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THE POTENTIAL OF LOCAL GINGER AS ANTIOXIDANT ON FULL-FAT MAYONNAISE

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ABSTRACT

The aims of this study were to investigate the potential of local ginger for natural antioxidants on full-fat mayonnaise. The used materials were sunflower oil, vinegar, egg yolk, white pepper, salt, sugar, mustard, and local ginger extract. The study was done by using laboratory experimental with Nested Completely Randomized Design with 2 factors and 3 replications. The first factor was used three ginger varieties, namely elephant ginger/(*Zingiber officinale* var. Roscoe) (G), red ginger (M)/(*Zingiber officinale* var. Rubrum) and emprit ginger (E)/(*Zingiber officinale* var. Amarum). The second factor was the addition levels, which were 0.5% (a), 1% (b) and 1.5% (c). The observed variables include pH, viscosity, moisture content and antioxidant activity (I_C50). Data were analyzed by using analysis of variance. The result showed that the used different ginger material and different levels of addition did not give significant effect ($P>0.05$) on pH analysis and gave highly significant effect ($P<0.01$) of the antioxidant activity, viscosity and moisture content. The study could conclude that mayonnaise added with red ginger showed physicochemical properties better than added with emprit ginger and gajah ginger. In addition, the best result was found in 1.5% ginger addition of each ginger variety in terms of physicochemical qualities of the mayonnaise.

Keywords: Mayonnaise; ginger; antioxidant

INTRODUCTION

Mayonnaise is an emulsion product made from egg yolk, vinegar and vegetable oils (Liu et al., 2007). An emulsion is dispersion or suspension of liquid to other liquid or emulsion systems dispersed to other fluid (Estiasih and Ahmadi, 2014). Mayonnaise product used as salad dressing or alternative food sauce. Full-fat mayonnaise has fat content around 70-80% (Chatterjee and Bhattacharjee, 2015). Most consumers assume that high-fat content on the mayonnaise can trigger degenerative diseases such as heart disease, cholesterol, and arteriosclerosis. Ginger is a herb commonly used as a spice to the food. Local ginger in Indonesia consists of three varieties, as red ginger (*Zingiber officinale* var Rubrum), emprit ginger (*Zingiber officinale* var Amarum) and elephant ginger (*Zingiber officinale* var Roscoe) (Rialita et al., 2015). Ginger content an antioxidant compound and has function to prevent free radical which can prevent degenerative disease.

The chemical contents in ginger include gingerol, turmeric, paradol, geraniol, geranial, borneol, linalool, camphene, zingerol and zingiberon (Yashin et al., 2017). The main component of ginger as antioxidants were gingerol, shaogaol, curcumin and diaryleptanoids which can prevent anti-inflammatory, anti-fat, anti-tumor and anti-pain (Kumari et al., 2014). The antioxidant content of elephant ginger in the amount of 79,19% (Purnomo et al., 2010). The gingers not used fully utilized. Local ginger in Indonesia can used as natural antioxidant and can increase the physicochemical quality of mayonnaise and can be used as functional food. Mayonnaise is vulnerable product against lipid oxidation because fat and lipid content more than 70%. Antioxidant added from ginger varieties needs to be added to mayonnaise. The aims of this research to determine the potential of local ginger with different concentrations to full-fat mayonnaise. The research used antioxidant which was applied to mayonnaise has been a lot. Mayonnaise with date palm oil as antioxidant (Amany et al., 2010), mayonnaise with ginger flour (Kiskh et al., 2013), mayonnaise added with aromatic plant such as lavender, thyme, rosemary as antioxidant (Gallego et al, 2013) and mayonnaise with cocoa butter as antioxidant (Mohamad et al., 2019).

MATERIALS AND METHOD

Materials

The materials used in mayonnaise production were sunflower oil (70%), egg yolk (15%), vinegar (8%), salt (2%), sugar (4%), mustard (0,5%) and white pepper (0,5%). Elephant ginger extract, emprit ginger extract and red ginger extract bough from Karangploso-Batu-Malang. The commercial mayonnaise was used as control from the supermarket. The materials used for analysis such as DPPH liquid and methanol (blank) for antioxidant activity assays.

The tools used for mayonnaise production were mixer, measuring cup, spatula, basin, the scale, pot film, knife, blender, and fabric filter. The tools used in the analysis were pH meter Schoot gerate, viscometer (Brookfield), analytic scale, oven, petri dish, pot film, clamp cup, test tube, cuvette, and spectrophotometry UV-vis.

Fresh local ginger extract preparation

Ginger extract preparation procedure allowing by Purnomo et al. (2010) with modification. Elephant ginger, emprit

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ginger, and red ginger were washed with running tap water and then it was weight. The gingers were sliced thinly and blended. The ginger was blended and squeezed to the basin or jar until the waste to be dry. The extract will be used.

Mayonnaise preparation

The mayonnaise was prepared by following Evanuarini et al. (2016) with modification. Mayonnaise made with mixed the salt, sugar, white pepper and mustard at 1500 rpm, for 1 min. The egg yolk added frequently and added by turn with sunflower oil and vinegar. After the mayonnaise to be emulsion, the extracted ginger with the treatment was added to the mayonnaise and mixed again. The mayonnaise was stored at room temperature (25^0C ± 2^oC) for 24 hand the mayonnaise will be used to analysis.

Methods

The methods were using laboratory experimental with Nested Completely Randomized Design with 2 factors and 3 replication. The first factor was three ginger varieties, namely elephant ginger (G), red ginger (M) and emprit ginger (E).

The second factor was the addition levels, which were 0,5% (a), 1% (b) and 1,5% (c). The factors result in 9 treatments. This experiment used negative treatment (P0-) and positive treatment (P0+) as control, and commercial mayonnaise as comparison.

pH measurement

The pH measurement was done by using a pH meter (AOAC, 2005). The pH meter was firstly calibrated with buffer pH 4 and buffer pH 7. The result will appear in the pH meter layout.

Viscosity measurement

Viscosity measurement was used viscometer (Brookfield) (AOAC, 2005). The samples 100 mL was prepared then added to beaker glass. Turn on viscometer and set with horizontal. The spindle was used with number L4. Press the button to the sample and record the result.

Moisture content

The dry method can be used to moisture content, the petri dish-washed and dried with tissue. The petri dish put into oven for 24 h and 105^oC. The petri dish put into exicator for 15-30 min. The petri dish was weighted and record as (P). The sample was weighted for 3 g and record as (Q). The petri dish with the sample put into oven for 24 h and temperature 105^0C. Then the petri dish put into exicator for 15-30 min. The petri dish was weighted and record as (R) (AOAC, 2005). Moisture content percentage can calculated with:

$$\% \text{ Moisture Content} = \frac{Q-R}{Q-P}\ x\ 100\%$$

Description:
P = Weight of empty petri dishes (g)
Q = Weight of petri dish and initial sample weight (g)
R = Weight of petri dish and samples after drying (g)

Antioxidant determination

The DPPH method was used for the determination of antioxidant (AOAC, 2005). Which is continued with the calculation of I_C50. Comparative sample and samples to be tested are made. Comparative solution and samples solution pipetted as 1 mL to the test tube and added with DPPH solution. The mixed solution was allowed to stand for 30 min at room temperature. The measurement of absorbance of the solution was measured with a spectrophotometer UV-vis at wavelength 517 nm with blank methanol. Percentage of free radical immersion can be calculated with:

$$\% \text{ Inhibition} = \frac{blank\ absorbance - sample\ absorbance}{blank\ absorbance}\ x\ 100\%$$

Sample concentration and % inhibition were included in the linear regression equation to determine I_C50 value. Concentration sample was added as x value and 5 inhibition was added as the y value. Determination of the value of I_C50 by entering the value of each sample in the equation. Y as 50 value and X as expected I_C50 value (Y=aX +b).

Statistical analysis

Analysis of variance was used to analyze the data, and then followed with Duncan Multiple Range Test (DMRT) to determine the significant differences.

RESULT AND DISCUSSION

The effect of different ginger extract on physicochemical quality of mayonnaise

The effect of different ginger extracts addition on the physicochemical quality of mayonnaise is presented in Table 1.

pH value

The added different ginger extract treatment didn't give significant effect (P>0.05) on pH of mayonnaise from each treatment. Mayonnaise (G) and mayonnaise (E) have the lowest pH value of 4.34 and mayonnaise (M) gives a higher pH value of 4.38. The pH value of mayonnaise control (P0-) has the same value as mayonnaise (G) and mayonnaise (E). Both of these treatments had higher acidity than mayonnaise (M). Mayonnaise with the addition of red ginger reduces sour taste. This is caused by mayonnaise having a more acid pH added to a more alkaline solution than the pH of red ginger and will reduce pH mayonnaise. Mayonnaise (P0-) with the lowest pH so the taste of mayonnaise is the most acid. Choonhahirun et al. (2008) stated that the control mayonnaise with the use of celery produced a pH value of 3.30. Gallego et al. (2013) mayonnaise with addition of thyme extract, lavender extract and rosemary extract from the leaf, flower, and stem have a pH value of 4-5 of mayonnaise. Kiskh et al (2013) mayonnaise with addition of flour ginger 0-1.25% has pH value 4.3 in the first week. Puligundla et al. (2015) stated that full-fat mayonnaise with soybean oil has pH value of 3.71.

Viscosity

The using of different ginger extract didn't give significant effect (P>0.05) on viscosity of mayonnaise from each treatment. Mayonnaise (G) gave the lowest viscosity of 3524.44 cP and mayonnaise (M) gave the higher viscosity of 3771.11 cP. The viscosity of treatments was higher than mayonnaise (P0+) but lower than mayonnaise (P0-). The characteristic moisture content, protein content and fat content contained in mayonnaise affect viscosity. The moisture content extract (M) has a low value of 5.35%. Moisture content extract (E) has a high value of 92.90%, the highest fat content among other ginger extracts was 0.47% and protein content was 0.86%. While moisture content extract (G) has a value 92.50%, fat content of 0.38% and protein content of 2.65%. The protein content in ginger can help the emulsification system in mayonnaise if there is a shaking or heating treatment so that it becomes more coagulated. The fat content contained in ginger will help the formation of texture so that the viscosity increases if the fat content is high. The moisture content of ginger extract will be effective for mayonnaise viscosity. The viscosity of mayonnaise will be decreased if the moisture content was higher. Fatimah et al. (2011) oil concentration which added to mayonnaise will be increased viscosity and the product will be thick. Puligundla et al. (2015) full-fat mayonnaise with the soybean oil have a viscosity of 2002.67 mPa.s.

Moisture content

The treatments gave a highly significant effect (P<0.01) on moisture content of mayonnaise. Mayonnaise (M)

gave the lowest moisture content of 13.57% and mayonnaise (E) gave the highest moisture content of 14.85%. The moisture content of mayonnaise (P0+) was 42.64%. The added starch is a polysaccharide which was very sensitive to water so that the starch will absorb water and cause high water content. Mayonnaise (P0-) has a moisture content of 13.13% and is the lowest when compared the mayonnaise with the addition of red ginger, emprit ginger, and elephant ginger. The mayonnaise (M) treatment has the lowest moisture content among other types of ginger. That was caused by high-fat content so the water absorption becomes less. Mayonnaise (E) has a higher moisture content. That is caused by the high moisture content of ginger extract with a low-fat content so that the moisture content of mayonnaise with the highest emprit ginger from all treatment of ginger. The overall moisture content of ginger has was lower than the mayonnaise standard. The BSN (1998) standard quality maximum moisture content of mayonnaise is 30%. Aghdei et al (2016) full-fat mayonnaise of control with soybean content of 78% gave moisture content of 14.70%.

Table 1. Physicochemical Quality of Mayonnaise with Added Different Ginger Extract

Variable	Control Treatment		Different Ginger		
	P0- / Without Treatment	P0+ / Commercial Mayonniase	Elephant Ginger (G)	Emprit Ginger (E)	Red Ginger (M)
pH*	3.71 ± 0.22	4.34 ± 0.13	4.34 ± 0.04	4.34 ± 0.05	4.38 ± 0.03
Viscosity (cP)*	4436.67 ± 155.67	1540.00 ± 134.54	3524.44 ± 766.67	3544.44 ± 770.51	3771.11 ± 636.22
Moisture Content (%)***	13.13 ± 0.51	42.64 ± 0.95	14.02^{a} ± 0.18	14.85^{b} ± 0.99	13.57^{a} ± 0.54
Antioxidant Activity (mg/mL) ***	126.72 ± 3.64	84.27 ± 2.40	105.43^{c} ± 9.56	109.99^{b} ± 2.78	90.45^{a} ± 5.68

Superscript in the same line shows *no significant effect (P>0.05); **significant effect (P<0.05); ***highly significant effect (P<0.01)

Antioxidant activity

A free radical amount of 50% can reduce by antioxidant concentration on µg/mL or antioxidant I_C50. The antioxidant I_C50 is inversely proportional to the antioxidant ability contained in an ingredient. The greater the ability of free radicals, the smaller the antioxidant value of I_C50 (Samuel et al., 2015). The statistical analysis showed that the treatment gave highly significant effect (P<0.01) on each treatment. Mayonnaise added with red ginger gave the lowest antioxidant activity of 90.45 mg/mL and mayonnaise added with elephant ginger gave the highest antioxidant activity of 109.99 mg/mL. This is caused by different antioxidants from each ginger. Based on previous research, red ginger contains antioxidant, total phenol and total flavonoids respectively 22.57 mg/mL, 98.87 mg/g and 15.95 mg/g; for elephant ginger 27.33 mg/mL, 50.60 mg/g and 8.97 mg/g and emprit ginger 24.57 mg/mL, 68.76 mg/g and 12.59 mg/g. Antioxidant activity can be seen from the total phenol and total flavonoids. Each ginger have different total phenol and total flavonoids. Ghazamsadeh et al. (2012), ginger was a source of high flavonoid components, cheap prices and can be used as an expensive food material. Bakota et al. (2015), phenolic acid is a molecule that mostly contains carboxylic acid molecules consisting of silicic acid compounds, gallic acid, caffeic acid, cinnamic acid, and other acids. Mayonnaise (P0-) has antioxidant activity I_C50 of 126.27 mg/mL and mayonnaise (P0+) has antioxidant activity I_C50 of 84.27 mg/mL.

Mayonnaise (P0+) uses synthetic antioxidants such as BHA and BHT which can have a negative effect on the body. Mayonnaise (P0+) have a higher antioxidant activity when compared with other treatment. Synthetic antioxidant has a good prevention role, but in the long run will result in adverse health effects. Bandhopadhyay et al. (2007) ginger extract shows the highest antioxidant value compared to commercial antioxidants such as BHA, BHT, and TBHQ. The usage of natural antioxidants can give benefits, such

as consumers acceptance, easy, and safe to use. Gallego et al. (2013) natural antioxidant contain vitamins, flavonoids, terpenoids, carotenoids, and phytoestrogen.

The effect different addition of ginger extract on physicochemical quality of mayonnaise

The effect of different addition level was 0.5% (a), 1% (b) and 1.5% (c) nested on different ginger on the physicochemical quality of mayonnaise showed in Table 2.

Viscosity

The different addition of ginger extract nested to different extract ginger gave a highly significant effect (P<0.01) on viscosity of mayonnaise from each treatment. The viscosity test results of treatment of adding the level of nested ginger extract level to elephant ginger from highest and the lowest were Gc (4290.00 cP) and Ga (2756.67 cP). The treatment of adding nested extract level to emprit ginger from highest and lowest was Ec (4373.33 cP) and Ea (2850.00 cP). The treatment of adding nested extract level to red ginger from highest and lowest were Mc (4446.67 cP) and Ma (3183.33 cP). The more levels of extract added to mayonnaise, the higher the viscosity will be.

This is in agreement with Gaonkar et al. (2010) addition of concentration in the dispersing medium will affect viscosity. Usman et al. (2015) showed that the standard viscosity of mayonnaise was 2540 Cp OR 24.5 Pa.s. The viscosity of mayonnaise can be influenced by carbohydrates contained in ginger extract. This was caused by hydrophilic group contained in the extract then binds the water so that the water increases its viscosity (Fitriani, et al., 2014). Mayonnaise added with mustard 0-1.5% will increase the viscosity of mayonnaise with the value 3759 cP – 4251 Cp (Milani et al., 2013).

Table 2. The Effect Different Addition of Ginger Extract on Physicochemical Quality of Mayonnaise

Variable	Different Ginger	Level of Addition		
		0.5% (a)	1% (b)	1.5% (c)
pH*	Elephant Ginger (G)	4.30 ± 0.05	4.36 ± 0.05	4.37 ± 0.04
	Emprit Ginger (E)	4.30 ± 0.06	4.32 ± 0.08	4.39 ± 0.12
	Red Ginger (M)	4.35 ± 0.03	4.37 ± 0.06	4.41 ± 0.01
Viscosity***	Elephant Ginger (G)	2756.67^{a} ± 266.33	3526.67^{b} ± 402.66	4290.00^{c} ± 212.84
	Emprit Ginger (E)	2850.00^{a} ± 155.24	3410.00^{a} ± 401.50	4373.33^{b} ± 315.65
	Red Ginger (M)	3188.33^{a} ± 76.38	3683.33^{a} ± 208.17	4446.67^{b} ± 126.62
Moisture Content**	Elephant Ginger (G)	13.83^{a} ± 0.99	14.05^{a} ± 0.70	14.18^{a} ± 0.63
	Emprit Ginger (E)	13.84^{a} ± 0.91	14.87^{a} ± 0.75	15.82^{b} ± 0.53
	Red Ginger (M)	13.04^{a} ± 0.65	13.53^{a} ± 0.41	14.13^{a} ± 0.54
Antioxidant Activity (mg/mL)***	Elephant Ginger (G)	116.14^{c} ± 1.44	102.39^{b} ± 1.45	97.76^{a} ± 1.92
	Emprit Ginger (E)	112.62^{b} ± 1.39	110.27^{ab} ± 1.67	107.08^{a} ± 1.32
	Red Ginger (M)	95.60^{c} ± 1.74	91.41^{b} ± 1.08	84.35^{a} ± 1.42

Superscript in the same line shows *no significant effect (P>0.05); **significant effect (P<0.05); ***highly significant effect (P<0.01)

Moisture content

The different addition of ginger extract nested to different extract ginger gave a significant effect (P<0.05) on moisture content of mayonnaise from each treatment. The moisture content test result of treatment of adding the level of nested ginger extract level to elephant ginger from highest and the lowest were Gc (14.18%) and Ga (13.83%).

The treatment of adding nested extract level to emprit ginger from highest to lowest were Ec (15.82%) and Ea (13.84%). The treatment of adding nested extract level to red ginger from highest to lowest were Mc (14.13%) – Ma (13.04%). The higher the level added to the mayonnaise, the moisture content will increase. This is due to the volume of water added to the mayonnaise and the water content of each different ginger. Increasing the volume of water in mayonnaise will affect the moisture content and texture of mayonnaise. The texture of mayonnaise will change to become thinner as the volume of water increases. Mayonnaise without treatment have the lowest moisture content from each treatment.

The treatment will the addition of 0.5%of each different ginger has a moisture content close to mayonnaise (P0-). Mayonnaise with the treatment addition of 1.5% from each different ginger between 14.13%-15.82%. Mayonnaise moisture content with treatment is still acceptable and below mayonnaise quality standard with a maximum value of 30% (BSN, 1998).

Antioxidant activity

The different addition of ginger extract nested to different extract ginger gave highly significant effect ($P<0.01$) on antioxidant activity of mayonnaise from each treatment. The antioxidant activity test result of treatment of adding the level of nested ginger extract level to elephant ginger from highest to the lowest was Ga (112.62 mg/mL) – Gc (107.08 mg/mL). The treatment of adding nested extract level to emprit ginger from highest to lowest was Ea (116.14 mg/mL) – Ec (97.76 mg/mL). The treatment of adding nested extract level to red ginger from highest to lowest was Ma (95.60 mg/mL) – Mc (84.35 mg/mL). The higher level of addition results in lower antioxidant activity and higher the antioxidant level.

This is because small molecules in antioxidants are able to inactivate the development of oxidation reactions by combining reactive molecules with free radicals (Samuel et al., 2015). Yashin et al. (2017) antioxidant can protect fats in oxidation degradation, control rancidity, slow the production of toxic oxidized products, improve the quality of nutrition and increase product shelf life.

CONCLUSION

This study can be concluded that mayonnaise with addition of red ginger is better than mayonnaise used elephant ginger or emprit ginger in terms of the physicochemical quality of mayonnaise. Mayonnaise using 1.5% level of each different ginger can improve the physicochemical quality of mayonnaise.

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