

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 ingredient of rendang is a source of animal protein that has a high biological value because of its amino acids essential 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^oC will reduce the amount of lysine content in it be 90%, while heating at a temperature of 160^oC will reduce levels of lysine by 50 %. While Murhadi [27] said that rendang cooking at temperature around 90^oC - 93^oC. 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 preparation 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°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°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% BF₃ 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 Na₂SO₄, 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 (Capillary column)
 Column dimensions :
 P = 60 m ,
 Ø inside = 0.25 mm
 film thickness μ = 0.25 μ
 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
 LμInjection Volume : 1 μ
 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 μL standard mixture of FAME . When all the peaks was out, injected 5 μL 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 :

$$C_x = \frac{A_x \cdot R}{A_s} \cdot C_s \quad (1)$$

where:

C_x = concentration of component x
 C_s = Concentration of the internal standard
 A_x = Peak area of component x
 A_s = 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

$$\frac{A_x}{A_s} \times C_{\text{standard}} \times \frac{V_{\text{sample}}}{100} \times 100\% = \frac{\text{g sample}}{\text{g sample}} \quad (2)$$

G. Determination Method R

Made of a mixture of X (pure) and S with the number of W_x and W_s known and made the Chromatogram. In this case,

W_x = A_x · R_x and

W_s = A_s · r_s

From this relation, then R calculated as

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

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.

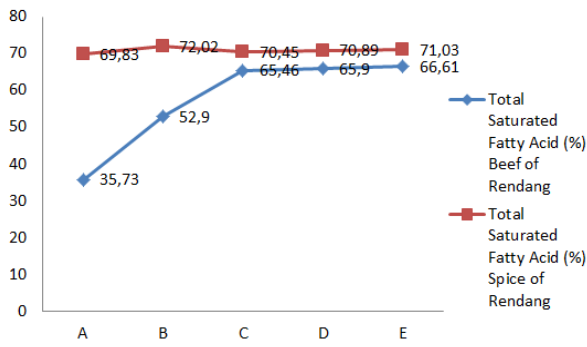


Fig. 1. Percentage of Saturated Fatty Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

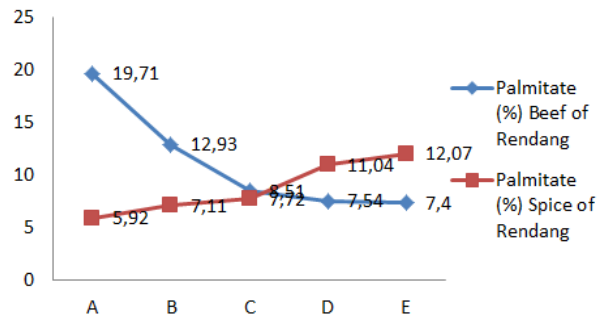


Fig. 5. Percentage of Palmitate Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

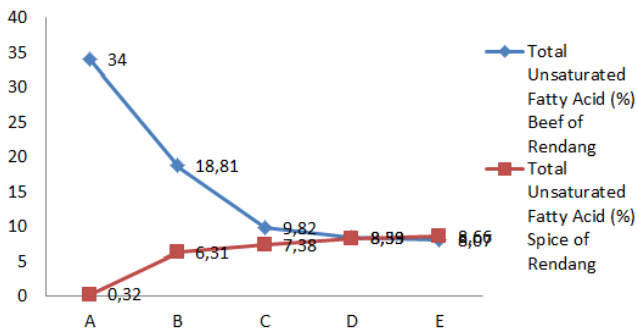


Fig. 2. Percentage of Unsaturated Fatty Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

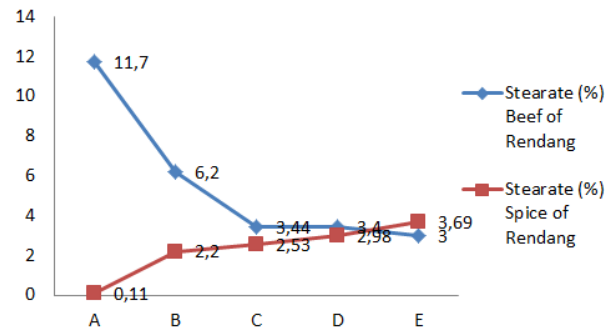


Fig. 6. Percentage of Stearate Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

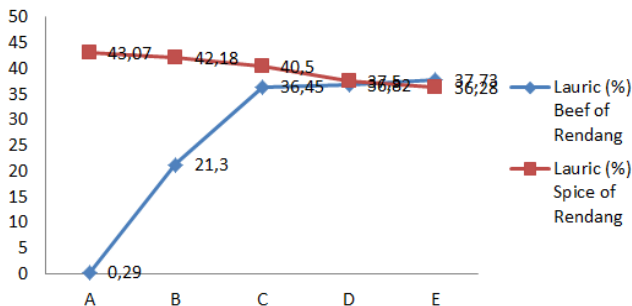


Fig. 3. Percentage of Lauric Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

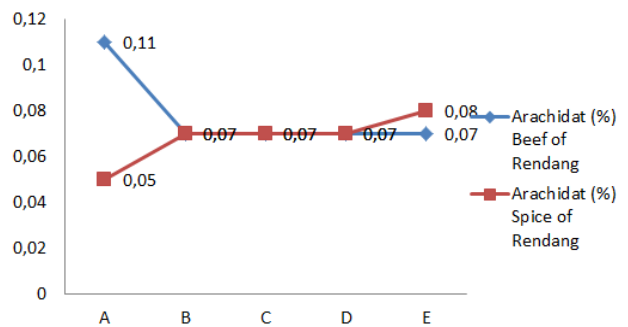


Fig. 7. Percentage of Arachidat Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

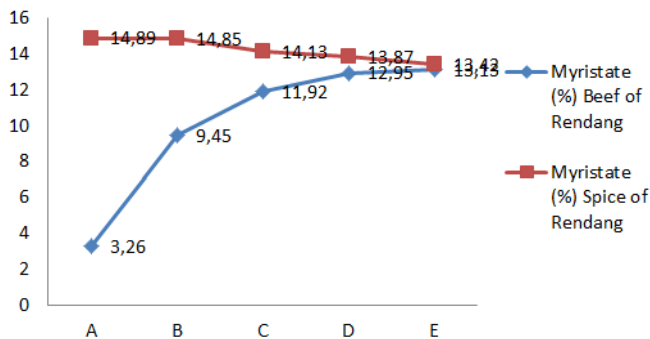


Fig. 4. Percentage of Myristate Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

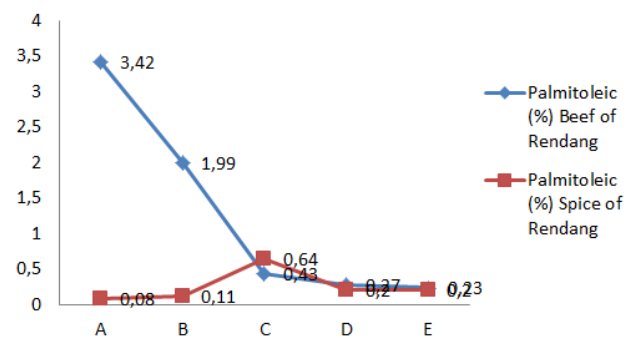


Fig. 8. Percentage of palmitoleic Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

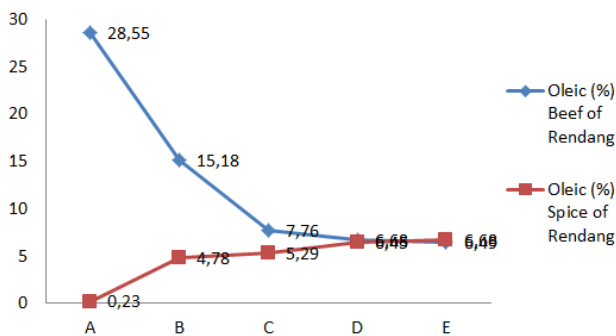


Fig. 9. Percentage of Oleic Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

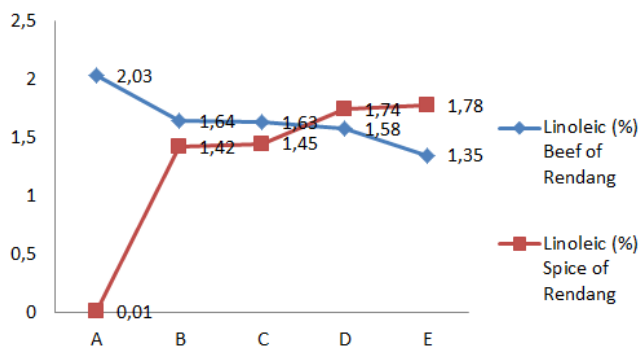


Fig. 10. Percentage of Linoleic Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

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 occurred 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 occurred hydrolysis of fatty acids, and broke 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 occurred 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 of rendang shown in Figure 5

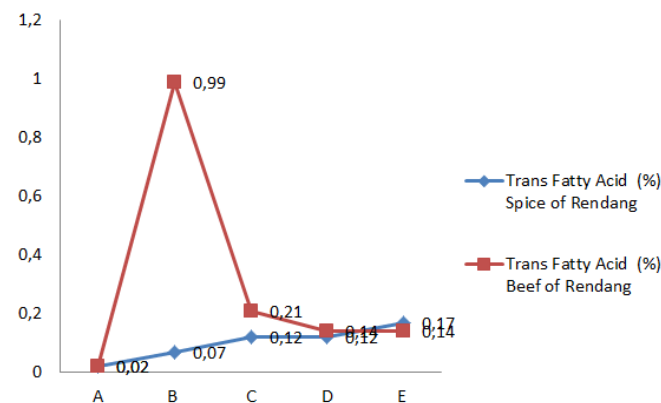


Fig. 11. Percentage of Total Trans Fatty Acids of Beef and Spice of Rendang. A (raw beef), B (freshly cooked Rendang), C (first heating), D (second heating), E (third heating)

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

REFERENCES

- [1] Achadi, E L. 2007. Gizi dan Kesehatan Masyarakat. Jakarta: PT Rajagrafindo Persada.
- [2] Ackman, R. G. 1994. Seafood lipids. Di dalam: Shahidi F, Botta JR, editor. Seafoods: Chemistry Processing Technology & Quality. London: Blackie Academic & Professional. Chapman & Hall.
- [3] Almtsier, S. 2006. Prinsip Dasar Ilmu Gizi. Jakarta: Gramedia Pustaka Utama.
- [4] Apriyanto, A. 2001. Perubahan sifat kimia pangan selama pengolahan. Fakultas Teknologi Pertanian. Bogor: Institut Pertanian Bogor.
- [5] Astawan, M. 2004. Makan Rendang dapat Protein dan Mineral. Dari http://web.ipb.ac.id/~tpg/de/pubde_ntrtnhlth_rendang.php diakses 19 Maret 2013
- [6] Association of Official Analytical Chemist (AOAC). 1984. Association of Analytical Chemist. Inc. USA
- [7] Budiman H. 2009. Asam lemak omega-3 dan kesehatan jantung. *Majalah Kedokteran Damianus*, (8):1.
- [8] Colpo A. 2005. LDL cholesterol: bad cholesterol or bad science. *Journal of American Physicians and Surgeons* 10(3) : 83-89.
- [9] Connel JJ. 1979. *Advances In Fish Sciences & Technology*. London : Fishing News Book Ltd.
- [10] Dean L, Fenner G, Boyd L. 2009. Characterization of lipids and their oxidation products in baked or fried breaded shrimp products. *J Food Science* 3(1) : 35-41.
- [11] Fennema, O.R. Editor. 1996. *Food Chemistry*, 3rd ed . Marcel Dekker. New York.
- [12] Forrest, J.C., E.D. Aberde, H.B. Hendrick. M.D. Judge, R.A. Merkel. 1992. *Principle of Meat Science*. W.H. Freeman and Co. San Fransisco – USA.
- [13] Man MW and Junge C. 2005. Kolesterol Rendah Jantung Sehat. Jakarta: PT Bhuana Ilmu Populer.
- [14] Gumilar, GG .Zackiyah. G.Dwiyanti. H.Siti. 2009. Pengaruh Pemanasan terhadap Profil Asam Lemak Tak Jenuh Minyak Bekatul. *Jurnal Teori Dan Hasil Penelitian Pembelajaran MIPA UPI*, Vol 14 No.2.
- [15] Hariyadi, P. 2000. Pengolahan pangan dengan suhu tinggi. Dalam P. Hariyadi (ed.). *Dasar-Dasar Teori dan Praktek Proses Termal*. Bogor: Pusat Studi Pangan dan Gizi. Institut Pertanian Bogor.
- [16] Hidajat B. 2003. Penambahan DHA dan AA pada makanan bayi: peran dan manfaatnya. <http://www.balita-anda.com> [3 Maret 2013].
- [17] Ho, C.T. and Hartman, T.G. (ed). 1994. *Lipids in Food Flavors*. ACS Symposium Series 558. ACS, Washington DC.
- [18] Katrina, A. 2000. Pengaruh pemanasan bumbu rendang terhadap aktivitas antimikroba pada *Staphylococcus aureus* dan *Bacillus cereus* [skripsi]. Bogor: Departemen Ilmu dan Teknologi Pangan. Fakultas Teknologi Pertanian. Institut Pertanian Bogor.
- [19] Ketaren, S. 2008. *Minyak Dan Lemak Pangan*. UI-Press: Jakarta.
- [20] Kusnandar, F. 2010. *Kimia Pangan Komponen Mikro.Dian Rakyat*. Jakarta.
- [21] Lawrie, R.A. 1991. *Meat Science 4th Edition* . Pergamon Press. New York.
- [22] Lehninger AL. 1990. *Dasar-dasar Biokimia*. Jakarta: Penerbit Erlangga.
- [23] Mainofri. 1990. Pengaruh suhu dan lama penyimpanan terhadap mutu rendang daging sapi [skripsi]. Bogor: Departemen Ilmu dan Teknologi Pangan, Fakultas Teknologi Pertanian, Institut Pertanian Bogor.
- [24] Marichamy G, Veerasingam S, Rajagopal S, Venkatachalapathy R. 2010. Fatty acid composition of Indian mackerel *Rastrelliger kanagurta* under different cooking methods. *Journal of Biological Sciences* 1(3): 109-112.
- [25] Muchtadi, T.R. and Sugiono. 1992. *Ilmu Pengetahuan Bahan Pangan*. Departemen Pendidikan dan Kebudayaan. Direktorat Jenderal Tinggi.
- [26] Muchtadi, D.1993. *Evaluasi Nilai Gizi Pangan*. Bogor: Pusat Antar Universitas Pangan dan Gizi, Institut Pertanian Bogor.
- [27] Murhadi. 1994. Identifikasi dan ketahanan panas bakteri pada produk rendang daging sapi. Tesis. Program Pascasarjana. Bogor: Institut Pertanian Bogor.
- [28] Okuzumi M, Fujii T. 2000. *Nutritional and Functional Properties of Squid and Cuttle fish*. Japan: National Cooperate Association of Squid Processors.
- [29] Purnomo, H. 1997. Studi tentang stabilitas protein daging dan dendeng selama penyimpanan. Laporan Penelitian. Fakultas Peternakan. Malang: Universitas Brawijaya.
- [30] Romans, J.R., W.J. Costello, C.W. Carlson, M.L. Greaser, K.W. Jones. 1994. *The Meat We Eat 13thEd* . Interstate Publishers Inc. Danville. Illinois.
- [31] Rusnam. 2012. *Pengolahan Daging Sapi*. Yogyakarta: Penerbit PT Citra Aji Parama.
- [32] Sampaio G.R, Bastos D, Soares R, Queiroz Y, Torres E. 2006. Fatty acid and cholesterol oxidation in salted and dried shrimp. *Food Chem* 96: 344-351.
- [33] Sartika, R.A.D. 2009. Pengaruh Suhu dan Lama Proses Menggoreng (Deep Frying) Terhadap Pembentukan Asam Lemak Trans. *MAKARA SAINS*, Vol 13 No.1.
- [34] Silalahi, J. and Tampubolon, SDR. 2002. Asam Lemak Trans dalam Makanan dan Pengaruhnya terhadap kesehatan. *Jurnal Teknol. Dan Industri Pangan*. Vol XIII, No.2.
- [35] Soeparno.1998. *Ilmu dan Teknologi Daging*. Yogyakarta: Gajah Mada University Press.
- [36] Sudarmadji, S., Haryono, Bambang., Suhardi. 1997. *Prosedur Analisa untuk Bahan Makanan dan Pertanian*. Edisi Keempat. Yogyakarta: Liberty.
- [37] Tan T.J. 2008. *Teknologi produksi high purity omega 3*. <http://docstoc.com> [3 Maret 2013].
- [38] Thoha. 2004. Asam lemak esensial untuk optimalisasi fungsi otak balita [Tesis]. Bogor: Program Pascasarjana, Program Studi Gizi Masyarakat, Institut Pertanian Bogor.
- [39] Wikipedia Indonesia. 2007. Sapi. <http://id.wikipedia.org/wiki/sapi> [2 Maret 2013].
- [40] Winarno, F.G . 2008. *Keamanan Pangan Jilid 1*. Bogor: M-Brio Pres
- [41] Winarno, F.G. 2004. *Kimia Pangan dan Gizi*. Jakarta: Gramedia Pustaka Utama.