The Study of Avocado Mayonnaise with Addition of Dadih as Emulsifier

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Abstract. Mayonnaise is a semi-solid dressing, an emulsion of oil in water that made of oil, acidifier, and egg yolk as an emulsifier. Nowadays, consumers prefer natural and healthy food such as salad and others with mayonnaise as a dressing. Innovations in mayonnaise production are necessary to fulfill their needs. In this research, avocado flesh was used as raw material with dadih as emulsifier. Dadih has a potential to replace egg yolk as an emulsifier in mayonnaise due to its casein content. This research objective was to identify the physical, chemical and sensory properties of the resulted mayonnaise. The technique used was explorative method. The treatment was avocado pulp – olive oil ratio variation. The result showed that the ratio variation had an influence to physical, chemical and sensory properties of the resulted mayonnaise.

Keywords: Mayonnaise; Avocado; Dadih; Emulsifier; Emulsion

1. Introduction

Mayonnaise is an emulsion of oil in water, eventhough amount of the water is lesser than the oil. Thus, the emulsion is remains stable. Emulsion is generated by gradual mixing of oil with premix that contains egg yolk, vinegar, mustard. The oil is added steadily, creating foam; the covered oil in water droplets that is called crude emulsion. The combination of low acidity and high fat constitute to its stability against microbial decomposition.

Egg contributed to emulsification, stabilization, taste formation and color creation of mayonnaise. It has remarkable nutritional value that is 75% of water, 12.5% of protein, 12% of fat, and small proportion of carbohydrates. Egg yolk and egg white contain components that have an emulsion activity (Drakos and Kiosseoglou, 2008). Despite its adequate capability as an emulsifier, there is a concern that it is probably inducing high cholesterol and blood pressure. In that case, several researches were conducted to eliminate the addition of egg in mayonnaise production.

Shiby, et al. (2016) found that the substitution of egg yolk with avocado puree in the level of 50% was capable to decrease the olive oil addition from 55% to 43 %. The corresponded mayonnaise also has a decent carotenoid content (1.4-1.8 μg /g) and emulsion stability that shown by its micro-creaming structure stability. Low fat mayonnaise had been created by Evanuarini, et al (2016) with kefir as emulsifier replacer in the level of 30%, and it was capable to stabilize the emulsion. Dickinson (2008) stated that casein rapidly absorbs water in the surface, creates new oil droplets, reduces surface
tension, and forms layer to prevent new droplets breakage and maintains emulsion stability through electrostatic stabilization.

Thus, casein can serve as an emulsion stabilizer. Accordingly, dadih also has a potential as one in mayonnaise production. Dadih is a product of spontaneous fermentation of water buffalo’s milk that kept in bamboo tube. Dadih is high in nutrition and contains probiotic bacteria. The combination of avocado and dadih in mayonnaise production is expected to generate mayonnaise with functional properties and substantial nutrition that can increase consumer’s health. This research objective is to study avocado puree and olive oil ratio to physical, chemical and sensory properties of the corresponded mayonnaise.

2. Materials and Methods
The research was carried out in Laboratory of Technology and Agricultural Product Process Engineering, Laboratory of Biochemical and Nutrition of Agricultural Product, Laboratory of Microbiology and Biotechnology of Agricultural Product and Laboratory of Instrument, Faculty of Agricultural Technology Andalas University.

Apparatus used were spectrophotometer, centrifuge, bright field light microscope, Brookfield digital viscometer, and laboratory glassware. Materials used for mayonnaise production were avocado (Mega Merapi type), olive oil, dadih, vinegar, spices, and gum arabic.

The research used Complete Randomized Design (CRD) with 5 treatments and 3 replications. Formulation of each treatment can be seen on Table 1. Parameters analyzed were emulsion stability, viscosity, pH, color measurement with HunterLab, total lactic acid bacteria and sensory evaluation.

| Ingredients        | P1 | P2 | P3 | P4 | P5 |
|--------------------|----|----|----|----|----|
| avocado (g)        | 15 | 30 | 45 | 60 | 75 |
| olive oil (g)      | 75 | 60 | 45 | 30 | 15 |
| dadih (g)          | 50 | 50 | 50 | 50 | 50 |
| salt (g)           | 1  | 1  | 1  | 1  | 1  |
| sugar (g)          | 1  | 1  | 1  | 1  | 1  |
| vinegar 5% (g)     | 10 | 10 | 10 | 10 | 10 |
| spices (g)         | 2  | 2  | 2  | 2  | 2  |
| arabic gum (g)     | 5  | 5  | 5  | 5  | 5  |

2.1. Procedure of Analysis

2.1.1. Emulsion Stability
Emulsion stability was analyzed based on method in Nikzade et al. (2012). The principle is to separate dispersed phase from continuous phase that has a specific gravity difference with the help of gravitation. The emulsion was centrifugated in 1460 g for 20 minutes to check the phase separation traits such as creaming or sedimentation. Stability of sample was represented by index of creaming (IC) as depicted by equations below, where HS was the level of supernatant and HE was emulsion height.

\[ IC = \left( \frac{HS}{HE} \right) \times 100 \]  

2.1.2. Viscosity
Viscosity analysis was done using Brookfield Digital Viscometer (M/s Brookfield Engineering Company, MA, USA) model LVDV-E with spindle number of 5 in 25 ± 1 °C. The principle is the measurement of fluid resistance to flow due to against deformation or a change in shape when the material is subjected to a certain force. The result of the test was expressed in unit of centipoise (cP).
2.1.3. Color Measurement
Color measurement was performed using colorimeter Color Quest XE (HunterLab, Reston, USA) with D65 illuminant and angle of 10. The parameters were CIELAB with L*(Lightness with value 0 was black to 100 was white), a*(red and green value, respectively), and b*(yellow and blue components). The instrument was calibrated with standard reference of white (L = 90.55, a = -0.71, b = 0.39) prior use.

2.1.4. Total Lactic Acid Bacteria
Serial dilution was done until 10⁹ dilution obtained. Each dilution step was as follow: 1 ml of probiotic was pipetted, mixed with 9 ml of NaCl 0.85%. The liquid was homogenized using vortex. Dilution of 10⁶ to 10⁸ was cultured in De Man, Rogosa and Sharpe agar (MRSA) plate, in duplo. It was incubated in 37°C for 48 hours. The calculation was based on Standard Plate Count (SPC) and equation below.

\[
\text{amount of} \ \frac{\text{cells}}{\text{ml}} = \frac{\text{average of total colony}}{\text{dilution factor}}
\]  (2)

3. Results and Discussions
3.1. Viscosity
The treatments influence to viscosity is shown on Table 2. The apparatus used was viscometer (Digital Brookefield) with spindle number 5 and speed of 30 rpm. Composition of raw materials in mayonnaise has an impact to the characteristic of mayonnaise, including viscosity. The increase ratio of avocado will affect viscosity where the maximum value shown in P5 of 4187.00 cP and minimum value in P1 of 3040.00 cP. Shiby et al. (2016) result on avocado addition in mayonnaise presented a similar trend. High viscosity was given by avocado pulp that acted as pseudoplastic fluid. The rise of viscosity may also influence by the addition of dadih as emulsifier and gum arabic as stabilizer.

| Treatments (avocado pulp : olive oil) | Viscosity (cP) | Emulsion Stability (Average ± Std. Dev.)* | pH (Average ± Std. Dev.) |
|--------------------------------------|---------------|------------------------------------------|--------------------------|
| P1 (1 : 5)                           | 3040.00       | 41.67 ± 8.99 a                           | 4.63 ± 0.25              |
| P2 (1 : 2)                           | 3067.00       | 65.48 ± 7.43 b                           | 4.63 ± 0.21              |
| P3 (1 : 1)                           | 3227.00       | 70.24 ± 7.43 b c                         | 4.60 ±0.24               |
| P4 (2 : 1)                           | 3320.00       | 82.14 ±6.19 c d                         | 4.61 ± 0.21              |
| P5 (5 : 1)                           | 4187.00       | 89.29 ± 3.57 d                          | 4.57 ± 0.14              |

Number in the same row followed by different lowercase letters, significantly different at the 5% level in Duncan’s New Multiple Range Test (DNMRT)

Viscosity is the resistance of fluid to movement. Viscosity will increase when internal phase (dispersed phase) has greater volume than external phase (continuous phase). As Rozaq (2010) stated that several factors influencing viscosity of emulsion including dispersed phase viscosity, continuous phase concentration, dispersed phase particle size, and concentration of emulsifier and stabilizer used.

Zuge et al. (2017) explained that phospolipid extracted from avocado oil capable of forming emulsion and maintains its stability. It was exhibited rheological behaviour of pseudo-plastic on pH 3 to 7. Besides, this emulsion also behaved as gel with strong intermolecular force. Thus, phospolipid of avocado that mostly waste material of oil industry has a potential to use in emulsion-based product, not only in food but also cosmetics and medical use.

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Mayonnaise viscosity also affected by its emulsion system. Excessive addition of water will made emulsion prone to break, while higher amount of fat particle in dispersed phase will increase viscosity (Mc Nulty, 2007). Avocado mayonnaise had adequate viscosity and the increase of avocado ratio followed by viscosity acceleration as can be seen in Table 2.

3.2. Stability of Emulsion
The treatment of avocado to olive oil ratio resulted in stability of emulsion ranging from 41.67 (P1) % to 89.29% (P5) as can be seen on Table 2. Those treatments also had a significant effect to stability emulsion. Emulsion stability is affected by phase density difference, particle size, storage condition, temperature, amount and effectivity of emulsifier (Suseno dan Husodo, 2002). Further, casein of fermented milk such as dadih may act as emulsifier in mayonnaise due to its capability in stabilizing emulsion droplets by forming layer in oil surface. Casein has a flexible random coil structure that rapidly opens in interphase and forms fine layer surrounding droplets (Evanuarini et al. 2016).

The increasing of stability of emulsion in mayonnaise was in parallel with the quantity of avocado pulp. Stability of emulsion was in accordance with experiment result of Shiby (2016). Zuge et al. (2017) found that phospolipid is abundant in avocado oil. Phospholipid is a natural surfactant that commonly used for preparation of oil-in-water (O/W) and water-in-oil (W/O) emulsion such as in chocolate, biscuit, mayonnaise and so on (Comas et al., 2006). Although surface area that separated oil and water phase is just a small part of an emulsion, but it has a vital role in physicochemical and sensory of the corresponded emulsion. Thus, utilization of emulsifying capability of basic materials is significant in enhancing emulsion quality.

Avocado mayonnaise is a reduced fat mayonnaise that commonly has high moisture content. It is common for such a product, due to process of decreasing dispersed phase that is oil, and increasing of continuous phase that is water. The use of materials that act as emulsifier (though without egg yolks) was contributed to emulsion stability that remains in high level. Several researches showed variety of technique to reduce fat content in mayonnaise. One of the methods was to use Chia seed mucus. Fernandes and Salas-Mellado (2018) found that Chia seed mucus had emulsifying capacity 100 times higher than soybean oil in mayonnaise. Thus, chia seed mucus is possible to used as fat substitute in food, decreasing fat content and maintaining product characteristics. Amin, et al. (2014) on the study of reduced fat mayonnaise had used carbohydrate as thickener. The increase of water addition resulted in the decrease of amount of fat.

3.3. Acidity (pH)
PpH value represents acidity in solution that is the result of dissociated hydrogen ions measurement. The treatment had no significant influence to the acidity of mayonnaise. As shown on table 2, pH of mayonnaise is ranging from 4.57 to 4.63. The addition of vinegar and dadih were contributed to the resulted pH. Dadih had pH of 4.47, while avocado had pH of 6 to 6.5. The optimum pH mayonnaise for preventing the growth of spoilage microorganisms is in the range of 2.5 to 4.5 (McClement, 2005)

3.4. Color Properties
Color is one of the important quality attributes in food product. Color is one of the standard that used by costumers in selecting product prior considering taste and nutritional value. Color measurement of mayonnaise were done by using Hunterlab colorflex Ez spectrophotometer with 3 color parameters with notations of L*, a*, and b*.

| Table 3. Color Measurement Result |
|----------------------------------|
| Treatments | L* | a* | b* | °hue ± SD | CRR |
| (avocado pulp: olive oil)        |
| P1 (1 : 5)  | 63.22 | -3.82 | 22.93 | 99.48 ± 1.24 | a | Yellow |
| P2 (1 : 2)  | 68.19 | -4.62 | 26.10 | 100.02 ±1.12 | a | Yellow |
| P3 (1 : 1)  | 67.06 | -5.22 | 26.31 | 101.21 ±0.77 | b | Yellow |
| P4 (2 : 1)  | 66.06 | -6.11 | 26.67 | 102.90 ±0.35 | b | Yellow |
P5 (5 : 1) 65.58 -6.51 27.26 103.43 ± 0.91 c Yellow

Note: - CRR is color range region
- Number in the same row followed by different lowercase letters, significantly different at the 5% level in Duncan's New Multiple Range Test (DNMRT)

6hue of mayonnaise were ranging from 99.48° in treatment A to 103.43° in treatment E. L* value is the representation of lightness of product with the value range of 0 to 100. The higher L* value means that product has higher brightness. Higher avocado ratio reduced the L* value. The color of avocado mayonnaise was more greenish although still in the color range of yellow. The resulted product is displayed in Figure 1. Shiby (2016) also found the same result of L* value due to the addition of avocado pulp.

3.5. Sensory Evaluation
Sensory evaluation has a vital function in determining customer acceptance of food product. The method used in this experiment was hedonic test with the scale of 1 to 5. The lesser number represents not liking, while the bigger number represents panelist likeness. The sensory test parameters were color, aroma, taste and texture. The result was shown in Table 4.

Table 4. Sensory Evaluation Result of Avocado Mayonnaise

| Treatments (avocado pulp : olive oil) | Color     | Aroma    | Taste    | Texture   |
|--------------------------------------|-----------|----------|----------|-----------|
| P1 (1 : 5)                           | 3.92 ± 0.91 | 3.56 ± 0.96 | 3.64 ± 0.95 | 3.44 ± 0.96 |
| P2 (1 : 2)                           | 3.52 ± 0.92 | 3.08 ± 0.91 | 3.12 ± 0.78 | 3.36 ± 0.86 |
| P3 (1 : 1)                           | 3.52 ± 0.77 | 3.20 ± 0.82 | 3.20 ± 0.71 | 3.44 ± 0.96 |
| P4 (2 : 1)                           | 3.84 ± 0.85 | 3.40 ± 0.71 | 3.48 ± 0.77 | 3.76 ± 0.66 |
| P5 (5 : 1)                           | 3.16 ± 0.85 | 3.24 ± 0.97 | 3.04 ± 0.79 | 3.36 ± 0.95 |

Mayonnaise product of P1 (1:5) had the maximum sensory acceptance followed by P4 (2:1). The resulted value was in the range of likeness. Mayonnaise color was dominated by yellow. The combination of avocado (type of Mentega) pulp, dadih and olive oil were affecting the color of the corresponded mayonnaise.

Food appeal is influenced by physical appearance such as color. It is appetize customer to select the product, together with aroma, taste and texture. The color of food is caused by natural pigment or addition of colorant. Natural pigments include the existed colorant and the pigment that formed during heating and storing.

Product appearance score decreased significantly in concomitant with the increase of avocado addition ratio. The color score of mayonnaise with 25% substitution of avocado was better than the other substitution level. Overall score of that treatment was also shown significant value compare to others. The overall value is mainly given by attributes such as apperance, color, aroma, texture and taste (Elsorady et al. 2016). Dadih addition also contributed to the increasing panelist likeness in color, taste, aroma and texture. The radar chart of panelist acceptance can be seen in Figure 2. Based on the chart, treatments that shown optimum score were P1 and P4.
3.6. Total Lactic Acid Bacteria (LAB)
LAB that existed in mayonnaise were from dadih. In general, LAB species in dadih are *Streptococcus thermophylus* and *Lactobacillus casei*. The total LAB found were $1.37 \times 10^6$ cfu in P1 and $5.79 \times 10^6$ cfu in P4. There was no significant difference due to the addition of dadih that remains constant. Dadih role in mayonnaise production is as an emulsifier that provided by casein of dadih.

LAB are main organisms that mainly responsible in milk fermentation and naturally milk is a suitable habitat for LAB growth. LAB exists in milk due to spontaneous fermentation or by deliberate addition as starter. On spontaneous fermentation without insertion of starter and appropriate sterilization of raw material, uncontrollable growth of LAB occurs, as practiced traditionally for years (Widyastuti et al. 2014). Wirawati et al., (2017) found the variety of LAB species on samples that collected from various locations in West Sumatra. Dominant genus of LAB that succesfully identify were *Lactobacillus, Leuconostoc, Lactococcus, Streptococcus* and *Enterococcus*, while identified bacteria was also diverse. It was depends on the analyzed sample origin. The characteristic of fermented milk by spontaneous fermentation is affected by region, due to variety of natural microflora that grows on different condition.

4. Conclusions
Based on sensory evaluation and physicochemical properties of the resulted avocado mayonnaise, it can be concluded that the ratio of avocado to olive oil in the level 2 to 1 produced low fat mayonnaise that accepted by panelists. The properties of the correspondent treatment were viscosity of 3320 cP, emulsion stability of 82.14 %, total LAB of $5.79 \times 10^6$ cfu. It is suggested to analyze functional characteristic of the resulted mayonnaise to determine its probability as functional food.

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