Versi Online: http://journal.ipb.ac.id/index.php/jtip
https://doi.org/10.6066/jtip.2022.33.1.21
Hasil Penelitian

J. Teknol. dan Industri Pangan
Vol. 33(1): 21-27 Th. 2022 ISSN: 1979-7788
Terakreditasi Ristekdikti: 164/E/KPT/2021

Low Fat Premixed Mayonnaise Block Used OSA-Corn Starch as Egg Yolk Replacer Plus Corn Starch Binding Agent

[Premixed Mayones Blok Rendah Lemak Menggunakan OSA-Corn Starch sebagai Pengganti Kuning Telur disertai Bahan Pengikat Pati Jagung]

Citra Pratiwi Prayitno*, Agus Wijaya, Filli Pratama, and Anny Yanuriati

Department of Agricultural Technology, Faculty of Agriculture, Sriwijaya University, Palembang, Indonesia

Received May 12th 2021 / Accepted March 29th 2022

ABSTRACT

Mayonnaise contains a substantial amount of fat and water. Therefore, it is easily degraded during storage. Reducing fat and moisture content in mayonnaise could extend its shelf life. It can be done by replacing the egg yolk to octenyl succinic anhydride (OSA)-corn starch and then forming it as a premixed block using a binding agent. The research objective was to obtain technology for low-fat mayonnaise making by OSA-cornstarch and corn starch addition but still acceptable by consumers based on its physicochemical and sensory characteristics. The low fat premixed mayonnaise was made by mixing the egg yolks and/or OSA-corn starch, corn starch, mustard, sugar, salt, and xanthan gum. A completely randomized research design was used with three levels of OSA-corn starch (0, 25, and 50%) to replace egg yolk and its combination with corn starch as a binder agent at 43 and 50%. The parameters analyzed on the premixed mayonnaise blocks included moisture and fat content, water absorption index, and water solubility. In contrast, parameters for constituted mayonnaise were moisture content, viscosity, and hedonic sensory analysis by 25 semi-trained panelists. The constituting step of the mayonnaise was the further addition of water, oil, and lime juice before serving. The data were analyzed with ANOVA. The results showed that OSA-corn starch and corn starch addition could reduce the fat content of premixed mayonnaise by 41.7% which was obtained from 50% OSA-corn starch and addition of 43% corn starch. The resulted mayonnaise was slightly liked by the semi-trained panelists (scored 3).

Keywords: OSA-corn starch, corn starch, egg yolk replacement, low fat premixed mayonnaise block

ABSTRAK

Mayones mengandung banyak lemak dan air sehingga mudah rusak selama penyimpanan. Penurunan lemak dan kadar air dalam mayones dapat memperpanjang umur simpannya melalui penggantian kuning telur dengan Oktenil Suksinat Anhidrat (OSA)-pati jagung, kemudian menjadikannya produk premixed dengan bahan pengikat pati jagung. Mayones rendah lemak dibuat dengan mencampurkan kuning telur dan/atau OSA-pati jagung, pati jagung, mustard, gula, garam, dan xanthan gum. Penelitian ini bertujuan untuk mengembangkan teknologi mayones rendah lemak menggunakan variasi komposisi OSA-pati jagung dan pati jagung yang dapat menghasilkan produk yang diterima oleh panelis semi terlatih berdasarkan karakteristik fisikokimia dan sensoris. Rancangan percobaan digunakan rancangan acak lengkap dengan 3 taraf OSA-pati jagung (0, 25, dan 50% penggantian kuning telur) dan 2 taraf kombinasinya dengan proporsi pati jagung (43 dan 50%). Data dianalisa dengan ANOVA. Parameter yang diuji pada sampel premixed mayones blok adalah kadar air, kadar lemak, indeks penyerapan air, dan kelarutan air sedangkan parameter pada sampel konstitusi mayones meliputi kadar air, viskositas, dan analisis sensoris. Tahap konstitusi mayoones adalah dengan penambahan air, minyak, dan perasan jeruk sebelum penyajian. Hasil penelitian menunjukkan penggantian kuning telur dengan OSA-pati jagung dan penambahan pati jagung berhasil menurunkan lemak pada mayones blok sebesar 41,7% diperoleh dari produk 50% OSA-pati jagung sebagai substitusi kuning telur dan 43% penambahan pati jagung yang setelah tahap konstitusi emulsi agak disukai (skor sekitar 3) oleh panelis semi-terlatih berdasarkan karakteristik fisik, kimia, dan sensoris.

Kata kunci: *OSA-pati jagung, pati jagung, penggantian kuning telur, premixed blok mayones rendah lemak*

The manuscript has been presented in the ASEAN Food COnference 2019, October 15th-18th, 2019, Bali-Indonesia
*Corresponding Author: E-mail: citra2312@gmail.com

INTRODUCTION

Mayonnaise is a semi-solid oil in water emulsion that consists of a dispersed phase (oil), a dispersing medium (water and vinegar), and an emulsifier (egg yolk) (Lee *et al.,* 2013). Egg yolk contributes very high fat content in mayonnaise ranging from 70-80%. Therefore, people limit their consumption because it can trigger the onset of several diseases (Evanuarini *et al.,* 2016; Nikzade *et al.,* 2012).

On the other hand, reducing fat in mayonnaise affects its properties such as flavor, texture, and emulsion stability (Zhen and Boye, 2013). The emulsion instability could be due to the reduction of oil droplet density, resulting in the phase separation into oil and water phases (Mirzanajafi-Zanjani *et al.,* 2019; Evanuarini *et al.,* 2016). Many studies have been carried out to reduce the fat content in mayonnaise (Bajaj *et al.,* 2019; Yu *et al.,* 2021). That study was mostly done with the addition of octenyl succinic anhydride (OSA)-starch because it has several functions as a tasteless, colourless, emulsifying, and thickening texture agent in oil-in-water emulsions (Ali *et al.,* 2014; Chivero *et al.,* 2016). The OSA-starch is obtained from starch molecules, hydrophobically modified with octenyl succinic anhydride (Hadnadev *et al.,* 2015). Those studies were in the form of liquid, *i.e.* higher moisture content. Therefore, it had a short shelf life. To extend the shelf life, a study was necessarily carried out to produce premixed low-fat mayonnaise blocks by adding corn starch as a binder whose low moisture content as well. Hung and Morita (2004) stated that starch is a good binder since it can hold water well, prevent syneresis, and thicken the texture. Other benefits of the premixed mayonnaise block are easily packed and prepared, and its viscosity can be maintained when it is prepared for serving through constituting step by addition of water, oil, and lime juice.

This study aimed to develop technology in making low-fat premixed mayonnaise block with OSA-corn starch to replace the egg yolk and corn starch as a binder. The OSA-corn starch was at the concentrations of 0, 25, and 50% (w/w), which replace egg yolk, and their combination with binding agent corn starch at 43 and 50%. The best formulation was determined based on the acceptance of sensory scores by semi-trained panelists and its physicochemical characteristics after their constitution.

MATERIALS AND METHODS

Materials

The raw materials used to make low-fat mayonnaise were OSA-corn starch (Cargill, Japan), corn starch (Ega Food), mustard (Hako Jaya Perkasa), palm oil, sugar, salt, xanthan gum (Brataco, Indonesia), egg yolk of broiler chicken and calamansi lime (*Citrus microcarpa*) bought in local supermarket. The other materials used for analyzing this research were aquadest (Bratachem Ltd) and n-hexane (Brataco Ltd).

Mayonnaise preparation

Low-fat mayonnaise was prepared according to Ghazaei *et al.* (2015) with a minor modification at a total weight of 30 g per sample. The OSA-corn starch, corn starch, sugar, salt, mustard powder, and xanthan gum were weighed according to the amount listed in Table 1. Those ingredients were mixed well using a blender (Phillips HR 2115, Indonesia) at medium speed before the addition of egg yolk. The mixture was formed into a cube at 2x2x2 cm by hydraulic block mold. Then it was kept in an airtight container and stored in a 2°C refrigerator until further analysis, approximately overnight. The constituted mayonnaise was prepared by mixing 5 g of premixed mayonnaise block, 3 g of water, 1 g of lime juice and 2.5 g of palm oil obtained from previous experiments by which this mixture was the best procedure to constitute the premixed mayonnaise block into mayonnaise ready to use.

Table 1. Formulation of premixed mayonnaise block ingredients

Samples	Ingredients Formulation (g)							Total
	Egg Yolk	OSA-corn Starch	Corn Starch	Sugar	Salt	Mustard	Xanthan Gum	
OSA0 CS43	8.0	0.0	13.0	7.0	1.0	0.7	0.3	30
OSA0 CS50	6.0	2.0	13.0	7.0	1.0	0.7	0.3	30
OSA25 CS43	4.0	4.0	13.0	7.0	1.0	0.7	0.3	30
OSA25 CS50	6.0	0.0	15.0	7.0	1.0	0.7	0.3	30
OSA50 CS43	4.5	1.5	15.0	7.0	1.0	0.7	0.3	30
OSA50 CS50	3.0	3.0	15.0	7.0	1.0	0.7	0.3	30

Note: OSA represents percentage of egg yolk substitution with OSA-corn starch (OSA0= 0%; OSA25= 25%; OSA50= 50%) while CS represent the percentage of corn starch (CS43= 43%; CS50= 50%)

Moisture content analysis

Water content was measured by gravimetry method based on AOAC (2006). The porcelain crucible was heated in the oven for 30 minutes, cooling down in a desiccator at room temperature for 15 minutes then weighed to the constant weight. The 2 g of mayonnaise samples were weighed and put in the crucible. The sample was dehydrated at 105°C until a constant weight was obtained (0.02 mg differences of sequential weighing). The sample's moisture content was calculated as the difference between the initial and dried weights divided by the initial weight.

Fat content analysis

The Soxhlet method (AOAC, 2006) was carried out to analyze the fat content of mayonnaise. Around 5 g premixed mayonnaise block was put into a paper thimble/roll covered with cotton. The paper thimble/roll containing the sample was dried in the oven with temperature no more than 80°C for approximately 1 hour, then weighed and inserted into the Soxhlet extractor. The sample was extracted with 100 mL n-hexane for eight hours at temperature around 69°C (boiling point). Hexane was distilled and the extract obtained was dried up at 105°C. The boiling flask containing the dried fat was cooled into the desiccator for 15 minutes, then weighed to a constant weight. The sample's fat content was calculated as the difference between an empty boiling flask and the boiling flask containing dried samples, divided by the sample's initial weight.

Fat content of the constituted mayonnaise was calculated by converting fat content of 5 g premixed mayonnaise block added with 2.5 g (palm oil addition) multiplied by 100% and divided by the total weight of constituted mayonnaise yield (11.5 g).

Water absorption index (WAI) analysis

The water absorption index measurement was according to Onyango *et al.* (2013), starting with 5 g of premixed mayonnaise block put into centrifuge tubes, then it was added by 25 mL of distilled water. The sample was permitted to absorb water for 20 minutes by which regularly well hand-shaken for 5 seconds every 5 minutes. The sample was centrifuged at 1,000 rpm for 15 minutes, and the supernatant was dried out carefully using a paper absorber. WAI was calculated by the difference between the dried tube weight and the original empty tube weight divided by the dry sample weight.

Water solubility (WS) analysis

Water solubility was determined using Onyango *et al.* (2013) method. Around 0.1 g of premixed mayonnaise was weighed directly into a centrifuge tube and was added by 10 mL of distilled water. The tube was heated at 60°C for 30 minutes then centrifuged at 1,200 rpm for 10 minutes. The supernatant was carefully removed and dried at 110°C until the weight was constant. WS was calculated as the dehydrated supernatant weight divided by the initial weight of the sample.

Viscosity analysis

Viscosity analysis was done using Brookfield Viscometer RVDV model according to Triawati *et al*. (2016) method. Around 100 mL of the constituted mayonnaise was put into a 100 mL beaker glass. Then, a spindle (RV) number 4 was immersed in the sample until the sample passed the spindle borderline, and the rotation speed was set at 3 rpm. The spindle was located into the center of the beaker glass, so it did not touch its bottom or sides. The viscosity value was read when the value was stable. Viscosity analysis was accepted when the % torque within the range from 10 to 100% by using any combination of spindle or speed.

Organoleptic characteristics

The organoleptic analysis was done using a method in Pratama (2018). The analysis using the sample of premixed mayonnaise block that had been constituted into mayonnaise products (after addition/mixing with lime juice, palm oil, and water). The organoleptic evaluation used the hedonic test method. The test was carried out by 25 semi-trained panelists, *i.e.* 13 females and 12 males, aged from 19 to 35 years old, and familiar with mayonnaise products. The constituted mayonnaise samples were served to panellists who evaluated their preferences using 4-point hedonic scales (1= very much disliked, 2 =slightly disliked, 3= slightly liked, 4= very much liked). The preferences towards texture, colour, taste, and flavour of the constituted mayonnaise samples were collected.

Statistical analysis

This research used a completely randomized design with 6 treatments. Each treatment was done in triplicates. The data obtained were analyzed of variance (ANOVA), and the significantly different treatment was further analyzed by Tukey's test at a 5% significance.

RESULTS AND DISCUSSIONS

Water absorption index (WAI) and water solubility (WS)

The water absorption index of premixed mayonnaise samples was up to 4.44 g/g (Table 2). The WAI of 0% products obtained from OSA-corn starch and 43% corn starch addition were insignificant compared to those using 25% OSA-corn starch and 43% corn starch. However, there was a significant increase in WAI for sample obtained from 50% corn starch addition. The addition of OSA-corn starch and corn starch at a higher concentration up to 50% did not increase the WAI significantly. The results were in line with Suarni *et al.* (2013), who stated that high amylose could help water absorption in foods, but protein and fat could prevent starch from absorbing water molecules.

Table 2. Water absorption index and water solubility of premixed mayonnaise

Samples	Water Absorption Index (g/g)	Water Solubility (%)
OSA0 CS43	2.53±0.37[a]	28.36±1.03[a]
OSA0 CS50	3.70±0.41[bc]	36.60±0.59[b]
OSA25 CS43	3.39±0.41[ab]	37.73±0.14[bc]
OSA25 CS50	3.98±0.19[bc]	39.65±0.50[d]
OSA50 CS43	4.10±0.18[bc]	39.23±0.22[cd]
OSA50 CS50	4.44±0.25[c]	40.79±0.65[d]

Note: Values are average from 3 replications ± SD. Values followed by the same superscript letter (a-d) in the same column are not significantly different at $p \leq 0.05$

Water solubility (WS) indicates the extent and rate at which starch can dissolve in water (Sawant *et al.,* 2013). The percentage of OSA-corn starch and corn starch addition had a significant increase ($p<0.05$) of WS of premixed mayonnaise block (Table 2). The increase was significantly higher by 25% for samples used 25% OSA-corn starch and the addition of 50% corn starch (coded as OSA25 CS50). This treatment was insignificant from OSA25 CS43 and OSA50 CS50. The WS increases were resulted from the hydrogen bonds between the hydroxyl group of amylose and amylopectin in corn starch granules with the hydrogen from water molecules (Pratama and Parwiyanti, 2018). It is important to note that the weakness of the WS and WAI measurement due to paper absorber and hand mixing which were unlikely capable of managing operational homogeneity among all replicating measurements. Better method in this procedure still required to be developed well, for instance the use of a rotating agitation instead of hand shaking and drain or air flow drying to replace the paper absorber.

Both WAI and WS value of premixed mayonnaise block tended to increase with the increasing OSA-corn starch and corn starch proportions. Table 2 shows that OSA50 CS50 has the highest WAI and WS value, *i.e.* 4.44±0.25 and 40.79±0.65, respectively. Wardhani and Indrawati (2016) asserted that WS is related to the WAI of the product. The higher WAI indicates that the product is more easily dissolved in water. Therefore, the dissolving process is easier.

Moisture content

The moisture contents of premixed mayonnaise block were between 80.97 and 88.65% db whereas those for constituted mayonnaise were in the range of 58.17-60.76% db (Table 3). Both samples tended to have significant reductions of moisture contents in line with the increase of OSA-corn starch and corn starch levels.

The lowest moisture content was the product using OSA50 CS50. Egg yolk has a moisture content of 49.4% and a protein content of 16.3 g (Hutapea *et al.,* 2016). Besides, according to OSA product information, OSA-corn starch had a maximum of 7% moisture content. The lower water content of OSA-corn starch compared to egg yolk resulted in lower water content in the mayonnaise with higher egg yolk replacement (*i.e.* higher OSA-corn starch). Kusnandar (2010) stated that hydrogen bonding could occur between the hydrogen's positive side in water molecules with the polar amines in protein molecules. Thus, the lesser egg yolk meant the lower polar amine existence in the mayonnaise containing higher OSA-corn starch.

Water and lime juice as the dispersing phase were responsible for the increased water content in constituted mayonnaise. According to the BSN (1998), the mayonnaise's maximum moisture content is 30%. This means that the moisture content of constitutes mayonnaise from this research exceeded the standard limits. The excessive moisture content was caused by the addition of excess water to produce a low-fat emulsion during constitution step prior to serving. Hutapea *et al.* (2016) stated that the emulsion products with low-fat content are made by reducing the dispersed phase (oil) and increasing the dispersing phase (water). Therefore, the final mayonnaise product of constituted mayonnaise ended up with a high water content obtained.

Table 3. Moisture content and fat content of premixed and its constituted mayonnaise

Samples	Moisture Content (% db)		Fat Content (% db)	
	Premixed	Constituted	Premixed	Constituted
OSA0 CS43	80.97±0.09[a]	58.17±0.10[a]	7.10±0.56[c]	42.68±0.40[c]
OSA0 CS50	83.96±0.18[b]	58.81±0.43[ab]	6.43±0.62[bc]	41.72±0.65[bc]
OSA25 CS43	84.73±0.23[b]	59.37±0.37[b]	6.17±0.34[bc]	41.14±0.47[b]
OSA25 CS50	86.65±0.11[c]	59.75±0.41[bc]	5.44±0.48[b]	40.35±0.60[b]
OSA50 CS43	87.84±0.81[d]	60.52±0.21[cd]	3.90±0.34[a]	38.72±0.11[a]
OSA50 CS50	88.65±0.10[d]	60.76±0.47[d]	3.53±0.66[a]	38.31±0.77[a]

Note: Values are average from 3 replications ± SD. Values followed by the same superscript letter (a-d) in the same column are not significantly different at $P \leq 0.05$

Fat content

The fat content of premixed and constituted mayonnaise can be seen in Table 3. The fat content of premixed mayonnaise block ranges from 3.53% to 7.10% db whereas those of constituted mayonnaise is in the range of 38.31 to 42.68% db. The proportion of OSA-corn starch and corn starch had a significant decreasing effects (p<0.05) on the fat content in all products. The significant fat reduction occurres in the product of OSA25 CS50. A higher fat reduction significantly takes place on a higher percentage of OSA-corn starch and corn starch addition.

The higher egg yolk replacement by of OSA-corn starch concomitantly with the increased corn starch addition contributed to the significant lowering fat content. In comparison to mayonnaise of red fruit oil which consists of 73.60% (db) fat and 46.50% (wb) moisture content (Sarungallo *et al.,* 2021) as well as Indonesian National Standard which rules out the minimum fat content of mayonnaise at least 65% (BSN, 1998), the present research succeeded to reduce significant amount of fat. All of the mayonnaise samples used OSA corn starch to substitute the egg yolk and the addition of corn starch, including the addition of the same quantity of palm oil (2.5 g), resulted in less fat content than the commercial common mayonnaise. The lowest fat content of constituted mayonnaise was found in OSA50 CS50 (23.27% db), which was not significantly different from OSA50 CS43.

Viscosity

The viscosity value of constitutes mayonnaise ranged between 83.40 and 156.53 Pa.s (Table 4). The viscosity was significantly affected by OSA-corn starch and corn starch addition which resulted in a significant reduction on mayonnaise viscosity. The 0% OSA-corn starch combined with the addition of 50% corn starch (OSA0 CS50) yielded a significant decrease compared to the 0% OSA-corn starch with the 43% corn starch (OSA0 CS43) (156.53 to 137.00 Pa.s). However, a more significant decrease and the lower viscosity value slightly liked (score ca 3) by the semi-trained panelist were those made from OSA-corn starch by 50% in combination with corn starch by 43% (OSA50 CS43).

Table 4. The viscosity of constituted mayonnaise

Samples	Viscosity(Pa.s)
OSA0 CS43	156.53±3.45^{d}
OSA0 CS50	137.00±6.22^{c}
OSA25 CS43	109.53±4.16^{b}
OSA25 CS50	108.20±11.01^{b}
OSA50 CS43	86.87±2.91^{a}
OSA50 CS50	83.40±1.80^{a}

Note: Values are average from 3 replications ± SD. Value followed by the same superscript letter (a-d) in the graph is not signifi-cantly difference at P≤0.05

The higher viscosity of mayonnaise can be obtained due to egg yolk lecithin, which functions as an emulsifying agent, and the corn starch with amylose. The amylose can absorb water molecules and expand starch granules (Hutapea *et al.*, 2016; Suarni *et al.,* 2013), but syneresing soon. Furthermore, lecithin has a lower molecular weight than OSA-corn starch, so that it can more actively reduce the size of globules in emulsion system. The decreasing globular size can increase the emulsion's resistance to flow, and the viscosity of emulsion will be higher (Ghazaei *et al.,* 2015; Koocheki and Kadkhodaee, 2011). For instance, Bajaj *et al.* (2019) state that the substitution of egg yolk with OSA-modified starch caused less gel structure in mayonnaise than the non-substituted one, thus the product has more water-based continuous phase. Moreover, the OSA-corn starch structure affected mayonnaise viscosity as the starch modification process shows more existence of pores on the granule surfaces, which results in the rising hydration ability. Therefore, the lower concentration of egg yolk and higher cornstarch concentration, which is figured in OSA50 CS50 treatment, produced the lower product viscosity.

Organoleptic characteristics

The results of organoleptic characteristics of the mayonnaise samples are shown in Table 5. The analysis observed 4 quality attributes, *i.e.* taste, colour, flavour, and texture. This score scales is acknowledged as the weakness of this research because of inadequate number of scales compared to the number of the tested samples, by which there absolutely occurred that panelists scored at a limited differentiating scale for six items. Regardless this weakness, the constituted sample with 50% OSA-corn starch and 43% corn starch addition obtained the highest scores at around 3 (slightly liked) by the semi-trained panelists. The OSA50 CS43 sample shows no significant difference in terms of texture, colour, and flavor of samples from the same group of replacement level combined with higher corn starch concentration (OSA50 CS50). The products were tasted insignificant for all treatments. Yet, samples using replacement less than 50% were scored lower (disliked) by the panelists for all parameters. The fat sources in mayonnaise, namely egg yolks, and vegetable oils, have volatile compounds that affect the mayonnaise's taste and aroma. For instance, the volatile compounds in the egg yolks are sulfides and dimethyl trisulfide (Jaya *et al.,* 2013), which can be concluded that lower egg yolk levels generated better organoleptic scores by semi-trained panelists in the present study.

Table 5. Organoleptic characteristics of constituted mayonnaise samples

Samples	Organoleptic Characteristics			
	Texture	Colour	Taste	Flavour
OSA0 CS43	2.64^{a}	2.96^{a}	2.64	2.56^{a}
OSA0 CS50	2.64^{a}	3.00^{a}	2.92	2.80^{ab}
OSA25 CS43	3.12^{b}	3.04^{a}	2.80	2.92^{b}
OSA25 CS50	2.96^{ab}	3.16^{ab}	3.08	2.84^{b}
OSA50 CS43	3.08^{b}	3.32^{bc}	3.12	3.04^{bc}
OSA50 CS50	3.28^{b}	3.44^{c}	3.08	3.24^{c}

Note: Value followed by the same superscript letter (a-d) in the same column is not significantly differenced at $P \leq 0.05$. (1= very much disliked, 2= slightly disliked, 3= slightly ilked, 4= very much liked)

CONCLUSIONS

Simultaneously replacing egg yolk with OSA-corn starch and adding the corn starch was found to significantly reduce the fat content of premixed and final constituted mayonnaise to 38.72%, referring to mayonnaise trading standard SNI which is more than 65%. This can be achieved through 50% egg yolk replacement level (equal to 50% OSA-corn starch) and 43% corn starch addition. Further-more, the constituted mayonnaise ready for serving was slightly liked (the highest score) by semi-trained panelists on physicochemical and sensory charac-teristics. The prototype finding is promising for further commercialization step.

REFERENCES

[AOAC] Association of Official Analytical Chemists. 2006. Official methods of analytical chemistry. 18th ed. Gaithersburg, Maryland: AOAC International.

Ali TM, Waqar S, Ali S, Mehboob S, Hasnain A. 2014. Comparison of textural and sensory characteristics of low-fat mayonnaise prepared from octenyl succinic anhydride-modified corn and white sorghum starches. Starch-Stärke 67: 183-190.https://doi.org/10.1002/star.201400153

[BSN] Badan Standardisasi Nasional. 1998. Syarat Mutu Mayones. SNI 01-4473-1998. Badan Standardisasi Nasional, Jakarta.

Bajaj R, Singh N, Kaur A. 2019. Properties of octenyl succinic anhydride (OSA) modified starches and their application in low-fat mayonnaise. Int J Biol Macromol 131: 147-157. https://doi.org/10.1016/j.ijbiomac.2019.03.054.

Chivero P, Gohtani S, Yoshii H, Nakamura A. 2016. Assessment of soy soluble polysaccharide, gum arabic, and osa-starch as emulsifiers for mayonnaise-like emulsions. LWT-Food Sci Technol 69: 59-66. https://doi.org/10.1016/j.lwt.2015.12.064

Evanuarini H, Nurliyani, Indratiningsih, Hastuti P. 2016. Kestabilan emulsi dan karakteristik sensoris low fat mayonnaise dengan menggunakan kefir sebagai emulsifier replacer. J Ilmu Teknologi Hasil Ternak 11: 53-59. https://doi.org/10.21776/ub.jitek.2016.011.02.6.

Ghazaei S, Mizani M, Piravi-Vanak Z, Alimi M. 2015. Particle size and cholesterol content of a mayonnaise formulated by osa-modified potato starch. J Food Sci Technol 35: 150-156. https://doi.org/10.1590/1678-457X.6555.

Hadnađev TD, Hadnađev M, Pojić M, Rakita S, Krstonošić V. 2015. Functionality of OSA starch stabilized emulsions as fat replacers in cookies. J Food Eng 167: 133-138. https://doi.org/10.1016/j.jfoodeng.2015.02.002

Hung PV, Morita N. 2004. Dough properties and bread quality of flours supplemented with cross-linked cornstarches. Food Res Int 37: 461-467. https://doi.org/10.1016/j.foodres.2003.11.011

Hutapea CA, Rusmarilin H, Nurminah M. 2016. Pengaruh perbandingan zat penstabil dan konsentrasi kuning telur terhadap mutu mayones rendah lemak. Jurnal Ilmu dan Teknologi Pangan 4: 304-311.

Jaya F, Amertaningtyas D, Tistiana H. 2013. Evaluasi mutu organoleptik mayones dengan bahan dasar minyak nabati dan kuning telur ayam buras. J Ilmu Teknologi Hasil Ternak 8: 30-34. https://doi.org/10.21776/ub.jitek.2013.008.01.4

Kusnandar F. 2010. Kimia Pangan. 37-38. Dian Rakyat, Jakarta.

Koocheki A, Kadkhodaee R. 2011. Effect of *Alyssum homolocarpum* seed gum, tweeen 80, and NaCl on droplets characteristics, flow properties, and physical stability of ultrasonically prepared corn oil-in-water emulsions. Food Hydrocoll 25: 1149-1157. https://doi.org/10.1016/j.foodhyd.2010.10.012

Lee I, Lee S, Lee N, Ko S. 2013. Reduced-fat mayonnaise formulated with gelatinized rice starch and xanthan gum. Cereal Chem 90: 29-34. https://doi.org/10.1094/CCHEM-03-12-0027-R

Ma Z, Boye JI. 2013. Advances in the design and production of reduced-fat and reduced-cholesterol salad dressing and mayonnaise- A review. Food Bioproc Tech 6: 648-670. https://doi.org/10.1007/s11947-012-1000-9

Mirzanajafi-Zanjani M, Yousefi M, Ehsani A. 2019. Challenges and approaches for production of a healthy and functional mayonnaise sauce. Food Sci Nutr 7: 2471-2484. https://doi.org/10.1002/fsn3.1132

Nikzade V, Tehrani MM, Saadatmand-Tarzjan M. 2012. Optimization of low cholesterol-low-fat mayonnaise formulation: Effect of using soy milk and some stabilizer by a mixture design approach. Food Hydrocoll 28: 344-352. https://doi.org/10.1016/j.foodhyd.2011.12.023

Onyango C, Mewa EA, Mutahi AW, Okoth MW. 2013. Effect of heat moisture-thread cassava amaranth malt on the quality of sorghum-cassava amaranth bread. Afr J Food Sci 7: 80-86. https://doi.org/10.5897/AJFS2012.0612

Pratama F. 2018. Evaluasi Sensoris. 65-74. Unsri Press, Palembang.

Pratama F, Parwiyanti. 2018. Impact of dry- and hydro- thermal treatments on swelling water absorption and water solubility on red-rice flours. CIGR J 20: 227-232.

Sarungallo, ZL, Santoso B, Roreng MK, Yantewo EP, Epriliati I. 2021. Karakteristik fisikokimia, organoleptik, dan kandungan gizi mayones minyak buah merah (*Pandanus conoideus*). Agritech 41: 316-326. https://doi.org/10.22146/agritech.55328

Sawant AA, Thakor NJ, Swarni SB, Drivate AD, Vidyapeeth BSKK 2013. Physical and sensory characteristics of ready-to-eat food prepared from finger millet based composite mixer by extrusion. CIGR J 15: 100-105.

Suarni, Firmansyah IU, Aqil M. 2013. Keragaman mutu pati beberapa varietas jagung. Penelitian Pertanian Tanaman Pangan 32: 50-56.

Triawati NW, Radiati LE, Thohari I, Manab A. 2016. Microbiological and physicochemical properties of mayonnaise using biopolymer of whey protein-gelatin-chitosan during storage. Int J Curr Microbiol App Sci 5: 191-199. https://doi.org/10.20546/ijcmas.2016.507.019

Wardhani MLA, Indrawati V. 2016. Pengaruh proporsi tepung maizena dan puree rumput laut terhadap kualitas produk siomay ikan gabus (*Opiocephalus striatus*). E-journal Boga 5: 148-157.

Yu B, Liu C, Cui B, Zhao H, Tao H, Liu P. 2021. Improving the stability of low-fat mayonnaise formulated with octenyl succinic starch by adding acetylated distarch phosphate. Starch–Stärke 73: 2000212. https://doi.org/10.1002/star.202000212