The effect of hydroxy propyl methyl cellulose on emulsion stability and sensory properties of virgin coconut oil mayonnaise

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Abstract. Mayonnaise is a semi-solid emulsion made by mixing ingredients such as vegetable oil, egg yolks, and other food ingredients with or without adding food additives, such as stabilizers. This research aimed to study the effect of hydroxypropyl methylcellulose (HPMC) on the emulsion stability and sensory properties of mayonnaise made from virgin coconut oil. In this study, the treatment was the addition of HPMC, namely MV1 (0%), MV2 (2%), MV3 (3%), MV4 (4%), and MV5 (5%), into the mayonnaise formulation. The data obtained were analyzed statistically using analysis of variance and continued with DNMRT at the 5% level. The analysis of variance showed that the HPMC concentration significantly affected emulsion stability, viscosity, degree of acidity, and sensory test of thickness but had no significant effect on the aroma, color, and taste of the mayonnaise. The best treatment was MV5 (5% HPMC), which had 100% emulsion stability, 70119.33 cP viscosity, 5.07 pH on day one, and 99.37% emulsion stability, 69047.33 cP viscosity, and 4.87 pH on day 15. The MV5 mayonnaise was yellowish, had a coconut taste, was slightly rancid, and was thick. The MV5 mayonnaise was more favorable than other treatments regarding the aroma, color, and taste of the mayonnaise.

1 Introduction

Virgin coconut oil (VCO) is oil prepared from fresh, mature kernels of the coconuts by mechanical or natural means, with or without the use of heat, but precisely without any chemical refining, bleaching, or deodorizing (RBD) [1]. Some minor components, like tocopherols and phenolic compounds, are retained, and VCO exhibited several pharmacological activities, including antioxidant, anti-inflammatory, immunomodulatory, anti-hyperlipidemia, and anticancer [2]. Virgin coconut oil can be processed into mayonnaise with higher antioxidant activity, but the 100% VCO sample had the largest droplet size, texture firmness, and viscosity among the samples [3]. Oil droplet size distribution, firmness, consistency, storage modulus (G0), and yield stress were influenced by the type of oil used [4][5]. Mayonnaise is a semi-solid oil-in-water emulsion in which, in addition to eggs, other stabilizers and thickeners are used as emulsifiers for better stability [6][7]. The earlier study's

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findings demonstrated a high potential for using VCO in mayonnaise production to improve the product's biological functions, but emulsion stability still needs to be improved.

Increasing the stability of the emulsion and viscosity of mayonnaise can be done by adding hydroxypropyl methylcellulose (HPMC*)* as a stabilizer. Hydroxypropyl methylcellulose is a cellulose ether widely used in drug formulations due to its biocompatibility, uncharged nature, solubility in water, and thermoplastic behavior [8]. Hydroxypropyl methylcellulose has been used in the food, cosmetic, and pharmaceutical industries for decades and has been granted GRAS status [9]. The HPMC has a neutral taste and smell, is stable if stored for a long time, and is not toxic or acid-resistant. Adding >1% HPMC can stabilize peanut butter for six months or longer, increasing sample firmness and adhesiveness, which mimics the properties of traditional peanut butter products stabilized with hydrogenated vegetable oils [9]. In this study, VCO-based mayonnaise products with HPMC as stabilizers are expected to improve emulsion stability and viscosity and maintain the mayonnaise's color, aroma, and taste. This study aimed to study the effect of HPMC on the emulsion stability and sensory properties of VCO mayonnaise.

2 Methods

2.1 Materials

The mayonnaise ingredients were virgin coconut oil (VCO), egg yolk, hydroxypropyl methylcellulose (HPMC) from Thirtha Food Mandiri Company, salt, granulated sugar, lemon, and water. The chemicals used were buffer solution, equates, and hexane,

2.2 Research design

This study used a complete randomized design with five treatments, each repeated three times. The treatment was the addition of HPMC, namely MV1 (0%), MV2 (2%), MV3 (3%), MV4 (4%), and MV5 (5%), into mayonnaise formulation. The mayonnaise was made from VCO, egg yolk, salt, sugar, lemon, water, and HPMC. The mayonnaise formulation is described in Table 1.

Table 1. Mayonnaise formulation made from virgin coconut oil.

Ingredient	HPMC addition				
	MV1	**MV2**	**MV3**	**MV4**	**MV5**
VCO (g)	55,0	55,0	55,0	55,0	55,0
Egg yolk (g)	20,0	20,0	20,0	20,0	20,0
HPMC (g)	-	2,0	3,0	4,0	5,0
Salt (g)	3,0	3,0	3,0	3,0	3,0
Sugar (g)	4,5	4,5	4,5	4,5	4,5
Lemon squize (g)	7,5	7,5	7,5	7,5	7,5
Water (g)	10	10	10	10	10
Total (g)	100	102	103	104	105

2.3 Mayonnaise preparation and analysis

Egg yolks and seasonings, such as salt and sugar, were weighed according to the formulation, then mixed and stirred until evenly distributed. Furthermore, VCO was mixed with HPMC stabilizer according to the treatment using a hand mixer for approximately 1 minute, then mixed into a mixture of egg yolks and seasonings little by little, made into a semi-solid emulsion. The lemon juice was added to the emulsion and mixed using a hand mixer for ±2 minutes until well mixed. Then, the mayonnaise was put in sterile jar glasses before analysis. The parameters observed were emulsion stability, viscosity, pH, and sensory of the mayonnaise on day 1 and 15 of storage.

2.4 Data analysis

Statistical data were analyzed using ANOVA and continued with DNMRT at 5%. The software used was IBM SPSS Statistics 23.

3 Results and discussion

3.1 Emulsion stability

Adding HPMC into the mayonnaise formulation had a significant effect (P<0.05) on the stability of mayonnaise emulsion on day 15. The emulsion stability on days 1 and 15 after further testing using DNMRT at 5% can be seen in Figure 1.

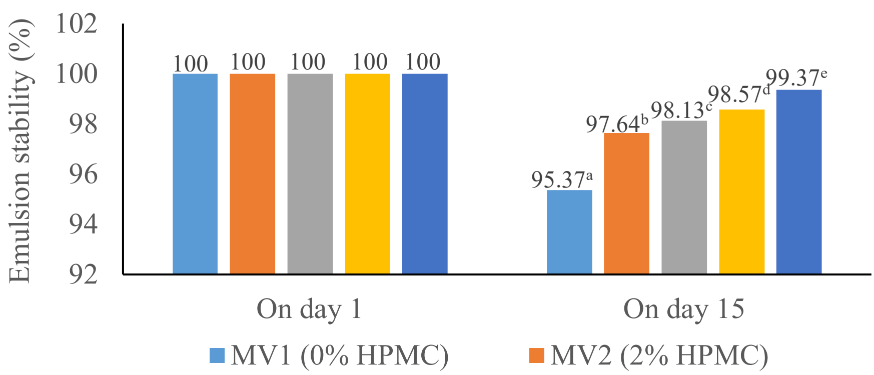

Fig. 1. The mayonnaise emulsion stability.

Figure 1 shows that the emulsion was stable on day 1 (100%), while on day 15, the emulsion stability decreased to 95.37-99.37%. According to [9], the primary stabilization mechanism was likely due to the physical entrapment of oil within expanded particles of freeze-dried HPMC sheets. This stabilization effect could be due to hydrogen bonding and non-hydrodynamic (Van der Waals) interactions or the adsorption of water and other hydrophilic entities to the surface of the dispersed particles, resulting in steric stabilization [10]. Based on [11], the HPMC has excellent water-binding properties and thickening properties of mayonnaise from patin and red palm mixture oil for up to 15 days of storage. However, HPMC gum had the lowest increase in the emulsion stability of cake batter among different gums and an emulsifier blend [12].

3.2 Viscosity

The HPMC concentration had a significant effect (P<0.05) on the viscosity of mayonnaise on days 1 and 15. The average viscosity of the mayonnaise after further testing using DNMRT at the level of 5% can be seen in Figure 2. The viscosity of the mayonnaise on day 1 ranged from 43710.00–70119.33 cP, while on the 15th day, it decreased from 40696.67-69047.33 cP. The viscosity of the mayonnaise in this study increased with the addition of HPMC concentration [8]; the separation process would not be observed at this interval.

A decrease in mayonnaise viscosity on the 15th day was associated with a decrease in mayonnaise emulsion stability; the higher the mayonnaise viscosity will cause an increase in mayonnaise emulsion stability, on the contrary, a decrease in mayonnaise viscosity will also decrease the stability of mayonnaise emulsion [11]. Typically, emulsions contain oil, water, and an emulsifier/thickening agent; each of these ingredients, depending on their level and quality, determine the quality characteristics of the emulsion. The perceived quality of emulsion-based food products is determined by their microstructure or the interaction of their ingredients [6].

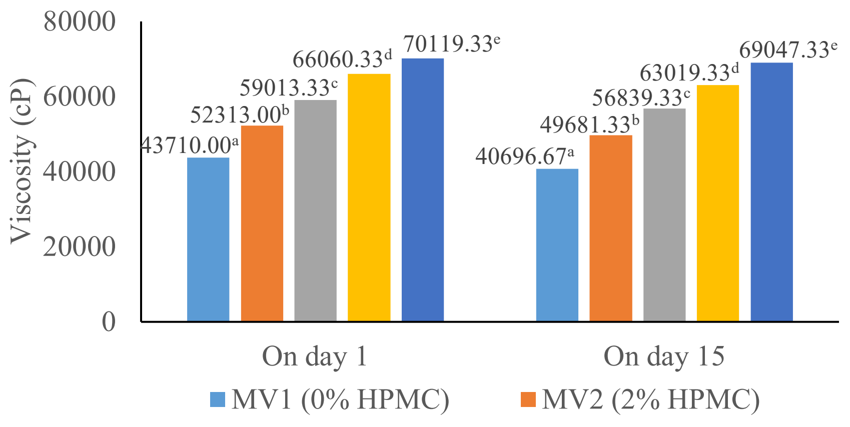

Fig. 2. Viscosity of virgin coconut oil mayonnaise.

3.3 Acidity (pH)

The results showed that the variations in HPMC concentration had a significant effect (P<0.05) on mayonnaise pH on days 1 and 15. The pH after further testing using DNMRT at the level of 5% can be seen in Figure 3.

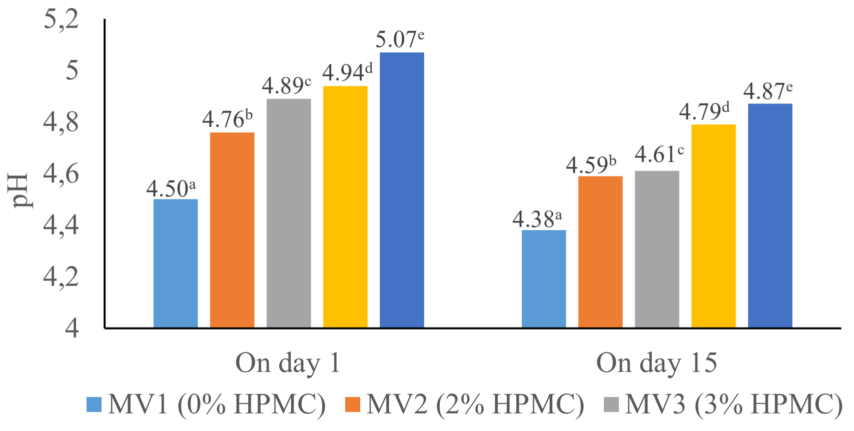

Fig. 3. Acidity (pH) of the virgin coconut oil mayonnaise.

Figure 3 shows that the pH of mayonnaise on day 1 ranged from 4.496–5.073, while on day 15, it ranged from 4.38–4.87. The increase in mayonnaise pH on day 1 was due to the addition of HPMC, which had a pH of 8.0–9.5. These results were in line with research [11], which stated that the increase in pH in mayonnaise was due to an increase in the concentration of HPMC addition. After 15 days of storage, the mayonnaise pH value decreased. This phenomenon was due to the reaction of oil oxidation and the growth of microorganisms, which was usually followed by an enzymatic reaction by microorganisms that can cause damage to mayonnaise.

3.4 Sensory assessment

The results showed that the addition of HPMC variations in mayonnaise had no significant effect (P>0.05) on the descriptive and the hedonic test of mayonnaise color, aroma, and flavor but had a significant effect (P>0.05) on the descriptive and hedonic test of the mayonnaise viscosity. The descriptive and hedonic assessment of the sensory mayonnaise can be seen in Figure 4.

Figure 4 shows that the panelists' descriptive assessment of mayonnaise color attributes ranged from 2.23–2.43 (yellowish), aroma ranged from 1.67 to 1.90 (slightly rancid), viscosity ranged from 2.43–3.47 (slightly watery–viscous), and flavor ranged 2.43–2.70 (slightly coconut-coconut flavored). This study's results align with [11]; the addition of HPMC did not affect the color flavor of mayonnaise. The HPMC had a white color and odorless and tasteless characteristics, so the HPMC did not influence the mayonnaise's color, aroma, and flavor.

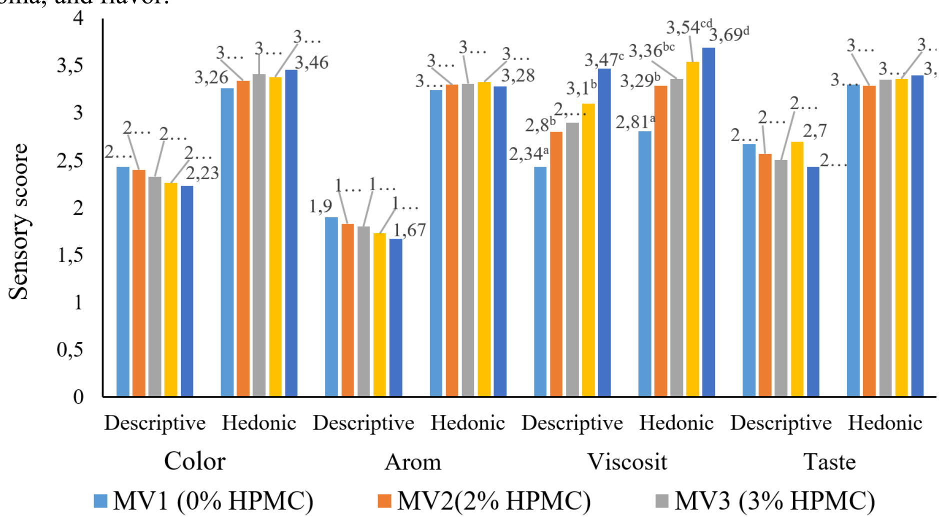

Fig. 4. Descriptive and hedonic sensory score of the virgin coconut oil mayonnaise. Color score: 1=white, 2= yellowish, 3=yellow, 4=very yellow. Aroma score: 1 =no rancid scent, 2=slightly rancid scented, 3=rancid scented, 4=very rancid scented. Viscosity score: 1=dilute, 2=slightly viscous, 3=viscous, 4=very viscous. Taste score: 1=no coconut flavor, 2=slightly coconut flavored, 3=coconut flavored, 4=very coconut flavored. Hedonic score: 1=strongly dislike, 2=dislike, 3=somewhat like, 4=like, 5=very like.

Figure 4 shows that the panelists' descriptive viscosity ranged from 2.43–3.47 (slightly watery–viscous). The increase in viscosity was due to the addition of HPMC; in addition to being a stabilizer, the added stabilizer also acts as a viscosity enhancer, gelling agent, and polymeric matrix in films, filaments, and inserts [8]. The sensory viscosity of mayonnaise was also related to the stability of the emulsion; the higher the viscosity of mayonnaise, the higher the stability of the emulsion mayonnaise. The results of [13] stated that no significant correlation was observed between sensory attributes and viscosity-related properties, such as apparent viscosities and flow curve parameters.

4 Conclusion

Adding HPMC as a stabilizer maintained the stability of the mayonnaise from VCO until 15 days of storage. Hydroxy propyl methyl cellulose could be used as a VCO mayonnaise stabilizer with some improvements in the sensory characteristics of mayonnaise.

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