from 3% kecombrang stem powder (Table 1). However, all combined treatments are not significantly different from the statistical evaluation. The dough of beef meatballs was grey, and kecombrang stem powder is yellowish-white (crème/off white). According to a previous survey (Kumalasari, 2012), color is fourth in the quality ranking based on the consumer preference for meatballs.

Scents

The result of the *Friedman Test* showed that the-type of powder of kecombrang plant parts (flowers and stems), together with the concentration of preservatives did not significantly affect the scents of beef meatballs, and then statistical analysis showed that all combined treatments were not significantly different (Table 2). The scents of beef meatballs were between kecombrang and meat. The best-combined treatments were A1B3 (addition of 2% kecombrang powder flower) with a value of 3.68 ± 0.75 (with meat and kecombrang scents).

Table 2. The mean result of sensory evaluation of beef meatballs

Sensory Evaluation	Colour	Scents	Texture	Flavor	Preference
A1B1	2.84±1.40 (87.65)	3.88±0.6 (98.98)	3.44±1.04 (95.56)	3.92±0.70 (98.99)	3.52±0.92 (97.78)
A1B2	2.92±1.19 (90.12)	3.68±0.85 (93.88)	3.24±0.67 (90)	3.84±0.85 (96.97)	3.36±0.95 93.33
A1B3	2.72±1.40 (83.95)	3.68±0.75 (93.88)	3.52±0.65 (97.78)	3.64±0.49 (91.92)	3.12±0.97 (86.67)
A1B4	2.88±1.39 (88.89)	3.80±0.82 (96.94)	3.24±0.78 (90)	3.64±0.57 (91.92)	3.24±0.97 (90)
A2B1	3.04±1.27 (93.83)	3.80±0.76 (96.94)	3.56±0.58 (98.89)	3.76±0.66 (94.95)	3.6±0.92 (100)
A2B2	3.00±1.15 (95.59)	3.92±0.86 (100)	3.60±0.76 (100)	3.96±0.61 (100)	3.36±0.86 (93.33)
A2B3	3.12±1.27 (96.30)	3.56±0.65 (90.82)	3.20±0.65 (88.89)	3.64±0.76 (91.92)	3.20±0.87 (88.89)
A2B4	3.24±1.30 (100)	3.72±0.79 (94.90)	3.24±1.05 (90)	3.56±0.65 (89.90)	2.72±1.24 (75.56)

Note: A1, kecombrang flower preservative powder; A2, kecombrang stem preservative powder; B1, 0%; B2, 1%; B3, 2%; B4, 3%.

Kecombrang flower has a strong scent (pungent), so the beef scents cannot cover the particular smell of kecombrang. A survey (Kumalasari, 2012) reported that scents is second in the quality ranking of consumer preference who mostly choose for meatballs with the scents of boiled beef.

Texture

The result of the Friedman test showed that the types of kecombrang plant powder (flowers and stems), together with the concentration of preservatives, did not significantly affect the texture of beef meatballs. The range of beef meatballs texture was from very much chewy to very much not chewy. The best-combined treatment was A1B3 (addition of 2% kecombrang powder flower) with the value of 3.52±0.65 (somewhat chewy) although the acceptable factor (AF) was not the highest because it was not significantly different (statistically) from the other combined treatments (Table 2).

The low texture score of the beef meatballs was presumably due to the less chewiness because of the high level of kecombrang powder. The addition of kecombrang powder could decrease the moisture content of meatball fish, although a higher amount of

water would make the product chewier. Kumalasari (2012), reported that texture was the third in the quality ranking of consumer preference where 45.5% of respondents preferred meatballs with somewhat chewy to a chewy texture.

Flavor

The result of the Friedman test showed that the types of kecombrang plant powder (flowers and stems), together with the concentration of preservatives did not significantly affect the flavor of beef meatballs. The flavor of beef meatballs in this study ranged from strong kecombrang flavor to strong meat flavor. The best-combined treatment was A1B3 (addition of 2% kecombrang powder flower) with a value of 3.64±0.49 (somewhat chewy) although the AF was not the highest because it was not significantly different (statistically) from the other combined treatments (Table 2).

The low flavor score of beef meatballs added with 3% kecombrang powder may be attributed to the diminished signature flavor of beef meatballs due to the high level of kecombrang powder. Additionally, the kecombrang stem powder could significantly reduce the meatball saltiness because all treatments received the same amount of salt. Kumalasari (2012),

reported that flavor was the first in the quality ranking of consumer preference to meatballs, where 91% of consumers preferred meatballs that were somewhat salty or salty enough.

Preference

The result of the Friedman test showed that the level of kecombrang stem powder preservatives (K) significantly affected the preference. The preference value of beef meatballs ranged from dislike to like very much. The selected best-combined treatment was A1B3 (addition of 2% kecombrang powder flower) with the value of 3.12 ± 0.97 (somewhat chewy) although the AF was not the highest because it was not significantly different (statistically) from the other combined treatments (Table 2).

The preference value was highly influenced by the panelists' subjectivity and affecting product acceptability. This study found that the higher the level of kecombrang powder mixed with the beef meatballs, the lower the panelists' level of acceptability. The decreased preference level was assumed due to the panelists' evaluation of the colour, scents, texture, and flavor of beef meatballs in this study.

Total Flavonoids

This study reported the total flavonoids of beef meatballs was 2.42 mg QE/ 100 mg. Flavonoids are bioactive compounds that serve as antioxidants. Akhlaghi and Bandy (2009) explained that flavonoids as a metal-chelating agent could chelate metals like Cu and Fe that play a role as the catalysts in the Fenton reaction. This reaction is one of the decompositions of hydrogen peroxide into $\cdot\text{OH}$. The metal chelate would decrease the catalytic activity of Cu and Fe, thus inhibiting the formation of $\cdot\text{OH}$ radicals and automatically

decreasing the process of DNA damage and fatty oxidation (PUFA).

The antioxidant activities from plant natural compounds like flavonoids are attributed to the hydroxyl clusters in the molecule structure. Flavonoid antioxidant activities, which is a phenolic compound, are dependent on the molecule structure, particularly the $(\text{CH}_3)_2\text{C}=\text{CH}-\text{CH}_2-$ prenyl cluster. Flavonoids prenyl clusters are developed for the prevention or therapy of free radicals-associated diseases. Additionally, flavonoids are phenolic compounds with a conjugated system, which becomes fragile at a high temperature (Pokorny et al., 2001). Sani et al., (2014) stated that some types of flavonoids have a glycoside bound with sugar molecules; therefore, the flavonoid units bind with sugar. Glycoside flavonoids are formed because the hydroxyl clusters in the flavonoids molecule (aglycone) binds with the carbonyl clusters from the sugar (glycone). The glycoside binding was broken at high temperatures. Antioxidant activity in beef meatballs may promote a longer shelf life and can serve as a functional food product.

Total Phenolic

Total phenolic compounds of beef meatballs in the present study were 179.53 mg QE/ 100 mg. The phenolic compounds in kecombrang flower extract can inhibit the formation of free fatty acids due to the oxidation by donating the hydrogen atoms that will bind with the peroxide clusters to produce more stable compounds (Pertiwi et al., 2019). Similarly, Naufalin (2019) stated that the antioxidant properties are derived from the phenolic clusters or their configuration with the molecular structure. Furthermore, phenolic compounds are the potential donors of hydrogen atoms in the initial phase of unsaturated fatty acid oxidation.

Rezaeizadeh et al., (2011) reported that the hydroxyl clusters in phenolic directly contribute to the antioxidant activities and play a significant role in capturing the free radicals because the hydroxyl clusters of phenolic compounds could donate hydrogen atoms, hence stabilizing the free radical compounds. However, phenolic was broken in particular conditions of heat (temperature), oxygen, light, and the internal factors of kecombrang powder. Some phenolic compounds are easily oxidizable by the oxygen, particularly in an alkali condition or by the polyphenol oxidase enzymes. The total phenolic content of beef meatballs is appropriate for a functional food product.

Conclusion

Increasing the level of kecombrang flower and stem powder for beef meatballs could decrease the moisture content, pH and total hydrolysable protein (Formol value) as well as increasing the flavonoids and phenolic, hence improving the shelf life. The addition of kecombrang flower and stem powder did not affect the panellist's evaluation on the color, scents, texture, flavor and preference. The proper addition of kecombrang flower or stem powder into beef meatballs from the physiochemical and sensory quality was 2%.

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