Physicochemical Quality of Reduced Fat Mayonnaise With *Aloe vera Powder* as a Natural Antioxidant

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ABSTRACT

Aims: This research aims at determining the effect of different percentages (2%, 4%, and 6%) of Aloe vera powder (AVP) on antioxidant activity, fiber, protein, and color analysis (L a* b*)
Study design: The research was designed as laboratory experimental method.
Place and Duration of Study: This research was conducted at the Animal Product Technology Laboratory, Egg Processing Division, Faculty of Animal Science, Brawijaya University. The study was conducted over a period of one month (July-August).
Methodology: The research used a laboratory experimental method with a CRD **(**Completely Randomized Design)**,** using four treatments and six replications. The data were analyzed using ANOVA, and any significant or highly significant differences were further tested using DMRT.
Result: The result of this study shows that the addition of aloe vera powder can enhance antioxidant activity (3.28%-30.52%), crude fiber (0.89%-1.24%), protein (13.80%-15.37%, reducing fat content (41.49%-72.84%), and improve the color quality of reduced fat mayonnaise (RFM)
Conclusion: The addition of AVP to RFM can increase the antioxidant activity, crude fiber, and protein content, while reducing the fat content. The addition of AVP also affects the color of the mayonnaise, making it brighter and more appealing. The addition of 6% AVP can improve the physicochemical quality of RFM.

Keywords: *Aloe vera powder,antioxidant, mayonnaise, and oxidation.*

1. INTRODUCTION

Mayonnaise is a popular food product, particularly as an accompaniment in various dishes. This product is typically made from a mixture of fresh eggs, oil, vinegar, and additional Ingredients like salt, sugar, mustard, and pepper, which combine to form a semi-solid emulsion (Liu, Sun, and Gontard, 2024). Mayonnaise is available in several varieties, including full fat mayonnaise, reduced fat mayonnaise (RFM), low fat mayonnaise, light mayonnaise, and salad dressing. The main characteristic of full fat mayonnaise is its high oil content, which gives it a creamy texture and distinctive flavor. However, its high fat content makes it less suitable for consumers who are concerned about their calorie or fat intake. To meet the demand from consumers increasingly aware of the importance of a healthy diet, RFM was developed. This variant contains less fat compared to full fat mayonnaise. In RFM, the fat content is reduced by about 40–50%, which makes it more prone to oxidation. As a result, natural antioxidants such as Aloe vera powder (AVP) are needed as a source of natural preservatives. Previous

studies have added natural antioxidants to RFM, such as avocado seed flour (Juliana and Evanuarini, 2024), pumpkin flour (Nidhal, Evanuarini, and Thohari, 2022), and apple peel powder (Evanuarini and Susilo, 2024).

Aloe vera is widely known as a plant with various benefits due to its content. *Aloe vera* contains a high level of antioxidants, approximately 31.49%. The antioxidants in Aloe vera are composed of phenolic compounds, flavonoids, polyphenols, and vitamins C and E (Agustian and Ruriani, 2024). *Aloe vera* as an antioxidant, has been proven to reduce the oxidation of soybean oil (Karami, Nateghi, and Asadollahi, 2023). Antioxidants also contain carbohydrates, fiber, and protein, so their addition to food ingredients brings health benefits to the body. *Aloe vera* also contains color pigments that can improve the color quality of fruit juices, as it enhances the a* and b* indicators (Moselhy et al., 2024). AVP has been added to food bars (Gorsi et al., 2024). It has also been incorporated into yogurt products to enhance their physicochemical quality (Khalel et al., 2023). While *Aloe vera* has been widely added to various food products, it has not yet been added to mayonnaise products. Therefore, this research is necessary.

Therefore, the addition of AVP is expected to provide a solution to the growing concerns about the increasing use of mayonnaise as a food accompaniment. This study seeks to explore the changes in the chemical and sensory characteristics of RFM with different concentrations of AVP, which are thought to play a role in the increasing prevalence of degenerative diseases like diabetes, obesity, and heart disease (Evanuarini and Nidhal, 2023).

2. MATERIAL AND METHODS

2.1 Materials

The ingredients used in the production of RFM include fresh eggs, 1-day old, obtained from the teaching farm of the Faculty of Animal Science, Brawijaya University. Other ingredients such as canola oil, vinegar, sugar, salt, pepper, and mustard were purchased from a supermarket, while AVP was commercially sourced through an online marketplace.

2.2 Methods

In this study, a laboratory experimental approach was utilized, using a completely randomized design with four different conditions and six replications for each condition. The treatments were as follows: FFM 0 (without the addition of AVP), RFM 1 (with the addition of 2% AVP), RFM 2 (with the addition of 4% AVP), and RFM 3 (with the addition of 6% AVP).

2.3 Procedure For Making Reduced Fat Mayonnaise

The production of RFM was carried out according to the formulation guidelines of Juliana and Evanuarini (2024), which have been modified and are outlined in Table 1.

Table 1. Formulation of Reduced Fat Mayonnaise

Ingredient (%)	FFM 0	RFM 1	RFM 2	RFM 3
Canola oil (%)	70	40	40	40
Egg Yolk (%)	20	20	20	20
AVP (%)	0	2	4	6
Vinegar (%)	5	5	5	5
Sugar (g)	2	2	2	2
Salt (g)	1.5	1.5	1.5	1.5
Pepper (g)	0.5	0.5	0.5	0.5
Mustard (g)	1	1	1	1
Water (%)	-	30	30	30

**FFM 0: Full fat mayonnaise without AVP. RFM 1: 2% AVP addition, RFM 2: 4% AVP addition, RFM 6% AVP addition.*

Prepare the predetermined formulation. Add the dry ingredients, such as sugar, salt, pepper, and mustard, into a bowl, then mix them until well combined. Add the egg yolks and mix until the color changes to a pale yellow. Gradually pour in the canola oil, alternating with vinegar, and continue mixing. Add the AVP that has been finely ground and sifted using a 100-mesh sieve, according to the treatments of 2%, 4%, and 6%. The RFM with added AVP is then transferred into a glass jar and stored in the refrigerator for 24 hours to achieve stable emulsion.

2.4 Mayonnaise Quality

2.4.1 Antioxidant Activity

The antioxidant activity was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay (AOAC, 2005). In this approach, 1 ml of the sample and ascorbic acid were each combined with 1 ml of a 0.1 M DPPH solution in a test tube, then left to incubate at room temperature for 30 minutes. Following this incubation, absorbance was measured using a UV-visible spectrophotometer at 517 nm, with 1 ml of methanol as the reference.The inhibition percentage of free radicals was calculated with the following formula:

$$\% \text{ inhibition} = \frac{A\ DPPH\ x\ A\ sample\ DPPH}{A\ DPPH} \text{ x } 100\%$$

2.4.2 Crude Fiber

The crude fiber test was conducted using the acid-alkali digestion method (AOAC, 2005). The principle of the crude fiber test involves hydrolyzing the sample with strong acid and base. A 2 g sample was first defatted with ether, then placed in a Soxhlet apparatus and treated with 220 ml of 0.225 N H_2SO_4. The sample was heated for 30 minutes and then homogenized. The mixture was filtered, and the remaining residue was rinsed with boiling distilled water until the acidity was eliminated. The residue was then transferred into an Erlenmeyer flask, washed with 200 ml of boiling 0.313 N NaOH, and filtered. The residue was washed with 10% K_2SO_4 (15 ml), followed by washing with 95% ethanol to remove any remaining chemicals. The filter

paper was dried at 60°C until a constant weight was achieved. The crude fiber content was calculated using the formula:

$$\text{Crude fiber (\%)} = \frac{c-b}{a} \text{ x } 100\%$$

Description:
a = Sample mass
b = Mass of empty paper (initial)
c = Mass of filter paper with residue (final)

2.4.3 Protein

The protein content was determined using the Kjeldahl method (AOAC, 2005). This test requires materials such as the sample, H_2SO_4 solution, distilled water (aquades), and a color indicator, as well as equipment including a balance, filter paper, Erlenmeyer flask, and beaker glass. First, the sample is digested with sulfuric acid (H_2SO_4), which converts the nitrogen in the sample into ammonium. After digestion, the solution is diluted, and sodium hydroxide (NaOH) is added to convert the ammonium into ammonia gas (NH_3). The ammonia gas formed is then distilled and absorbed in boric acid solution. Next, the absorbed ammonia is titrated with a standard acid solution to determine the nitrogen content. The protein content is calculated by multiplying the determined nitrogen amount by a conversion factor of 6.25.The protein content is then calculated using the following formula:

$$\text{Protein (\%)} = \frac{(D-C)\ x\ n\ Na0H\ x\ 0{,}014\ x\ 6{,}25}{B-A} \text{ x } 100\%$$

Description:
A = The mass of the paper (g)
B = The mass of the paper and sample (g)
C = The mass of NaOH for titrating the sample (mL)
D = The mass of NaOH for titration without the sample (mL)

2.4.4 Fat Content

The Soxhlet method was employed to determine the fat content AOAC, 2005). The fat test requires materials such as the sample, Petroleum Ether (PE) solution or Petroleum Benzene (40 ml above, 60 ml below). The equipment needed includes filter paper, cotton, an oven, an desiccator, and an analytical balance. First step is preparing the sample, which is dried and ground, and then placed in a cellulose thimble. The thimble is then placed in the Soxhlet apparatus, and a solvent such as ether or hexane is heated to extract the fat from the sample. After extraction is complete, the fat dissolved in the solvent is collected in a receiving flask, and the solvent is evaporated. The fat content is determined by weighing the remaining fat after the solvent has been evaporated. The fat content can be determined using this formula:

$$\text{Fat content}(\%) = \frac{A\ (B-C)}{A} \text{x } 100\%$$

Description:
A = Sampel weight (g)
B = Weight of the paper + cotton + sample after being oven-dried (g)
C = Weight of filter paper (g)

2.4.5 Color L a* b*

The color L a* b* test was performed using an instrument called a color reader (AOAC, 2005). The procedure involves turning on the device, calibrating it by measuring black and white porcelain colors, and positioning the color reader perpendicularly. After that, the sample color is measured, and the values for dL, da*, and db* will appear. The L scale ranges from 0 to 100, while the a* and b* scales range from -128 to 128.
Description:
L = Lightness
a* = Redness, the further it moves from the positive value, the closer it gets to green
b* = Yellowness, the further it moves from the positive value, the closer it gets to blue

2.5 Data Analysis

The data from the study were processed with the Statistical Package for the Social Sciences (SPSS) Statistics 25 and analyzed through analysis of variance (ANOVA). If significant or highly significant differences are observed, additional testing will be carried out using Duncan's Multiple Range Test.

3. RESULTS AND DISCUSSION

The research data on the chemical quality of reduced fat mayonnaise with the addition of Aloe Vera powder is presented in Table 2, while the research data on the color test (L a* b*) is presented in Table 3.

Table 2. Characteristics of Chemical Quality of FFM and RFM with the Addition of AVP

Parameter	FFM 0± SD	RFM 1± SD	RFM 2 ± SD	RFM 3± SD
Antioxidant Activity (%)	3.28 ± 0.09^{a}	10.05 ± 0.02^{b}	20.35 ± 0.04^{c}	30.52 ± 0.03^{d}
Fiber (%)	0.89 ± 0.08^{a}	1.05 ± 0.09^{b}	1.15 ± 0.05^{b}	1.24 ± 0.05^{b}
Protein Levels (%)	13.80 ± 0.12^{a}	14.11 ± 0.08^{b}	14.70 ± 0.08^{c}	15.37 ± 0.07^{d}
Fat content (%)	72.84 ± 0.06^{c}	41.66 ± 0.02^{b}	41.55 ± 0.02^{a}	41.49 ± 0.03^{a}

**FFM 0: Full fat mayonnaise without AVP. RFM 1: 2% AVP addition, RFM 2: 4% AVP addition, RFM 3: 6% AVP addition. The difference in superscripts within a single row indicates a highly significant difference. SD: Standard Deviation.*

Table 3. Average value of L a* b* (lightness, redness, yellowness)

Treatments	Lightness ± SD	Redness ± SD	Yellowness ± SD
FFM0	85.79 ± 0.42^{a}	0.85 ± 0.15^{b}	67.56 ± 0.41^{c}
RFM1	86.17 ± 0.47^{a}	0.64 ± 0.14^{b}	62.16 ± 0.78^{b}
RFM2	88.05 ± 0.73^{b}	0.43 ± 0.17^{a}	60.27 ± 0.30^{a}
RFM3	89.81 ± 0.82^{c}	0.23 ± 0.09^{a}	59.54 ± 0.29^{a}

**FFM 0: Full fat mayonnaise without AVP. RFM 1: 2% AVP addition, RFM 2: 4% AVP addition, RFM 3: 6% AVP addition. The difference in superscripts within a single row indicates a highly significant difference. SD: Standard Deviation.*

3.1 Antioxidant

Antioxidant activity plays a crucial role in combating free radicals. The antioxidant activity values of RFM with the addition of AVP are presented in Table 2. Table 2 shows that the AVP has a highly significant impact ($P<0.01$) on antioxidant activity. The higher the addition of AVP, the greater the antioxidant activity. This is because AVP contains natural antioxidants such as vitamin E, vitamin C, chlorophyll, phenols, flavonoids, and polyphenols, which can protect lipids from factors that trigger oxidation or by reducing the spread of the oxidation process itself, a phenomenon known as "chain breaking" (Agustian and Ruriani, 2024). Therefore, its application in fat-based food products, such as mayonnaise, can be an effective way to prevent the deterioration of product quality typically caused by oxygen. The highest antioxidant activity value was 30.52%, which is higher than the RFM with 3% apple peel powder, which showed an antioxidant activity value of 19.38% (Evanuarini and Susilo, 2021).

3.2 Crude Fiber

The crude fiber of RFM with the inclusion of AVP is shown in Table 2. Table 2 indicates that the addition of AVP has a significant impact ($P<0.01$) on the crude fiber content. The higher the concentration of Aloe vera powder added, the greater the fiber content in the RFM, ranging from 0.89% to 1.24%. As the amount of AVP increases, more crude fiber becomes integrated into the product. This is because AVP contains polysaccharides such as hemicellulose and cellulose, which form the structural components of plant cell walls (Comas-Serra, 2024). These fibers cannot be digested by the human body, thereby increasing the crude fiber content in the RFM in proportion to the amount of AVP used. The crude fiber content in RFM with the addition of pumpkin flour ranges from 0.30% to 0.90% (Nidhal, Evanuarini, and Thohari, 2022).

3.3 Protein

The protein content data of the research is shown in Table 2. Based on Table 2, it can be observed that the addition of AVP significantly impacted the protein content ($P<0.01$). This is because AVP contains approximately 0.12% protein (Kamble, *et al*., 2022). Although its protein content is low, it still has an impact on the protein content of the RFM. The protein content values in this study ranged from 13.80 % to 15.37 %. These protein content values are considered satisfactory, as they meet the SNI standard for mayonnaise, which specifies that the protein content in mayonnaise should be at least 0.9% (SNI 01-4473-1998). This value is also comparable to research on the inclusion of apple peel flour to RFM, which resulted in a protein content ranging from 1.26% to1.44% (Evanuarini and Susilo, 2024).

3.4 Fat Content

The fat content results of RFM presented in Table 2. The addition of AVP to RFM significantly affected its fat content ($P<0.01$). The main factor in determining the fat content in mayonnaise is the amount of vegetable oil added, although the fat content of egg yolk also contributes slightly to the overall fat content. In the control treatment without the addition of AVP, the fat content was 72.84%, as it used a 70% vegetable oil percentage. In contrast, treatments RFM 1 to RFM 3 resulted in fat content ranging from 41.66% to 41.49%. As the percentage of AVP increased, the fat content decreased. This is because AVP contains a small amount of pectin, which can help bind fat by forming a matrix that traps fat particles (Gorsi et al., 2024). The results of this research are almost comparable to RFM with the addition of konjac flour, which showed a fat content ranging from 37.61% to 64.11% (Fakhira et al., 2024).

3.5 Color L a* b*

A color reader was used to conduct the L a* b* color test. Color indicators measured were lightness, redness, and yellowness. The results for each color indicator are presented in Table
The study shows that the addition of AVP has a important impact ($P<0.01$) on the lightness, redness, and yellowness indicators. The lightness values ranged from 85.79 to 89.81, indicating that the RFM has a bright color. The AVP is added, the higher the L value increases. This is because the *Aloe vera* gel, which is turned into powder, has a bright white color, thereby increasing the lightness level of the RFM product.The a* or redness indicator showed a decrease in value ranged from 0.23 to 0.85, The lower the value of a*, the color tends to shift towards green, which is due to the chlorophyll content in AVP (Mohammadi et al., 2024). The addition of more AVP can decrease the b* value or yellowness, rangedas AVP tends to have a bright and slightly green color, which contains little to no yellow pigments. In previous studies, RFM with the addition of corn starch had an L value of 92.7 (Carcelli et al., 2020), while RFM with the addition of white yam powder showed a green color with a value of 3.70 (Rojas-Martin et al., 2023). RFM with the addition of avocado seed powder had a b* value ranging from 34.27 to 54.14, indicating a yellow product (Juliana and Evanuarini, 2024).

4. CONCLUSION

The addition of AVP to RFM can increase the antioxidant activity, crude fiber, and protein content, while reducing the fat content. The addition of AVP also affects the color of the mayonnaise, making it brighter and more appealing. The addition of 6% AVP can improve the physicochemical quality of RFM.

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