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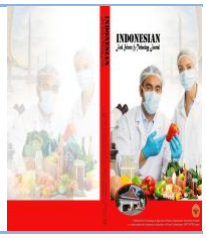

The Quality of Lokan (*Geloina erosa*) Rendang Oil Substituted with Red Palm Oil Olein

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***Abstract*— Rendang is a typical Minangkabau cuisine in West Sumatra, which is usually made with beef and other protein resources such as Lokan, which contains amino acids L-leucine and L-isoleucine. It is made with coconut milk that produces oil during cooking. The oil can be substituted with Red Palm Oil Olein (RPOO), which contains nutrients essential for the body as antioxidants. This study aims to determine the effect of RPOO substitution in Lokan rendang on color properties, vitamin A content, antioxidant activity, and organoleptic properties. A Completely Randomized Experimental Design (CRD) with one factor and five treatment levels was used in this study. The treatment factor was RPOO substitution with 0, 25, 50, 75, and 100% Lokan rendang oil. Each treatment was repeated three times resulting in 15 experimental runs. The data of vitamin A and antioxidant activity was analyzed using ANOVA followed by LSD, whereas sensory data were analyzed using the Friedman Ranking Test. The result showed that RPOO substitution significantly affected the antioxidant activity and organoleptic properties (taste, aroma, and overall) of rendang Lokan. The greater the substituted RPOO, the greater the vitamin A content in Lokan rendang. The substitution of 50% oil in rendang lokan with RPOO improved provitamin A and antioxidant activity significantly without disrupting the acceptability of its sensory values. Therefore, the 50% substitution of rendang lokan oil can be utilized to fortify vitamin A.**

***Keywords*— Antioxidant Activity; Red Palm Oil Olein; Rendang; Substitute; Vitamin A**

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I. INTRODUCTION

Rendang is one of Minangkabau's quintessential cuisines due to the people who make it come from West Sumatra. Rendang is a traditional food that has been proven used on the community market for decades, and a product representation of a community and culture ([1]). Regular rendang is made with beef, seasoning, and coconut milk [2], [3]. Beef rendang contains about 29.87% water, 59.67% protein, 21.10% t, 5.13% ash, and 14.10% carbohydrates [1]. Moreover, rendang also contains amino acids, which are advantageous for the body. The two amino acids of appreciable quantity are L-leucine (15.38%) and L-isoleucine (7.20%) [1]. Rendang has a long shelf life as well as containing the necessary nutrients. Rendang with the essential ingredients of chicken and xanthan gum as the thickener has six months of shelf life. During storage, the xanthan gum can reduce physical and chemical changes to maintain the stability and quality of rendang. In addition, the rendang texture has been modified to ease the elderly swallowing (dysphagia) [4].

The primary ingredients of rendang are beef, egg, eel, chicken, and others (ref). The protein resource depends on the potential environment around the community. The coastal communities use *Lokan* (*Geloina erosa*) or a type of local shellfish as a protein resource in making rendang [3]. Furthermore, the Lokan also has a preference because the price is lower than beef's. *Lokan* contains protein, amino acids, and fat-soluble vitamins such as A, E, and K[3]. Additionally, Lokan also contains a variety of minerals such as calcium (Ca), iron (Fe), potassium

(K), phosphorus (P), and selenium (Se) [5]. The production process of Lokan rendang is the same as beef rendang.

Cooked coconut milk will form fat or oil, which can be substituted with Red Palm Oil Olein (RPOO). RPOO is a substitute and fortification ingredient in processed food products such as chicken noodles' seasoning, grilled meatball sauce, batagor (fried tofu meatball) peanut sauce, cookies, siomay (dumpling) seasoning, snack, easy-to-digest biscuit, and pan bread [6]–[11]. Another example is the substitution of RPO and vegetable oil for making beef sausages. The 10% of substituted RPO comprises protein, fat, β-carotene, and the best sensory [12]. Adding RPOO to several processed food products can improve vitamins A and E and antioxidants. Vitamin A comes from β-carotene contained in RPOO(approximately 600-750 ppm of α and β-carotene), 710-774 ppm of vitamin E, lycopene, and phenolic components [11], [13]. Afterward, RPOO is microencapsulated to maintain the stability of the carotene and vitamin E content [14]. RPO and ginger extracts are also helpful for nanoemulsions in high-antioxidant fields [15].

The substitution of RPOO and Lokan rendang oil can be an alternative for providing high provitamin A food products based on local potential. Moreover, the RPOO substitution can develop the local Lokan as a filling functional food with high nutrition, healthy, and beneficial for the body. Therefore, this research aims to study the effect of RPOO substitution on organoleptic (color, aroma, taste, and overall), vitamin A content, and antioxidant activity of Lokan rendang.

II. MATERIALS AND METHODS

A. Material

The equipment for rendang production included cauldrons, blenders, cutting boards, stoves, and knives, while the analysis were done with a UV-Vis spectrophotometer, analytic scale, Erlenmeyer, volumetric flask, eye dropper, graduated pipette, and test tube.

The ingredients for producing rendang were an olein fraction of red palm oil (RPO), Lokan shellfish, shallots, garlic, coconut milk, red chilies, salt, bay leaves, galangal, lime leaves, turmeric, lemongrass, cinnamon, rendang seasoning, as well the analysis was β-carotene and DPPH standard, petroleum ether, acetone, and distilled water.

B. Experimental design

The experimental design in this research was a Completely Randomized Design (CRD) with one factor and five treatment levels. The treatment factor was RPOO substitution with 0, 25, 50, 75, and 100% Lokan rendang oil. Each treatment was repeated three times resulting to 15 experimental runs.

C. Sample preparation

Production of Lokan Rendang

Lokan rendang was made following the recipe of Oswari Food. First, 1 kg of mussels removed from the shells were washed with cold water until clean. Second, the necessary seasoning was 25 g of garlic, 25 g of shallots, 150 g of red chili, 25 g of ginger, 15 g of turmeric, 15 g of galangal, 15 g of salt, and adequate rendang seasoning. Rendang production begins with stir-frying all the seasoning except galangal and its leaves. All the seasonings are blended with coconut milk and heated until thickened. The cooking time is 1 hour at 80-93°C [1]. Then, it was heated and 2 L of coconut milk and stirred for 1 hour at 90°C. Third, the cleaned Lokan was mixed with coconut milk and seasoning. One stalk of lemongrass, bay leaf, and four lemongrass leaves are also added and stirred until the coconut milk thickens and the Lokan meat texture softens. Last, the cooked Lokan rendang was separated from the oil and seasoning. The Lokan rendang oil was separated and prepared to substitute the oil with RPOO according to the treatment. Each substituted RPOO to Lokan rendang oil was homogenized or manually stirred and then analyzed.

D. Parameters

Color Analysis

The Munsell tool analyzed sample color, which was recorded as hue, value, and chroma. Hue indicates the spectrum colors of red, green, and yellow. Value shows the lightness according to the amount of reflected light. Chroma is the gradation of purity from the color intensity [16].

Vitamin A Analysis

Vitamin A analysis was measured by determining the β-carotene followed by according to ([17])analysis was started by calculating the β-carotene, which was measured using a Genesys 10s UV-Vis spectrophotometer Thermo Scientific USA at the wavelength of 450 nm [6]. The standard solution was made with concentrations of 0, 0.2, 0.4, 0.6, 0.8, and 1 ppm of β-carotene in petroleum ether: acetone (10:1). The results were transformed into an equation curve of y=ax+b. Then, the sample was measured with the same wavelength of 450 nm, and the absorbance results were recorded and calculated by the equation as follows:

$$Retinol\ Equivalents\ (RE) = \frac{\beta - caroten\ content\ (ppm)}{Conversion\ ratio\ (6\mu gRE)}$$

[18].

$$Vitamin\ A\ requirements\ (\frac{g}{day}) = \frac{RDA\ Vitamin\ A\ (\frac{RE}{day})}{RE\ Red\ Palm\ Oil\ Olein}$$

[19].

Antioxidant Activity Analysis

Antioxidant activity was measured according to DPPH (2,2-diphenyl-1picryhyrazil) radical-scavenging activity method ([20]) The antioxidant activity of the RPOO-substituted Lokan rendang was analyzed using a Genesys 10s UV-Vis spectrophotometer Thermo Scientific USA . Hundred milligrams (100 mg) of the sample was dissolved in 10 mL of methanol. At the same time, the solution was made with concentrations of 5, 10, 15, 20, and 25 ppm. 1 mL of each concentration was added to 2 mL of 20 ppm of DPPH solution.

Then, the sample was incubated for 30 minutes and measured by a Genesys 10s UV-Vis spectrophotometer Thermo Scientific USA spectrophotometer at a wavelength of 517 nm. Antioxidant activity was measured as a decrease in the absorption of the DPPH solution by adding the sample. The value was expressed as % inhibition (antioxidant) with the following equation (ref):

$$\%\ Antioxidant = \frac{Control\ absorbance - Sample\ absorbance}{Sample\ absorbance}\ x\ 100\%$$

The antioxidant values are concentration (ppm) (X-axis) and % inhibition value (Y-axis), and then the IC50 value was determined [21].

Organoleptic testing

Organoleptic testing was carried out to the parameters of color, aroma, taste, and overall by 25 semi-trained panelists from the University of Bengkulu's students. Each panelist was requested to give scores based on a five-hedonic score for RPOO substituted Lokan rendang parameters. The favorite scales can be seen in **Table 1**.

TABLE 1.
THE SCALE OF PANELISTS' ACCEPTANCE OF RPOO SUBSTITUTE RENDANG LOKAN

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

Source : [22]

E. Data Analysis

Physical properties (color) and vitamin A content were analyzed descriptively. Antioxidant activity data was analyzed by SPSS 24 with Analysis of Variance (ANOVA) at the 5% level. The significant influences were compared with Duncans's Multiple Range Test (DMRT). The organoleptic testing data were analyzed using non-parametric statistical methods with Friedman test.

III. RESULTS AND DISCUSSION

A. Color

Color parameters can determine the product quality. The color change of products as the effect of substituted RPOO to Lokan rendang oil is shown in **Table 2**. The increasing ratio of RPOO exhibited the superlative hue and value of 5-10R and 4-5, respectively. 25% of substituted RPOO to Lokan rendang oil had the huevalue, and chroma values of 5R 4/14, which showed the red color (**Table 2**)[16]. 100% of substituted RPOO had the hue, value, and chroma values of 10R 5/14, which showed a moderately reddish-orange color [16].

RPOO provided the reddish-yellow color originating from the carotenoid pigments [23]. In this study, the sausage owned the color because of the phenomenon from the RPO [12]. Furthermore, RPO also provided a deep reddish-orange color because of the carotenoids in instant noodle oil seasoning [24]. The carotenoid pigments also provided an attractive color in RPO substituted ice cream [13].

TABLE 2.
THE RESULT OF COLOR ASSESSMENT OF LOKAN RENDANG OIL

Substitution RPOO	**0%: 100%**	**25%: 75%**	**50%: 50%**	**25%: 75%**	**100%: 0%**
Munsell Color Chart of Lokan Rendang Oil	5R 4/11	5R 4/14	7.5R 4/12	10R 3/12	10R 5/14
Color of Lokan Rendang Oil Sample					

B. Vitamin A

The attempt to increase the vitamin A content and other important micronutritions in human body various foods rich in β-carotene have been investigated through fortification and biofortification studies [25],[26],[27] . Based on Table 3, substitution 25% or higher of lokan rendang oil could increase significantly pro-vitamin A content of rendang lokan. 25% of substituted RPOO to Lokan rendang oil could fulfill the RDA of vitamin A to men and women of 20.17% and 24.20%, respectively.

Similar studies involving substitution 100% seasoning oil of chicken noodle and seasoning oil in siomay sauce could provide 23% of RDA and 38% of RDA of Vitamin A for an adult male and a breastfeeding mother respectively [28], [10]. The main different is that the rendang lokan in recent study contained arelatively higher protein as compare to protein content in chicken noodle and siomay in previous study.

TABLE 3.
THE B-CAROTENE CONTENT TO RDA OF VITAMIN A

RPOO(%) : RLO(%)	**Total β-carotene Content (ppm)**	**Vitamin A RL (*) (µgRE)**	**Vitamin A demand (%)**	
			Men*	**Women***
0% :100%	345.54	57.59	9.60	11.51
25%:75%	726.19	121.03	20.17	24.20
50%:50%	735.87	122.64	20.44	24.52
75%:25%	755.22	125.87	20.97	25.17
100%:0%	777.80	129.63	21.60	25.92

Note: (*) RDA of Vitamin A for women is 500µgRE
RDA of Vitamin A for men is

Various studies reported that the addition or red palm oil (RPO) could boost the carotene content, thus increase vitamin A content in the product [10],[12], [13].

C. Antioxidant Activity

The reaction to the DPPH radical compound measures a product's or material's antioxidant activity, calculated by reducing or providing hydrogen ions to form DPPH-H, which caused the purple color to fade [29]. In this study, IC50 represented the antioxidant activity value, and the substituted RPOO significantly affected the IC50 value ($p<0.05$). An increased number of substituted RPOO was contrary to the number of IC50 when the substituted RPOO went up, the IC50 went down. The DMRT result shows the difference in the influence of substituted RPOO (**Figure 1**). β-carotene found in RPO and RPOO is a natural antioxidant presence in the oil. Therefore β-carotene is an important source of vitamin A and natural antioxidant. The addition RPO in the cookies ingredient could boost the β-carotene in potato cookies [30]. Another reason for increasing antioxidant activity with the addition of RPOO is the presence of a strong antioxidant vitamin E as tocotrienols and tocopherols in palm oil ([31],[32]. In this study, tocopherol and β-carotene were estimated as antioxidants. Tocopherol was also known as vitamin E [33]. Similar study reported that increasing RPOO in meatball sauce increases the vitamin E, and resulting in stronger antioxidant activity of the sauce ([7]). The lower IC50 value indicated the stronger antioxidant activity [29].

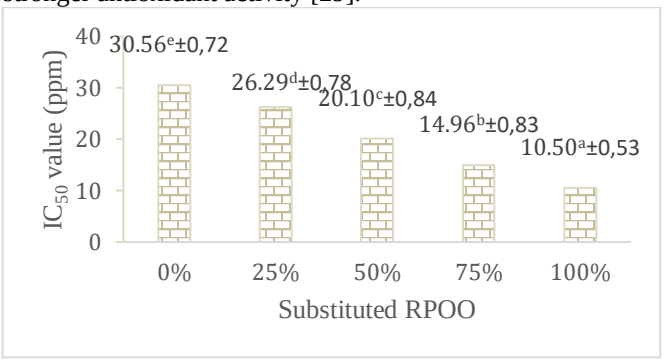

Fig 1. IC_{50} value in substituted RPOO to Lokan rendang oil
Note: Different superscripts show that the values are significantly different at $p<0.05$ DMRT test.

D. Organoleptic of Color, Aroma, Taste, and Overall

Substituted RPOO to Lokan rendang oil had no significant effect on the color by Friedman test results. The panelists' favorite scores for color parameter ranges were 3.60 to 4.00 **(Figure 2**). The Lokan rendang color produced with 100% substituted RPOO was moderately reddish-orange **(Table 2).** It was acquired by carotene pigments from RPOO so that panelists like the reddish-yellow color [23]. The panelists liked the Lokan rendang oil color with substituted RPOO. Other studies also showed that the sensory color of RPO-NLC (nanostructured lipid carriers) yogurt and RPO-NLC orange juice was not significantly affected [34], [35].

They substituted RPOO with Lokan rendang oil, which significantly affected aroma by the Fredman test. An increased number of substituted RPOO was contrary to the number of favorite scores when the substituted RPOO rose while the aroma parameter declined **(Figure 2).** Panelists did not like the distinctive aroma of the carotenoids in palm oil fruit. Frequent palm oil's carotenoids were lost when it was refined so that it was tasteless and odorless. Furthermore, the oil refining results also fade the volatile aroma compounds [24]. However, the RPOO was not used in this study to reduce the carotenoids, so the typical palm oil aroma still occurred. The result was parallel with the increasing substituted RPO to ice milk, which decreased the panelists' acceptance of the aroma parameter [13].

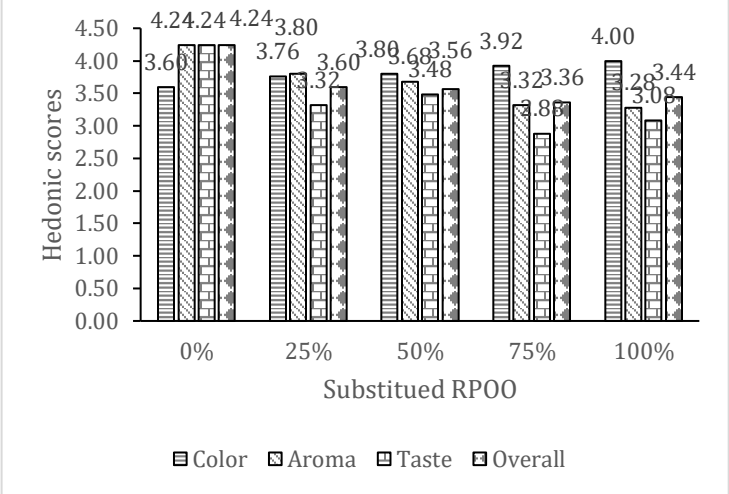

Fig 2. The substituted RPOO to the Hedonic score of color, aroma, and overall level in Lokan rendang

The substituted RPOO to Lokan rendang was significantly affected by taste and overall linking score by the Friedman test. An increased number of substituted RPOO was contrary to the number of panelists' favorite scores for taste and overall parameters when the substituted RPOO went up. At the same time, the taste and overall parameters went down **(Figure 2).** Based on hedonic scores, the substitution of 50% rendang lokan oil with RPOO had an acceptable score in each parameter, especially for taste and aroma hedonic parameters that tend to decrease with the addition of RPOO in the rendang oil. The results were parallel with other studies that concluded that substituted RPOO could reduce the panelists' favorite taste and overall parameters of grilled meatball sauce and seasoned oil chicken noodles [7], [10].

CONCLUSION

The substituted RPOO significantly affected organoleptic (taste, aroma, and overall) and antioxidant activity. The Lokan rendang color produced with 100% substituted RPOO was moderately reddish-orange. Substitution 50% of rendang lokan oil with RPOO improved provitamin A, and antioxidant activity

significantly and was acceptable in all sensory values. Therefore, the 50% substitution of rendang lokan oil can be utilized to fortify vitamin A and a healthy traditional food.

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