AGRITROPICA
Journal of Agricultural Sciences

Content available at:
https://ejournal.unib.ac.id/index.php/jagritropica/index

ISSN (PRINT) 2621-217X ISSN (ONLINE) 2621-699X

Substitution of Red Palm Oil Olein (RPOO) as a Source of Provitamin E in Grilled Meatball Sauce

Marini Yupita, Budiyanto Budiyanto, Hidayat Koto
Department of Agricultural Technology, Fakulty of Agriculture, University of Bengkulu
* Corresponding author: budiyanto@unib.ac.id

ABSTRACT: Indonesia is the largest crude palm oil (CPO) producer globally, with a total production of fcccc\dc36.59 million tonnes in 2018. One of the downstream products that can be made is RPOO which has\gh vitamin A and E content. This study aims to determine the effect of red palm oil olein (RPOO) substitution on grilled meatball sauce's physical and organoleptic characteristics and determine the vitamin E content in grilled meatball sauce. This study used a completely randomized design with RPOO substitution as a treatment (0%, 25%, 50%, 75%, 100%). The results showed that RPOO substitution affected the physical characteristics of grilled meatball sauce, namely emulsion stability, organoleptic properties, and vitamin E content. The emulsion stability obtained was in the range of 89.33% -100% values. Grilled meatball sauce with 50% RPOO substitution is preferred as the best treatment by consumers best on overall. The vitamin E content in one serving of the selected grilled meatball sauce is 20.5559 mc g, beyond recommended daily consumption of vitamin E (15 mc g). Consuming one serving of grilled meatball sauce can meet the daily vitamin E needs of adolescence, adult male, and female.

Keywords: Grilled Meatball Sauce; Red Palm Oil Olein (RPOO); Vitamin E.

This paper should be referenced:
M. Yupita, B. Budiyanto, H. Koto. 2022. Substitution of Red Palm Oil Olein (RPOO) as a Source of Provitamin E in Grilled Meatball Sauce. *Agritropica: Journal of Agricultural Science.* 5(1):13-21. Doi: https://doi.org/10.31186/J.agritropica.5.1.13-21.

INTRODUCTION

Indonesia is the largest producer of crude palm oil (CPO) globally, with 44,759 million tons in 2020 (Central Bureau of Statistics, 2022). However, downstream products from CPOs are still lacking. One of the downstream products that can be made is Red Palm Olein Oil (RPOO) which has a high content of vitamins A and E and a low cost of use compared to other sources (Scrimshaw, 2000).

Vitamin E is a vitamin that is an antioxidant, so it plays an essential role in counteracting free radicals that can damage body cells. Vitamin E deficiency can occur if you don't consume enough food sources of vitamin E in your daily diet. According to Fatmah (2006), vitamin E is a good treatment for preventing Alzheimer's disease, increasing immunity, and is essential in maintaining the immune system. Consuming vitamin E has a tremendous health impact on the body, especially during the Covid-19 pandemic today, because the body must have a robust immune system to fight viral infections. Foodstuffs that contain lots of vitamin E are vegetable oils (sunflower seed oil, soybean oil, and corn oil), nuts, and seeds (Triana, 2006). Another vegetable food source with high vitamin E content is red palm oil or red palm oil olein (RPOO).

According to Basiron & Weng (2004), RPOO can be used as a functional food. Vitamin E content of RPOO is 900-1000 mg/kg consisting of 20% -tocopherol, 25% -tocotrienol, 45% -tocotrienol and 10% -tocotrienol (Dauqan et al., 2011). The vitamin E in RPOO is in the form of tocotrienols, which are more potent antioxidants and provide more significant health benefits than tocopherols while also acting as cholesterol-lowering activity (Cassiday, 2017). This makes RPOO suitable to be substituted for local food, one of which is grilled meatballs.

Grilled meatballs are snacks that are easy to find and favored by various groups of people. Grilled meatballs are usually served with an oil-containing sauce as a flavor enhancer. RPOO can be fortified by substituting the oil in the grilled meatball sauce. Many studies have been carried out on replacing RPOO with the original oil ingredient of selected foods. Agustina et al. (2019) reported that substituting all (100%) of 6.7 g chicken noodle seasoning oil with RPOO did not affect prepared chicken noodles' acceptability. In addition, the substitution of RPOO up to 75% in original oil in siamay sauce did not affect the preference of siomay (Budiyanto et al., 2019a).

Substitution of RPOO in grilled meatball sauce is an effort to add vitamin E to local food. However, information about the number of RPOO substitutions in grilled meatball sauce that can be added appropriately without changing the physical and organoleptic characteristics is still unknown. In addition, information about the increase in vitamin E that occurs due to oil substitution in sauces with a certain amount of RPOO is still undisclosed; thus, it is necessary to study the effect of RPOO substitution on the characteristics of grilled meatball sauce and the impact of RPOO substitution on the level of consumer preference and under these conditions how much vitamin E is consumed—absorbed by the body. This study aims to determine the effect of substituting red palm oil olein (RPOO) on grilled meatball sauce's physical and organoleptic characteristics and determine the content of vitamin E in grilled meatball sauce consumers prefer based on organoleptic tests.

MATERIAL AND METHODS

The materials needed in this research are the standard solution of tocopherol, crude palm oil (CPO), phosphoric acid (H3PO4) 75%, NaOH 0.1 N, citric acid 20%, nitrogen (N2), distilled water, alcohol 96%, shallots, garlic, red chili, candlenut, pepper, chili sauce, sweet soy sauce, brown sugar, salt, and 68 gr cooking oil and red palm olein oil (RPOO).

The equipment needed in this study were HPLC, 1000 ml Erlenmeyer, hot plate stirrer, centrifuge, stirring rod, analytical balance, dropper, 50 ml measuring cup, 1000 ml beaker, measuring flask, separating funnel, test tube, stopwatch, thermometer. , beakers, cauldrons, blenders, spatulas, cellphone cameras, label paper, cups, tissues, and stationery

Grilled meatball sauces were prepared by grinding spices such as garlic, chili, nutmeg, pepper, salt, and candlenut, then sauteing in 18 tablespoons or 68 g of vegetable oil. Brown sugar and sweet soy sauce were added and blended into the sauteed spices to prepare a grilled meatball sauce. Various percentage substitutions of vegetable oil (0%, 25%, 50%, 75%, and 100% of the amount of original oil in the recipe) with RPOO were

the only treatment of the study. The observed variables in this study were emulsion stability, acceptability of sensory attributes, and vitamin E content.

Emulsion Stability

The emulsion stability was measured by observing the mixture of red palm oil in the sauce, which was put into a test tube as much as 10 ml, then stored at room temperature, and then observed the total volume of the sauce and the importance of the top layer formed after 24 hours. The formula can calculate emulsion stability:

Emulsion stability: $\frac{V0-V1}{V0} x \ 100\ \%$

Where:

V0 = Total volume (ml)

V1 = Volume of top layer (ml)

Acceptability of sensory attributes of the sauce

This hedonic test was conducted at the Agricultural Technology Laboratory, Faculty of Agriculture, Bengkulu University using 30 untrained panelists. Grilled meatball sauce served with chicken meatballs. Each sample treatment was coded three and presented to 30 panelists. Each panelist was asked to give a score based on five scales of preference for taste, aroma, color, and overall appreciation for grilled meatball sauce. The acceptance score for the product can be seen in Table 1.

Table 1. Panelist acceptance score is based on a point scale.

Hedonic scale	Hedonic Attribute
5	Very like
4	Like
3	Neutral
2	Dislike
1	Very dislike

Vitamin E content

Vitamin E content in RPOO and grilled meatball sauce were evaluated using the high-performance liquid chromatography (HPLC) method. Preparation of the test solution using 5 g of sample weighed and put into a brown bottle, added 5 ml of aquadem, 10 ml of antioxidant solution, and 17.5 ml of saponification solution. The piece was homogenized with a vortex for 2 minutes, then placed in a shaking water bath at 70°C ±2°C for 30 minutes, then removed and placed in a tub filled with ice cubes at room temperature. The sample was transferred into a separating funnel, and the remaining sample was rinsed with 15 ml of distilled water and put into a separating funnel. Add 25 ml of the extraction solution, shake for 2 minutes, and remove the bottom layer into a separatory funnel; add 15 ml of washing solution, shake slowly for 30 seconds, and allow to separate; remove the bottom layer and wash repeated up to 3 times with the addition of 15 ml of washing solution. The extraction results were put into a dark 25 ml volumetric flask and adjusted to the mark with the extraction solution. 10 ml of the solution was pipetted and put into a brown bottle filled with nitrogen gas to dry. Reconstituted with 10 ml of mobile phase and homogenized using a vortex.

Then the preparation of the mother standard solution by weighing 10 mg of alpha-tocopherol acetate standard was put into a brown bottle, added 5 ml of aquadem, 10 ml of antioxidant solution, and 17.5 ml of saponification solution. The following steps are the same as making the test solution, but after the extraction results are put into a 25 ml volumetric flask, 20 ml of the solution is pipetted and put into a brown bottle filled with nitrogen gas to dry. Reconstituted with 50

ml of mobile phase and homogenized by the vortex. Next, the serial standard solution preparation was carried out by pipetting 0.05: 0.1: 0.25: 0.4: 1.0: and 2.0 ml of the common mother solution, put into a dark 5 ml volumetric flask and adjusted to the measuring mark, with the mobile phase. Then make a blank solution in the same way as the test solution. The blank solution, mother standard solution, and test solution were injected separately into the high-performance liquid chromatography under the following conditions:

Mobile phase: 100% methanol
Column : C18 (25 cm x 4.6 mm), particle size 5 m
Detector: UV wavelength 296 nm
Flow rate : 1.2 ml/min
Injection volume : 20 l
Vitamin E levels can be calculated using the formula:

Vitamin E levels (mg/kg) =(Csp x F)/w
Note:
Csp: Vitamin E levels obtained from calculations using the line equation y= bx + a (µg/ml)
F: Dilution factor (ml)
W : Sample weight (g)

Data of emulsion stability measurement was analyzed using the DMRT follow-up test at a level of 5% using the SPSS version 24.0. Hedonic test data and emulsion stability were analyzed by Analysis of Variance (ANOVA) at a significance level of 5%. If there is a significant difference, then the hedonic test data is continued with a different test using the Tukey test with 5%. Meanwhile, data on vitamin E content and color were analyzed descriptively.

RESULTS AND DISCUSSION

Emulsion stability

The emulsion stability test showed that the treatment with the highest stability was obtained by RPOO 50% substitution with a stability value of 100% in 24 hours. The lowest strength, 89,335, was found in the 100% RPOO substitution. Analysis of variance (ANOVA) indicates that RPOO substitution significantly affected emulsion stability. The DMRT test at the 5% level showed that the treatment with 25% RPOO substitution was substantially different from the 100% RPOO substitution treatment but was not significantly different from the 0%, 50%, and 75% RPOO substitution treatment. The stability of the grilled meatball sauce emulsion for each treatment can be seen in Figure 1.

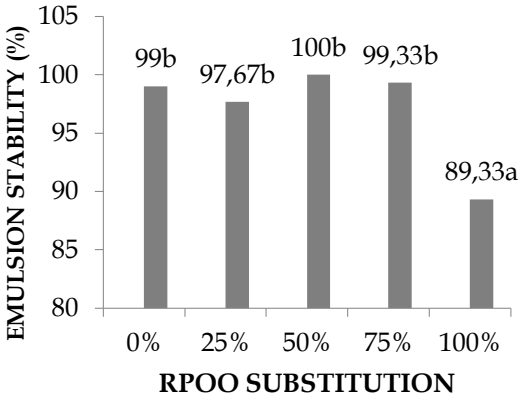

Figure 1. Stability of grilled meatball seasoning emulsion on various RPOO substitutions.

Although RPOO substitution affected the stability of the emulsion, it was only significantly different in the 100% substitution treatment, while the 25% to 75% substitution resulted in the same strength. The stability of the grilled meatball sauce emulsion at a concentration of RPOO substitution of

25% to 75% remained stable for up to 24 hours.

Emulsion stability plays a vital role in determining the quality of food products containing oil, such as mayonnaise and sauces. The use of emulsifiers can increase the strength of the emulsion because it can reduce surface tension (Ayu et al., 2020). In a study conducted by (Nurhayati & Budiyanto, 2016), using a 1.5% Tweem 80 emulsifier was able to maintain the stability of the red palm oil emulsion for up to 22 hours.

Color

The assessment of the color of the sauce is a subjective assessment that is captured by the sense of sight. Color is one of the elements that is seen first. The color preference for the color of the grilled meatball sauce produced ranged from 3.60 to 4.37, which was in the range of neutral–like. The results of the organoleptic test indicated that the color preference of the sauce with 25% substitution treatment was not significantly different from the 0%, 50%, and 75% RPOO substitution treatment but significantly different from the 100% RPOO substitution.

Figure 2 shows that the researcher's level of preference for the color of the grilled meatball sauce decreases as the RPOO substitution increases because the higher the RPOO substitution, the darker the resulting sauce will be. This is consistent with the results of the color grab test, where the higher the RPOO substitution, the lower the resulting RGB value, meaning that the color of the sauce is getting darker and therefore become less attractive.

The graph of the panelists' preference for the color of the grilled meatball sauce can be seen in Figure 2.

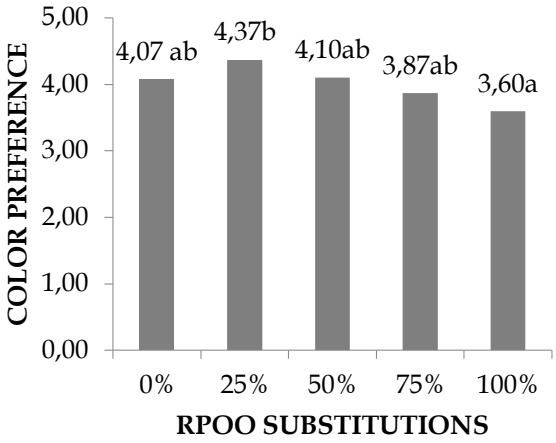

Figure 2. The effect of RPOO substitution on color preference level

The results obtained in this study are in line with research by Agustina et al. (2019), where the effects of organoleptic tests on color showed that the color of the chicken noodle seasoning with the highest color preference value was in the 25% RPOO substitution treatment with a value of 4.48 (like). However, Budiyanto et al. (2019) reported that the color preference of siomay sauce increase with increasing concentration of RPOO in the sauce.

Aroma

Aroma assessment is subjective and difficult to measure because everyone has different sensitivities and preferences. The results of the organoleptic test showed that the panelists' preference for the aroma of grilled meatball sauce substituted with RPOO had a value ranging from 3 - 4.33, which was in the neutral-like range. The treatment with the highest preference for aroma was 25% RPOO substitution with a value of 4.33 (like). In comparison, the treatment with the lowest level of preference for aroma was 100% RPOO substitution with a value of 3 (neutral). The graph of the panelists' preference for the aroma of grilled meatball sauce can be seen in Figure 3.

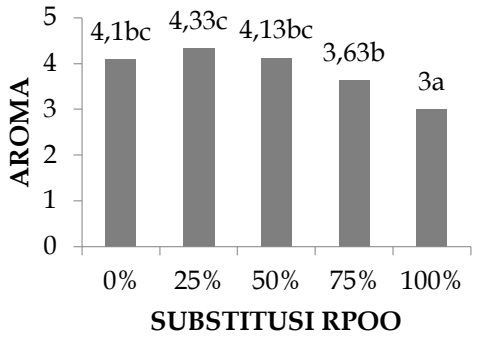

Figure 3. The effect of RPOO substitution on the level of aroma

Figure 3 indicates that the higher the RPOO substitution, the lower the panelists' preference for the aroma of grilled meatball sauce. The higher the addition of RPOO, the panelists' preference for aroma will decrease. This is because the distinctive aroma of red palm oil is more dominant in covering the aroma of other ingredients. The aroma that arises is the distinct smell of red palm oil, which is unpleasant.

The statistic test indicated that the aroma preference of the sauce with 25% RPOO substitution was significantly different from the 75% and 100% RPOO substitution treatment but was not substantially different from the 0% and 50% RPOO substitution treatment.

This study is in line with research from various studies that preference for aroma decreases with more addition serving of RPOO in the product (Budiyanto et al., 2019a; Budiyanto et al., 2019b; Novita et al., 2020; Nurhayati dan Budiyanto, 2026; Robiyansyah et al., 2017). This is presumably because red palm oil has an unpleasant aroma.

Taste

Taste is the most important assessment factor for accepting or rejecting a food ingredient. Taste arises from chemical stimuli that the sense of taste or tongue can receive. The preference test results showed that the treatment with the highest level of taste preference was 0% and 25% RPOO substitution with a value of 4.23 (like). In comparison, the treatment with the lowest level of preference was 100% RPOO substitution with 2.93 (disliked). The graph of the panelists' preference for the taste of grilled meatball sauce can be seen in Figure 4

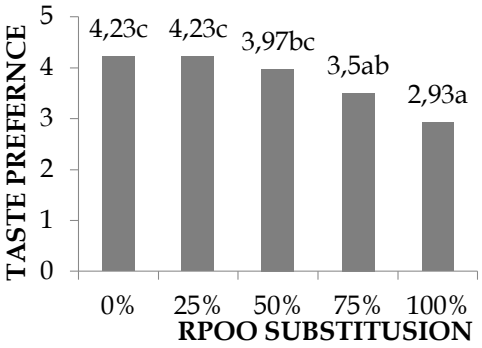

Figure 4. The effect of RPOO substitution on the taste preferences

Figure. 4. Indicate that the higher the RPOO substitution, the lower the panelists' preference for the taste of grilled meatball sauce. This is in line with Agustina et al. (2019) research. The 5% level ANOVA test results showed that the substitution of RPOO in grilled meatball sauce had a significant effect on the panelists' preference for taste. Further analysis indicated that the taste preference of the sauce with 25% RPOO substitution was significantly different from the 75% and 100% RPOO substitution treatment but was not significantly different from the 0% and 50% substitution treatment.

The taste of grilled meatball sauce in the treatment with 0% to 75% RPOO substitution was still acceptable to the panelist's preference values ranging from 3.5 to 4.23, which was in the neutral-like range. However, the panelists did not

favor the treatment with 100% RPOO substitution with an acceptable value of 2.93 (dislike). Grilled meatball sauce with 100% RPOO substitution is not preferred because the original taste of the sauce has been reduced and has been dominated by RPOO.

Overall

Panelists assess the Overall acceptance of the overall combination of color, aroma, and taste parameters. The results of the organoleptic test on the level of consumer preference overall ranged from 3.17 to 4.3, which was in the neutral–like range. The graph of the overall acceptance of grilled meatball sauce substituted with RPOO can be seen in Figure 5.

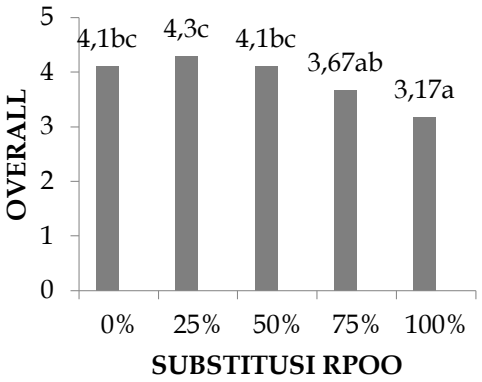

Figure 5. The Effect of RPOO Substitution on the Overall Preference Level

The statistic test revealed that the treatment with 25% RPOO substitution was significantly different from the 75% and 100% RPOO substitution treatment but was not significantly different from the 0% and 50% RPOO substitution treatment. Based on the benefit of vitamin E for human health, the sauce with 50% substitution of RPOO becomes a favorable choice.

Based on the organoleptic test, the panelists' most preferred grilled meatball sauce was a sauce with 50% RPOO substitution. With a preference value for color 4.37, aroma 4.33, taste 4.23, and overall 4.3. Studies reported that increasing substitution or addition of RPOO serving in the original recipes could decrease the preference for flavor and taste of the final product (Budiyanto et al., 2019a; Budiyanto et al., 2019b; Novita et al., 2020). The more RPOO added, the more unpleasant flavor and taste of RPOO dominate the grilled meatball sauce and decrease the likebility score in the hedonic test.

Vitamin E content

Measurements were made using High-Performance Liquid Chromatography (HPLC); the vitamin E content in RPOO was 194,48 ppm, while the vitamin E content in grilled meatball sauce without RPOO substitution was 0.11079 ppm. Based on sensory evaluation, the preferred sauce for grilled meatball sauce was prepared by substituting 50% or 68 g of original vegetable oil in the recipe. Since the sauce in each experimental unit was ready for ten servings of grilled meatballs, each serving of grilled meatball sauce contained 3.4 grams of RPOO and 3.4 grams of seasoning oil. Accordingly, each serving of the preferred sauce contains 20.5559 ppm or 20.55 mc g of vitamin E consisting of 194.48 ppm in the form of tocopherol RPOO and 0.11079 ppm of seasoning oil. Considering the daily requirement of vitamin E for adult men and women is 15 mc g of vitamin E (Kementrian Kesehatan Republik Indonesia, 2019), therefore, consuming one serving of meatballs in a grilled sauce enriched with RPOO can meet the daily vitamin E needs of children to adult men and women.

Substitution of original seasoning oil with RPOO was conducted at the final step of preparation of the sauce; after all, the ingredients were mixed and sauteed. Since RPOO was not heated during sauce preparation, the risk of vitamin E damage due to heating and radiation can be reduced (Ping et al., 2020). Vitamin E content in the sauce is higher than reported in this study since only vitamin E in tocopherol was measured. Studies said that vitamin E content in RPOO consists of 20% in the form of tocopherols and 80% in the form of tocotrienol (Cassiday, 2017; Daucan et al., 2011).

CONCLUSION

RPOO affects the organoleptic characteristics of grilled meatball sauce. The organoleptic test showed that the higher the RPOO substitution, the lower the preference for color, aroma, taste, and overall. The most preferred grilled meatball sauce in terms of acceptance of color, smell, taste, and overall was the sauce in which 50% of the original oil in the recipe was substituted with RPOO. The vitamin E content in each serving of the sauce is 20,5559 mc g/g. Therefore, consuming one serving of grilled meatball sauce can meet adult men's and women's daily vitamin E needs.

REFERENCE

Agustina, L., Budiyanto, B., & Tutuarima, T. (2019). Subtitusion of RPO to Seasoning Oil and Acceptability and Fortification Potency of Vitamin a Trough Chicken Noodle. *Jurnal Agroindustri*, *8*(2), 150–158. https://doi.org/10.31186/j.agroind.8.2.150-158

Ayu, D. F., Lumban Gaol, T. S., & Diharmi, A. (2020). Stabilitas Emulsi dan Sensori Mayones Campuran Minyak Abdomen Ikan Patin dan Minyak Sawit Merah dengan Penambahan HPMC SS12 Sebagai Penstabil. *Jurnal Teknologi Dan Industri Pertanian Indonesia*, *12*(2), 63–70. https://doi.org/10.17969/jtipi.v12i2.16285

Badan Pusat Statistik. (2020). *Statistik Kelapa Sawit Indonesia 2020*. Badan Pusat Statistik. Jakarta

Basiron, Y., & Weng, C. K. (2004). The Oil Palm and its Sustainability. *Journal of Oil Palm Research*, *16*(1), 1–10.

Budiyanto, B,, Devi Silsia. A. Napitupulu. 2019a. Alternatif Fortification Vitamin A for Lactating Mother using Siomay Sauce Enriched with Red Palm Oil. *J. Agritropica*, 2(1): 13-25.

Budiyanto.B., Sidebang, B., Samosir, R. S. D. S. 2019b. Pengaruh Penambahan Ekstrak Jeruk kalamansi (*Citrus microcarpa*) dan CMC terhadap preferensi Emulsi Minyak Sawit Merah (Red Palm Oil). *J. Agroindustri*, 9(1): 49-55.

Cassiday, L. (2017). *Red Palm Oil.* International News on Fats and Related Materials (INFORM). 28 (2) : 6-10.

Dauqan, E., Sani, H. A., Abdullah, A., Muhamad, H., & Gapor Md Top, A. B. (2011). Vitamin E and beta carotene composition in four different vegetable oils. *American Journal of Applied Sciences*, *8*(5), 407–412. https://doi.org/10.3844/ajassp.2011.407.412

Fatmah. (2006). Respons Imunitas yang Rendah pada Tubuh Manusia Usia Lanjut. *Makara Kesehatan*, *10*(1), 47–53.

Kementrian Kesehatan. 2019. Peraturan Menteri Kesehatan Republik Indonesia Nomor 28 Tahun 2019 Tentang Angka Kecukupan Gizi Yang Dianjurkan Untuk Masyarakat Indonesia. 33p. Peraturan Menteri Kesehatan Republik Indonesia Nomor 28 Tahun 2019 Tentang Angka Kecukupan Gizi Yang Dianjurkan Untuk Masyarakat Indonesia. Jakarta.

Novita, L., Budiyanto, B., Surawan, F.E.D . 2020. Pengaruh substitusi fraksi olein minyak sawit merah pada bumbu kacang batagor terhadap karakteristik fisik, sensoris dan kandungan pro-vitamin A. *Teknologi Agro-Industr,* 7 (2), 132-145.

Nurhayati & Budiyanto. (2016). *Stabilitas dan Penerimaan Emulsi Minyak Sawit Merah Menggunakan Berbagai Konsentrasi Tween 80*. Jurnal Agroindustri, 6 (2), 80-87.

Ping, B. T. Y., Idris, C. A. C., & Maurad, Z. A. (2020). Oxidative stability of refined red palm olein under two Malaysian storage conditions. *Journal of Oleo Science*, 69(10), 1209–1218. https://doi.org/10.5650/jos.ess20045

Robiyansyah, Zuidar, A. S., & Hidayati, S. (2017). Pemanfaatan Minyak Sawit Merah dalam Pembuatan Biskuit Kacang Kaya Beta Karoten. *Jurnal Teknologi & Industri Hasil Pertanian*, *22*(1), 11–20.

Rodiyah, T.N. (2017). *Pemanfaatan Minyak Sawit Merah (Red Palm Oil) sebagai Sumber Provitamin A dan Pengaruhnya terhadap Organoleptik dan Karakteristik Fisik Saus Bakso Bakar*. Skripsi. Jurusan Teknologi Pertanian. Fakultas Pertanian. Universitas Bengkulu. Bengkulu.

Scrimshaw, N.S. 2000. *Nutritional potential ofred palm oil for combating vitamin A deficiency*. *Journal of Food and Nut Bull.*, 21 (2) : 195-201

Triana, V. (2006). Macam-Macam Vitamin dan Fungsinya dalam Tubuh Manusia. *Jurnal Kesehatan Mayarakat*, 1(1), 40–47.

Winarno, F. G., 2002. *Kimia Pangan dan Gizi*. PT Gramedia Pustaka Utama. Jakarta. 253 Hal.