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1 Chemical Characteristic and Fatty Acid Profile in Rendang Minangkabau

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Abstract— Rendang is a traditional Minangkabau foods which voted by CNN viewers in 2011 as one of the most delicious foods in the world. The basic ingredients of rendang are beef meat, coconut milk and spices. The process of cooking Rendang took around 5 to 6 hours at the temperature around 80-93oC. There are 2 types of food will be produce during the cooking processes differentiated by water content and colors. They are as following: Kalio (cooked until the sauce was thick brown color) and Rendang (cooked until the sauce was thick and dry and dark brown color). Rendang if cooked properly still good to consume until 3 weeks in room temperature, even last month stored in refrigerator and up to six months in frozen. As the food is cooked in a relatively longer period of time and with various spices it is interesting to know the nutritional value of the food. This paper is presenting a preliminary results of the research which aim to evaluate the nutritional value of Rendang by analysing the chemical characteristic of fat and fatty acid profile of Rendang. Rendang and kalio as a food will have 3 part such as a the meat, sauce and oil (fat and oil). This paper will discussed just for the fat and oil of Rendang. The result showed that the chemical characteristic of fat and oil of Rendang relative stable (not change) compare to Kalio where the fat and oil in Kalio and Rendang around 99,24% - 99,46%, peroxide value not detected, free fatty acid (FFA) number 0,21 - 0,28%, thio-barbituric acid (TBA) test 0,56 - 0,70 mg/kg fat and oil, and the trans fatty acid (TFA) not detected. The profile of fatty acid showed that the fatty acid of kalio and rendang are dominate by the saturated fatty acid short chain and medium chain (SCFA and MCFA) around 59,48 - 59,91%, long chain fatty acid (LCFA) around 31,41 - 31,47% and the rest are unsaturated fatty acid around 9,10 - 8,61%. From chemical characterization of fat and oil we can take a conclusion that Kalio and Rendang good to consume.

Keywords— cooking process; kalio; rendang; fat characteristic; fatty acid profile

I. INTRODUCTION

Rendang is a traditional food of Minangkabau ethnic in West Sumatra which is cooked by using heat from fire wood. The basic ingredients of rendang are beef meat, coconut milk and spices. The process of cooking rendang take around 5 - 6 hours, with temperature hanging around 80 - 90°C, until the meat turn soft and tender and the color turn to dark brown or black and give specific flavor and aroma[1].

The purpose of the such kind of cooking processes are to convert the raw material of food into edible foods and to prolong the storage life of rendang. Food processing, in general, can alter nutritional components both in positive and negative ways. The positive alteration are in the form of improved the protein digestibility, increased in availability of nutritive components, and decreased anti-nutrition component in raw material. On the other hand, the negative alteration decreased nutritive components because their sensitivity to pH, heat, oxygen, light and combination of them. The micro nutritive component especially copper, ferrum and enzyme can be a catalyst in the process [2].

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The basic ingredients of Rendang are meat and coconut milk which is rich in protein and fat. Fat and oil play an important role in forming: flavour, aroma, texture and nutritional quality of food. Fat and oil may be added during manufacturing or maybe they inherent to the product or ingredient.

Heating fat and oil can cause the chemical reaction such as hydrolysis and oxidation and will increase if water and oxygen are available. The damage of fat and oil while cooking process will influence the quality and nutritive value of food. During heating process, various chemical reactions occur, such as thermal oxidation, hydrolysis, and polymerization, due to the exposure of the oil to high temperatures in the presence of air and moisture. As a result, cooking oil decomposes and forms volatile compounds and various monomers and polymers [3,4]. Several factors can affect the quality of cooking oil during heating, including ventilation, temperature, heating duration, the type of oil, the saturation ratio of the oil, and the presence of a catalyst/antioxidant. These components can change in physical and chemical structure while cooking process [4].

Hydrolysis of fat and oil will produce free fatty acid, and oxidation of fat and oil will produce peroxide, hydroperoxide and the next reaction will produce aldehyde and ketones and free fatty acid. These component in high percentage will give off flavour in food and some of them are toxic. Off flavour where come from hydroxylation named as hydrolytic rancidity and from oxidation named as oxidative rancidity. Rancid food has a bad smell, taste and texture or appearance [3]. But in other ways heating process will inactive the enzyme such as protease, lipase, lipoxigenate, amylase, oxidative enzyme and hydrolytic enzyme where can protect the food material from off flavour.

Lipid oxidation process are generally considered to occur in three phases such as initiation phase, propagation phase and termination phase. The products of each phases will increase and decrease overtime.

Lipid peroxidation, the oxidative deterioration of the unsaturated and polyunsaturated lipids of food leads through formation of hydro peroxide to short chain, aldehydes, ketones and other oxygenated compound which are considered to be responsible for development of rancidity in stored foods [4] and related to experimental heart disease, cancer, and aging in animal.

Oxidation process started from the production of peroxide and hydro peroxide and the next step is brake down of free fatty acid and hydro peroxide converse to aldehyde and ketone and free fatty acid. The rancid are come from aldehyde and ketone not from peroxide [4].

There are 2 types of food will be produce during the cooking processes of Rendang, differentiated by water content and colors. They are: Kalio (cooked until the sauce was thick brown color) and Rendang (cooked until the sauce was thick and dry and dark brown color)[1]. As the food is cooked in a relatively longer period of time and with various ingredients it is interesting to know the nutritional value of the food.

Because rendang have been consumption since late year in Minangkabau and now all people over the world eat rendang, but no yet scientific research report about rendang. The report find just popular writing but not yet scientific research, so it is really necessary to do research about rendang Minangkabau. This research aim to evaluation of nutritional value and characteristic of aromatic component so can give information to consumer, producer and for development of the knowledge. This paper will report the preliminary result about the chemical properties and fatty acid profile of fat and oil in rendang.

II. MATERIAL AND METHOD

A. Basic Material

The basic material are: beef tenderloin, coconut milk from the mature coconut, spices such as red chili, onion, garlic, ginger, galangal, coriander, nutmeg, clove, white pepper, caraway, cardamom, lemon grass, turmeric leaf, lime leaf, and bay leaf.

The equipment need: equipment for cooking rendang, GC (Gas Chromatography), analytic balance, Kjedadahl, soxlet apparatus, spectrophotometer, glassware, filter, and others. This is an on going research in laboratories Faculty of Agricultural technology, Andalas University; Laboratories

Faculty of Animal husbandry IPB Bogor, Laboratories Faculty of GMSK IPB Bogor and Laboratories Saraswanti Indo Genetech Bogor.

B. Cooking Process of Rendang

All of the spices grounded except galangal and leafs mix together with coconut milk and then heat in temperature around 90 - 93°C and 90 minute until the sauce is thick. Put the meat in to the sauce and keep in the heat in temperature around 90 - 93°C and 90 minute until the sauce more thick and the color change brown, this product named Kalio. Continue the process but decrease the temperature into 80-83°C, it will take 2 hours until the product dry and the color change to dark brown or black, this product named Rendang. While cooking time rendang need to stir regularly to protect from burn.

C. Analysis of Product

Before analysed the chemical characteristic, Rendang separated into 3 part component, they are meat, sauce and fat and oil. In this paper we will report just for the fat and oil of Kalio and Rendang. The fat and oil were analysed the chemical characterization such as water content (gravimetry method), protein (Kjedahl), total fat (soxlet), ash (gravimetry method), free fatty acid (Titrimetri method), peroxide value (Titrimetri), trans fatty acid (Gas Chromatography) and fatty acid profile (Gas Chromatography).

III. RESULT AND DISCUSSION

A. Chemical Characteristic

Chemical analysis of fat and oil from Kalio and Rendang due by separated the fat and oil from sauce and meat. The chemical characteristic of fat and oil showed in Table 1.

TABLE I
CHEMICAL CHARACTERISTIC OF FAT AND OIL FROM KALIO AND RENDANG

| Ccomposition (% WB) | Kalio | Rendang |
|--|-------|---------|
| Water content (%) | 0.50 | 0.54 |
| Total fat (%) | 99.46 | 99.24 |
| Ash (%) | 0.00 | 0.00 |
| Peroxide value (meq O ₂ /kg) | 0.00 | 0.00 |
| Free fatty acid (%) | 0.21 | 0.28 |
| TBA test (mg/kg oil) | 0.56 | 0.70 |
| Trans free fatty acid (%) | 0.00 | 0.00 |

1) *Water content in fat and oil:* The water content in kalio and rendang are around 0,50% - 0,54%, this mean that the water content of fat and oil are very low. This is because the process of cooking Rendang relative in a long time period (5 -6 hours) with temperature around 80 - 93oC. While cooking process of Rendang the water will continuously evaporate from the food so the water content is very low. The low of water content in fat and oil enable Rendang to be preserve in longer time in store.

2) *Total Fat:* Concentration of total fat and oil in Kalio and Rendang are really high around 99,24% - 99,46% , it means that nearly all of them is fat and oil. Fat and oil in kalio and rendang large part of them come from coconut milk and only small part come from meat and spices. These

statement supported by the result of profile fatty acid (show in Table 2) who show that large part of them are saturated fatty acid (90.90 - 91.39%) with medium chain fatty acid (MCFA) around 59.48 - 59.91% and long chain fatty acid (LCFA) around 31.41 - 31.47%. The rest of them is unsaturated fatty acid around 8.61 - 9.10%.

Coconut is a unique vegetable oil because it is the only oil where about 50% of the fatty acid composition is C12, where total medium chain fatty acid about 60%, and long chain about 30%, and the rest unsaturated fatty acid about 10% [5]

3) *Free Fatty Acid (FFA)*: Free fatty acid determined the amount of free fatty acid in the fat and oil due to defect of hydrolysis and oxidation of fat [3]. The free fatty acid in Kalio around 0.21% and increase become 0.28% in Rendang. Concentration of free fatty acid in kalio and rendang relative low because the water content is low too around 0.50 - 0.54%. Free fatty acid is formed from the result of hydrolysis reaction between fatty acid triglyceride and water in the presence of catalyst and action of lipase enzymes. Hydrolysis reaction between triglyceride and 3 molecule water formed 3 molecule of free fatty acid and glycerol.

The high concentration of free fatty acid in fat and oil or food indicated that the food start to damage where in the maximum level the food no longer suitable to eat. The damage of fat and oil by hydrolysis action named as hydrolytic rancidity. Reference [3], said that the rancid come from the break down of free fatty acid and hydro-peroxide to form aldehydes and ketones.

For edible food with high concentration of fat and oil the maximum free fatty acid is 2%. Industrial Department in Indonesia determined that free fatty acid in vegetable oil not more than 0.3% (SII-92).

4) *Peroxide Value*: Peroxide value determined that the amount of peroxide in fat and oil because of the oxidation process and indicated that the oxidation on fat and oil specially on unsaturated fatty acid already happen. This reaction will increase when the oxygen and temperature increased. The mechanism of thermal oxidation involves the initiation, propagation, and termination. The first step hydroperoxide will form and will break down into secondary oxidation products (aldehydes, ketones, etc.) [3] The number of peroxide present in vegetable oils reflects its oxidative level and thus tendency to become rancid.

In Kalio and Rendang the peroxide value not detected, this is because the fat and oil are from the coconut oil who have large portion of saturated fatty acid where they are around 90 - 92%. Reference [10], said that theoretically coconut oil should exhibit a low rate of oxidation due to its low content of unsaturated fatty acid.

Oxidation can happen in double bond of unsaturated fatty acid chain with oxygen, where free fatty acid in coconut milk just around 8 - 10%. The low of peroxide value in Kalio and Rendang maybe because a lot of variety spices added in cooking process of Rendang. The spices have an activity as antimicrobial and antioxidant [6,7,8].

The peroxide value obtained were relatively low, indicating that the sample were highly stable against oxidation. Product with peroxide value between 1 and 5

meq/kg is classified at low oxidation state, between 5 and 10 meq/kg at moderate oxidation and above 10 meq/kg is classified at high oxidation state. High peroxide values are definite indication of a rancid fat [10] Industrial Department in Indonesia determined that peroxide value in vegetable oil not more than 1 mg O₂/100 g (SII-92).

5) *Thio barbituric acid (TBA) number*: Thio barbituric acid (TBA) number is a kind analysis to test the rancidity in fat and oil specially for food that have small amount of unsaturated fatty acid. The basic principle of this method is the reaction of 1 molecule malonaldehyde (MDA) and two molecules thio barbituric acid to form a pink pigment malonaldehyde-thio barbituric acid complex, which can be quantitated spectrophotometrically [11]. Malonaldehyde is a major degradation products of lipid hydroperoxides has attracted much attention as a marker for assessing the extent of lipid peroxidation [3,11].

The analysis of TBA test in kalio 0,56 MDA/kg oil, and in rendang increase become 0,70 MDA/kg oil. This result in low number and mean that rendang is good and healthy to consume. This is maybe because lipid in rendang dominate by saturated fatty acid so the oxidation process in low level. And other reason is because cooking process of rendang added a lot of various spices that have a function as a antioxidant and antimicrobial [6,7,8,9,10]

6) *Trans Fatty Acid*: Geometric isomer of unsaturated fatty acid generally call as cis/trans isomer, they are form when unsaturated fatty acid with cis configuration (band structure) change into trans configuration (linear structure). Trans fatty acid are formed during the partial hydrogenation of vegetable oils, a process that converts vegetable oil into semisolid fats such as margarine where in the process need a high temperature (180 - 200°C), pressure and catalyst. The average consumption trans fatty acid according to WHO less than 1% from total energy intake or approximately 20 calories for person consuming 2000 calories per day to avoid adverse effects and to minimize health risks.

Analysis result of trans fatty acid in rendang is negatif or not detected, it is mean that no trans fatty acid produced in rendang cooking process. This is because rendang produced in moderate temperature (around 80 - 93°C) and used various spices that can protect unsaturated fatty acid from oxidation. Reference [3,12] shows that trans fatty acid was formed after second repeating of deep frying in 200 °C and increased inline with the frequent of repeating.

B. Fatty Acid Profile of Kalio and Rendang

Analysis Fatty acid profile used Gas Chromatography aim to know the change of fatty acid from kalio to rendang in cooking process of rendang. The change of fatty acid because of chemical reaction in lipid such as oxidation, hydrolyzation and polymerization. Profile of fatty acid resulted show in Table 2.

The result show that not significant change in fatty acid profile and some of the fatty acid quite stable. This is because fat in Rendang come from coconut milk that have large part of saturated fatty acid (about 90.90 - 91.392%) where they are from medium chain fatty acid (MCFA) and long chain fatty acid (LCFA). These fatty acids are stable from oxidation because do not have double bond to oxidize

by oxygen. Medium chain fatty acid about 59.91% they are: caproic acid (0.69%), caprilic acid 8.40%, capric acid 5.92% and lauric acid 44.45%.

TABLE II
FATTY ACID PROFILE OF KALIO AND RENDANG

| Fatty Acid (%) | Kalio | Rendang |
|------------------------------|-------|---------|
| C6:0 (Caproic acid) | 0.69 | 0.67 |
| C 8:0 (caprilic acid) | 8.40 | 8.31 |
| C 10:0 (capric acid) | 5.92 | 5.97 |
| C 11:0 (undecanoic acid) | 0.02 | 0.02 |
| C 12:0 (lauric acid) | 44.45 | 44.94 |
| C 13:0 (tridecanoic acid) | 0.03 | 0.03 |
| C 14:0 (myristic acid) | 18.19 | 18.47 |
| C 14:1 (miristoleic acid) | 0.02 | 0.02 |
| C 15:0 (pentadecanoic acid) | 0.04 | 0.04 |
| C 16:0 (palmitic acid) | 9.36 | 9.26 |
| C 16:1 (palmitoleic acid) | 0.12 | 0.09 |
| C 17:0 (heptadecanoic acid) | 0.08 | 0.06 |
| C 17:1 (heptadecanoic acid) | 0.05 | 0.04 |
| C 18:0 (asam stearat) | 3.62 | 3.52 |
| C 18:1 (oleic acid) | 7.14 | 6.92 |
| C 18:2 (linoleic acid) | 1.52 | 1.46 |
| C 18:3 (linolenic acid) | 0.01 | 0.01 |
| C 20:0 (arachidic acid) | 0.09 | 0.09 |
| C 20:1 (eikosoanoic acid) | 0.03 | 0.02 |
| C 20:2 (eikosadienoic acid) | 0.00 | 0.00 |
| C 20:3 (eikosatrienoic acid) | 0.02 | 0.02 |

Unsaturated fatty acids in Kalio and Rendang in a small part they are miristoleic acid 0.02%, palmitoleic acid 0.12% , oleic acid 7.14%, linoleic acid 1.52%, linolenic acid 0.01%, eikosoanoic acid 0.03% and eikosatrienoic acid 0.02% and all of them quite stable too. Other reason may be because of the various spices used in Rendang processing that have function as antioxidant and antimicrobial. Each spices have specific component that have an activities as antioxidant such as alin and alisin in onion and garlic, capsaicin in red chili, zingeron in ginger[6,7,8].

Saturated fats in coconut are medium chain fatty acids whose properties and metabolism are different and do not undergo degradation and re-esterification processes and are directly used in the body to produce energy. They are not as bad for health as saturated fats [10].

IV. CONCLUSIONS

The chemical characterization of Kalio and Rendang are not significantly change where the water content around 0.50 - 0.54%, lipid total 99,24% - 99,46%, peroxide value 0,00%,

Free fatty acid number 0,21 - 0,28%, thiobarbituric acid test 0,56 - 0,70 mg/kg fat and oil, and trans fatty acid 0.00%. The profile of fatty acid showed that the fatty acid of Kalio and Rendang are dominate by the saturated fatty acid around 91.20%. Where they are from short chain and medium chain around 59,87%, long chain fatty acid around 31,33% and the rest are unsaturated fatty acid about 8.80%. From chemical characterization of the fat we can take a conclusion that Kalio and Rendang good to consume.

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