# 5._The_Effect_of_Repeated_Heating_on_Fatty_Acid.pdf

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# The Effect of Repeated Heating on Fatty Acid Profile of Beef and Spices of Rendang

Rina Yenrina[#], Deivy Andhika[#], Ismed[#], Dini Rasjmida[*], Pertiwi Triyani[#]

[#] *Faculty of Agricultural Technology, Andalas University-Padang, Indonesia*
*E-mail: yenrinarusdi@yahoo.co.id*

**Department of Nutrition. Poltekkes KemenKes RI Padang, Indonesia*
*E-mail: pietdini@gmail.com*

***Abstract*— Rendang is a traditional Minangkabau cuisine with the main ingredient of beef or buffalo meat which is cooked using coconut milk and some spices. Rendang is cooked more than 2 hours, and after that do the repeated heating. This study aimed to determine the effect of repeated heating on fatty acid profiles of beef and spices of rendang. The analysis carried out at Chemistry Lab. and Biochemistry Lab. In Fateta Unand and Integrated Lab in IPB Bogor. This study designed used a completely randomized design with 5 treatments and 3 replications. The treatments that used in this study were A (raw beef), B (freshly cooked rendang), C (first heating), D (second heating), E (third heating) where the heating was done every 2 days. Data were collected for fatty acids profile of beef and spices of rendang. Analysis of the Type of Fatty Acid by HPLC method AOAC. The results shown that repeated heating of beef and spice of rendang had significantly different effect on the type of fatty acids and an increased trans fatty Acid of rendang.**

***Keywords*—rendang , repeated heating , fatty acids, beef , spices.**

## I. Introduction

Rendang is one of the traditional Minangkabau cuisine with the main ingredient of beef or buffalo meat which is cooked using ingredients such as coconut milk and herbs like garlic, onion, ginger, galangal , chilli, salt, turmeric leaves, lemon grass leave, bay leaves, lime leaves and other spice as well as the heating process was carried out to obtain tender beef [27]. Beef, which is the main ingridient of rendang is a source of animal protein that has a high biological value because of its amino acids essensial content [21]. The use of spices in cooking rendang can improve taste of delicious and savory, so as to arouse the appetite. Besides, the spices also act as a natural preservative , as it contains antimicrobial and antioxidant [5].

In widespread community, rendang is made in large quantities. For durability rendang heated frequently. This will certainly affect the quality of rendang. According to Fennema [11], beef heating at a temperature of 70$^0$C will reduce the amount of lysine content in it be 90%, while heating at a temperature of 160$^0$C will reduce levels of lysine by 50 %. While Murhadi [27] said that rendang cooking at temperature around 90$^0$C - 93$^0$C. Besides, repetitive heating of meat will also make the meat becomes more tender than raw meat. Three things affect the process of softening the meat are fatty meat melts and contributes to the softening of meat, collagen connective tissue becomes dissolved in the heating medium, as well as muscle fibers separate and become more soft tissue [21]. Fat content in beef will determine the quality of the beef, because fat is a component that determine and shape the taste and aroma of the beef. Beef fat rich of stearic acid , palmitic acid and oleic acid.

## II. Materials and Methods

### *A. Materials and Equipment*

The materials that used in this study were beef sirloin, herbs, milk coconut and chemicals materials for analysis of beef and spice of rendang. The equipment used include cooking utensils, glassware, oven, Soxhlet , HPLC.

### *B. Making of Rendang*

Formula that used in the making of rendang was 2 kg of beef, 250 g of chili, onion 250 g, 100 g garlic, 50g galangal, 50 g ginger, 3 pieces of turmeric leaves, 2 pieces of bay leaves, 2 stalks lemon grass, lime leaves, 5 liters of coconut milk from 6 coconuts. The procedure starts with prepareation of beef by cut them with a size of 4 cm x 3 cm

x 3 cm. After the beef washed down with water cleanly, then drained in 5-10 minutes. The coconut milk cooked with lemon grass, lime leaves, turmeric leaves and other spices that had been mashed until boiled. Put the beef that had been cut into pieces in the boiled coconut milk. Stir rendang until turn brown and oily, cooking done for 3 hours at a temperature of $90^0$C.

*C. Procedure of rendang repeated heating*

Freshly cooked Rendang put in a glassware stored at room temperature. The heating done in a frying pan at temperature $90^0$C for 20 minutes. The heating were done every 2 days until day 6. So the heating were done 3 times for this study.

*D. Analysis of Beef and Spice of Rendang*

Observations that were done on beef and spice of rendang were analysis of the type of fatty acids.

*E. Analysis of the Type of Fatty Acid HPLC method AOAC*
*Sample preparation (hydrolysis and esterification)*

1. Weighed 20-30 mg of fat or oil sample in a tube covered with Teflon.
2. Added 1 ml of 0.5 N NaOH in methanol and heated in a water bath for 20 minutes.
3. Then added 2 mL of 16% BF 3 and 5 mg / mL of internal standard, heated again for 20 minutes.
4. Cooled, then added 2 mL of saturated NaCl and 1 mL of hexane, shaken it well.
5. Moved hexane layer by the aid of a Pasteur pipette into a tube contained 0.1 g of anhydrous $Na_2SO_4$, left for 15 minutes.
6. Separated liquid phase then injected into gas chromatograph.

*F. Analysis of fatty acid components , as FAME*

1. Arranged the equipment in following conditions
   Column : Cyanopropil methyl sil (Capilary column)
   Column dimensions :
   P = 60 m ,
   Ø inside = 0:25 mm
   film tickness = 025 m
   N2 flow rate : 20 mL / min
   H2 flow rate : 30 mL / min
   Air flow rate : 200-250 ml/ min
   Injector temperature : 200 ° C
   Detector temperature : 230 ° C
   Column temperature : the temperature program
   - Column temperature :
   First 190 ° C left for 15 minutes
   End 230 ° C left for 20 minutes
   Rate of 10 ° C / min
   Ratio : 1 : 8
   L Injection Volume : 1
   Linear Velocity : 20 cm / sec
2. Injected 1 mL of solvent into the column. When the carrier gas flew and heating system was perfect , the solvent peak appeared in less than 1 minute
3. Upon the pen back to zero (baseline) injected 5 L standard mixture of FAME . When all the peaks was out, injected 5 L sample that was prepared (A)
4. Measured retention time and the peak of each component. If the recorder equipped with an integrator, retention time and peak area was obtained directly from the integrator
5. Compared with standard retention times to obtained information on the types of components in the sample
6. For the internal standard method, the amount of each component in the sample calculated as follows :

$$C_x = \frac{A_x \,.\, R \;\; C_s}{A_s} \qquad (1)$$

where:
Cx = concentration of component x
Cs = Concentration of the internal standard
Ax = Peak area of component x
As = Peak area of internal standard
R = response of the detector to the x component relative to the standard

7. For external standard method, done the same preparation, but the sample and standard were done separately, there was no addition of the standard solution into the sample. Number of component content in the sample was calculated as follows

$$\frac{\frac{Ax}{As} \times C\ standard \times \frac{Vsample}{100} \times 100\ \%}{g\ sample} \qquad (2)$$

*G. Determination Method R*

Made of a mixture of X (pure) and S with the number of Wx and Ws known and made the Chromatogram. In this case,
Wx = Ax. Rx and
Ws = As. rs
From this relation, then R calculated as

$$R = \frac{R_x}{R_s} = \frac{W_x . A_x}{W_s . A_x}$$

*H. Research Design*

This study designed used a completely randomized design with 5 treatments and 3 replications. The treatments that used in this study were A (raw beef), B (freshly cooked rendang), C (first heating), D (second heating), E (third heating) where the heating was done every 2 days.

## III. Results and Discussion

*A. Fatty Acid Profile of Beef And Spice of Rendang*

The type of fatty acids of beef and spice of rendang can be seen in Figure 1. until Figure 11.

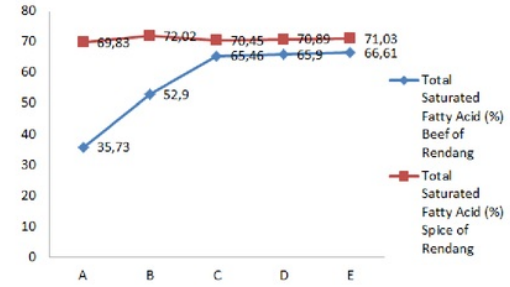


Fig. 1. Percentage of Saturated Fatty Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

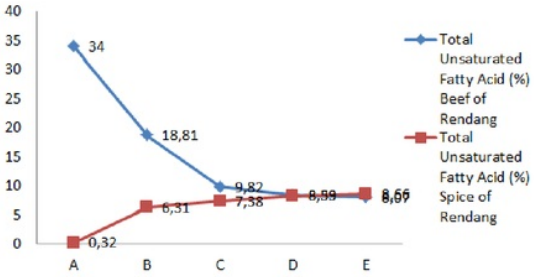


Fig. 2. Percentage of Unsaturated Fatty Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating

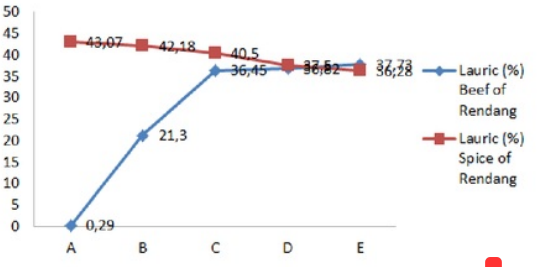


Fig. 3. Percentage of Lauric Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

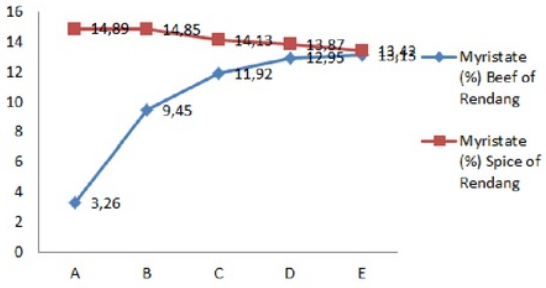


Fig. 4. Percentage of Myristate Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

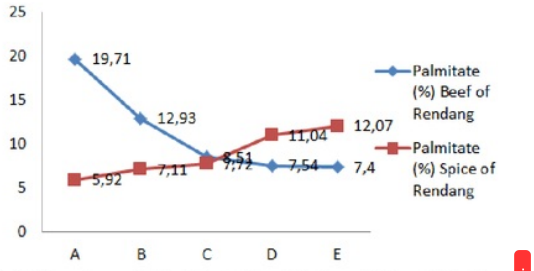


Fig. 5. Percentage of Palmitate Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

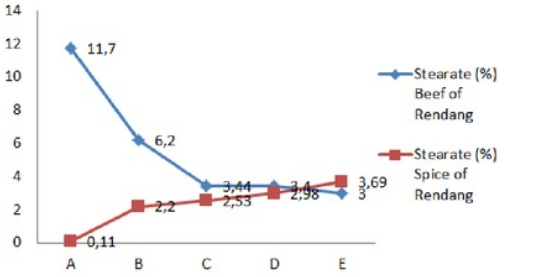


Fig. 6. Percentage of Stearate Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

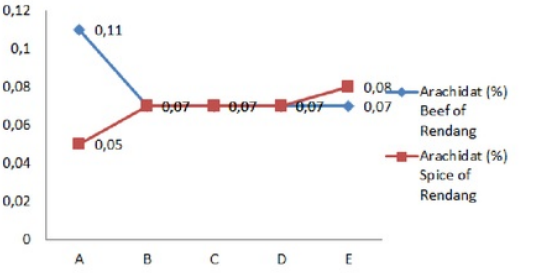


Fig. 7. Percentage of Arachidat Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

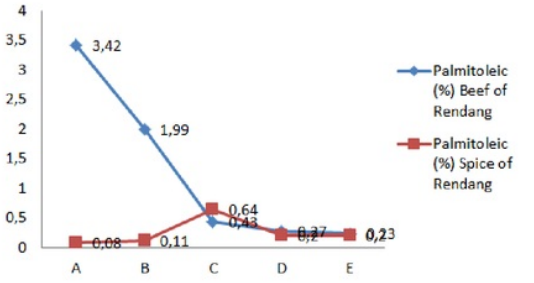


Fig. 8. Percentage of palmitoleic Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

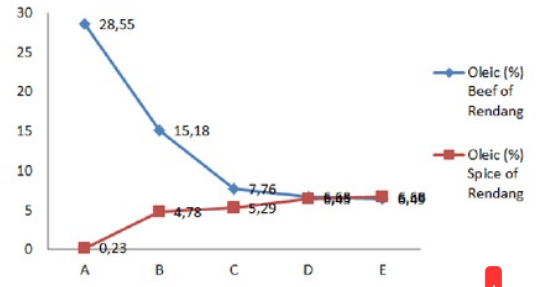


Fig. 9. Percentage of Oleic Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

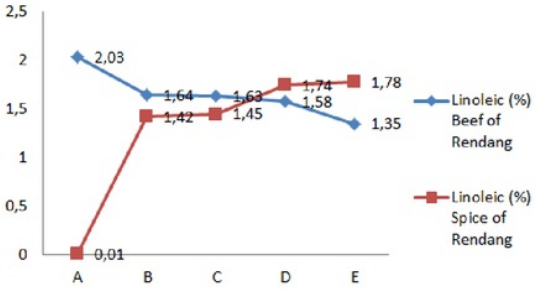


Fig. 10. Percentage of Linoleic Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

Based on figure 1. known that repeated heating increased total saturated fatty acids of rendang beef. However, in another way repeated heating decreased total unsaturated fatty acids of rendang beef. This was presumably due to the migration of the fatty acids of spice of rendang to the beef rendang.

From Figure 1 also known that total saturated fatty acids of rendang was highest at 66.61 % that was in treatment E and the lowest of 35.73 % was in treatment A. The total saturated fatty acids of rendang spice was highest in treatment E with value 71.03 % and the lowest value of 69.83 % was in the treatment of A. In Figure 3 shown that total unsaturated fatty acids of rendang was highest at 34.00 % found in treatment A and the lowest of 8.07% was in treatment E. Total saturated fatty acids of rendang spice was highest at 8.66 % found in treatment E and the lowest of 0.32 % found in treatment A.

Saturated lauric acid (C12 : 0) of rendang had the highest improvement, arachidat acid in rendang beef had the lowest decline. Chemical changes that occured in the fat molecules due to heating depend on 4 factors, namely duration of heating, temperature, presence of accelerators, such as oxygen or the results of the process of oxidation, and the composition of fatty acid mixture and also the position of the banded fatty acid in the triglyceride molecule [19]. Marichamy et al [24] added that factors such as fat content, processing temperature, the size of the beef affected the composition of the fat in the beef after the cooking process.

Unsaturated oleic acid (C18 : 1) is an unsaturated fatty acid that had a double bond [40]. This study revealed that oleic acid in rendang beef was a type of unsaturated fatty acids that had the most drastic reduction. This was because when the heating occured hydrolysis of fatty acids, and brook into short-chain fragments and wasted together with the result of the condensation to evaporated [19]. Oxidation of unsaturated fats formed peroxide compounds, further degradation of the hydroperoxide formed a variety of aldehydes compounds that were volatile and contributed to the formation of rancid odors [20]. Fat hydrolysis reactions might occured when there was water and heating [20].

### *B. Trans Fatty Acids of Beef and Spice of Rendang*

The percentage of trans fatty acids in beef and spice os rendang shown in Figure 5

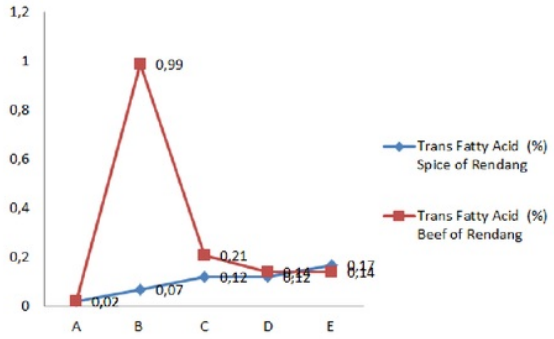


Fig. 11. Percentage of Total Trans Fatty Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

Based on Figure 11. known that the repeated heating of beef and spice of rendang increased total trans fatty acids. This was because the unsaturated fatty acids contained in beef and spice removed double bond (oleic acid, linoleic and linolenic acid ) as well as the isomerization.

Formation of trans fatty acids might not only originated from cis fatty acids undergo isomerization, but also from trans fatty acids that naturally already presented in beef (ruminants), which later during the cooking process the trans fatty acid and components of the beef was dissolved [33].

## IV. CONCLUSIONS

Processing of raw beef to be rendang with repeated heating process given significant effect on fatty acids of beef and spice of rendang. Saturated lauric acid in rendang beef was the highest increased and the lowest was arachidat acid. Saturated lauric acid, myristic acid and palmitic acid in rendang spice had a high improvement and arachidat acid was the lowest decline. Total trans fatty acids Increased in the beef and spice of rendang during the heating process repeated.

Suggested to not heat rendang repeatedly because the heat can lower its nutritional value. Suggestions for future research is determining the nutritional value of protein in rendang beef that heated repeatedly

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