MOISTURE, FAT AND FATTY ACID PROFILE OF BEEF DENDENG IN MALANG CITY

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ABSTRACT

The objective of this study was to determine the chemical characteristics of sliced beef dendeng and ground beef dendeng circulating in Malang city, i.e., fat content, fatty acid profile, moisture content, water activity and total calories. The quantitative descriptive analysis was used as research design. The data obtained were analyzed statistically by using the calculation formula according to the method used. The sliced dendeng and ground dendeng circulating in Malang city was used as sample. Beef dendeng circulating in Malang city had a fat content of 3.43-6.77%, moisture content of 19.56-27.50%, water activity of 0.69-0.84, and total calories of 93.38-136.77 kcal. The sliced beef dendeng with the best chemical characteristics (closed to national standard) was tested for fatty acid profile analysis. About 37 fatty acids were identified, consisting of 19 saturated fatty acids and 18 unsaturated fatty acids. It was concluded that both types of beef dendeng circulating in Malang city had different fat content, fatty acid profile, moisture content, water activity and total calories. These differences were influenced by raw materials, spices and processing used.

Keywords: Beef; ground dendeng; sliced dendeng; spices; traditional food

INTRODUCTION

Meat is an easily damaged livestock product. Protein content of 18.4-21.2%, fat of 8.3-12.3%, total ash or minerals of 0.9-1.2% and moisture content of 66.1-69.3% in meat can be an ideal environment for harmful microbial growth (Bintoro, 2008). Preservation and processing are carried out to extend meat shelf life. Various traditional and modern processed meats are loved by consumers. One of traditional meat processing products from Indonesia is dendeng. Dendeng is a traditional dish made of sliced meat or ground meat added by flavor, printed as a thin sheet and dried (Gunawan *et al.*, 2015). Dendeng is classified as an intermediate moisture food which has a water content ranging from 15%-50% (Soeparno, 2009).

The moisture content in dendeng is one of the causes of oxidation during storage. Oxidation of fat is a reaction in food that easily occurs when there is contact between fat with a certain amount of oxygen during storage. According to the RI Law Regulations No. 18/2012 about food states that traditional food is food that has existed and been passed down from generation to generation by a process that is carried out using food additives consist of spices as the constituent material. The addition of spices to the processing of beef dendeng can affect the quality and characteristics of beef dendeng. Humectants that are used and added to the product will affect the dendeng product. Another influencing factor is the drying process, which can affect the moisture content and the water activity of the final product. The addition of sliced beef, ground beef, spices, processing, selection of raw materials and others will give different qualities to the final beef

dendeng product. The selection of raw materials, seasonings, storage, and others varies between producers, therefore affecting the quality of the beef dendeng produced. There are two types of beef dendeng, sliced beef dendeng and ground beef dendeng. Sliced beef dendeng is meat that is thinly sliced, soaked in spices and then dried. Ground beef dendeng is ground meat, added with spices and printed in thin sheets and then dried. The two types of dendeng have different characteristics and the nutritional content in them is also different. The process of ground meat also causes the sugar to be added more evenly than using sliced meat (Purnomo, 2012). The quality of sliced and ground beef dendeng in Malang city is still unknown, the purpose of this research had to determine the chemical characteristic of sliced beef dendeng and ground beef dendeng in Malang city analyzed from fat content, moisture content, water activity, total calories and fatty acid profile. There are two types of beef dendeng, sliced beef dendeng and ground beef dendeng.

MATERIALS AND METHODS

This research was conducted at the Food Quality and Safety Testing Laboratory, Faculty of Agricultural Technology, Universitas Brawijaya to analyze beef dendeng which moisture content, water activity, total calories and fat content. Fatty acid profile analysis was carried out at the Saraswanti Indo Genetech Bogor Laboratory. The research material used eight samples of commercial dendeng brands in Malang City, consisting of four commercial ground beef dendeng products and four commercial sliced beef dendeng products. All beef dendeng was taken from

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traditional markets and supermarkets in Malang City. Sampling was done by purposive sampling. The materials used for analysis distilled water, methylene blue, alcohol 70%, silica gel, H₂SO₄ solution, K₂SO₄, HgO, H₃BO₃, NaOH, HCl 0.043664 N, AgNO₃, glycerol, and hexane. The tools used in making dendeng include stoves, gas cylinders, blenders, meat grinders, pans, basins, spatulas, knives, and cutting boards. The tools used for the analysis are beaker glass, petri dish, erlenmeyer, magnetic stirrer, oven, water bath, pH meter, measuring cup, test tube, test tube rack, volumetric pipette, mortar pestle, and spatula.

Research Method

The research method used in this research was a survey using a quantitative descriptive analysis design. Dendeng samples were taken from supermarkets in

Malang by purposive sampling consist of (G1) ground beef dendeng brand 1, (G2) ground beef dendeng brand 2, (G3) ground beef dendeng brand 3, (G4) ground beef dendeng brand 4, (S1) sliced beef dendeng brand 1, (S2) sliced beef dendeng brand 2, (S3) sliced beef dendeng brand 3, (S4) sliced beef dendeng brand 4, (S4) sliced beef dendeng brand 4.

Moisture Content Analysis (AOAC, 2005)

Empty petri dishes were dried in an oven at 105°C for 15 min and cooled in a desiccator, then 10 g of samples were weighed and put in a weighed petri dish. Dry in oven at 105°C for 12 h. The plate containing the dried sample is then transferred into a desiccator, cooled then weighed. Drying is carried out until a constant weight is obtained. The percentage of water content is calculated as follows:

$$\text{Moisture content (\%)} = \frac{(\text{initial sample weight} - \text{final sample weight})}{\text{initial sample weight}} \times 100\%$$

Water Activity Analysis

The tool was calibrated first with a saturated NaCl solution. The sample (5 g) was crushed and put into the sample chamber. The start button was pressed and waited until the water activity value was analyzed by the tool.

Total Calories Analysis

Total calorie analysis of beef dendeng was carried out based on Handa *et al.* (2012) caloric value (g/100 g), obtained from the calculation of protein content (g/100 g), fat (g/100 g) and carbohydrates (g/100 g).

Fat Content Analysis (AOAC, 2005)

Hydrolysis stage

Tools and materials were prepared. Sample was weighed 4-5 g (W) carefully into a 500 mL or 300 mL beaker glass, added with 45 mL of distilled water and brought to boil with the solvent while stirring until homogeneous. About 55 mL of 8 M HCl (2 parts of HCl plus 1 part of water) and a

few grains of boiling stone were added. The beaker was covered with a watch glass and then simmered for 15 min. The watch glass was rinsed with distilled water and put the rinsing water into the beaker. The precipitate was filtered using a fat-free filter paper.

The beaker was rinsed 3 times with distilled water, washed until it was chlorine-free which was determined by adding 1–3 drops of AgNO₃, 0.1 M to the filtrate if there was no white precipitate (AgCl). The filter paper was transferred to the extraction timble or a fat-free filter paper sleeve and dried for 6 h at 100-101°C.

Extraction stage

The fat flask containing a few grains of boiling stones was dried for 60 min. After cooling in a desiccator and weighing (W), the flask was connected with an extractor. Soxhlet lead was supported by glass bead. The cup was rinsed and used for hydrolysis and drying process with 3-5 mL of petroleum ether or hexane and poured into

the soxhlet, then poured into 2/3 of the capacity of the flask above the heater. Extract for 4 h with an extraction speed of more than 30 times. Dried the boiling flask and fat in the oven at a temperature of 100-101°C for 1.5-2 h. Cooled in a desiccator and weighed (W₂). The drying was repeated until the difference in the weight of the fat weight was less than 0.05%. It is calculated by the following formula:

$$(\%) = \frac{W_2 - W_1}{W} \times 100\%$$

Fatty Acids Profile Analysis

Analysis of fatty acid profiles was based on Okarini *et al.* (2019), a gas chromatography device and the sample were prepared. Dendeng was grounded and dried in an oven at 50°C for 12 h. Dried samples were crushed using a mortar pestle until it becomes flour and filtered using a membrane (250 µm). Mix 100 mg of the fine sample with 1 mL (1000 µL) absolute methanol or hexane, then centrifuged at 15000 rpm for 5 min at room temperature. 100 µL of supernatant was taken and added to 900 µL of absolute methanol, then centrifuged at 15.000 rpm for 5 min at room temperature. The resulting supernatant can be used directly and ready to be injected into gas chromatography. The amount of supernatant that must be injected is 1 µL. The analysis of the sample extract was performed using 1 set of Agilent Technologies 6890 N (G.1540M) gas chromatography (GC) equipment (Palo Alto, CA, USA) connected to a detector

(Agilent Technologies 5973 Inert Mass Selective Detector) to generate data, equipped with HP5MS column (id. 30 m x 0.32 mm).

Data Analysis

Data were analyzed statistically using Microsoft Excel 2010 to find the average value and standard deviation. At this stage, the results of the analysis and processed data will be described fully descriptively to get the conclusions.

RESULTS AND DISCUSSIONS

Moisture Content

The average moisture content of ground and sliced beef dendeng can be seen in Table 1. The moisture content of ground beef and sliced beef dendeng ranged from 19.56-27.50%. The average value of the highest moisture content of beef dendeng was in sample G1 with 27.50%, while the average value of the lowest moisture content of beef dendeng was found in sample S3 with 19.56%. The moisture content value of the two types of commercial beef dendeng in Malang City is still not sufficient for the average value of SNI (Indonesian National Standard) (2013), which has a maximum moisture content value of 12%. However, the two types of commercial beef dendeng in Malang City is still included in the intermediate moisture food (IMF) category, IMF products generally have a water activity range value of 0.60-0.90 and a moisture content value of 10-40% (Setijawaty *et al.*, 2019).

Table 1. Moisture content of commercial beef dendeng in Malang city

Sample Code	Moisture Content (%) ± SD
G1	27.50±0.69
G2	25.04±0.04
G3	26.92±0.19
G4	22.28±0.55
S1	20.76±0.03
S2	21.23±0.91
S3	19.56±0.32
S4	22.84±0.55

The moisture content value beef dendeng sample G4 has a high moisture content value compared to other samples. Several factors affect the high moisture content value in the G4 sample, one of which is the seasoning factor. This type of beef dendeng has a low moisture content. Because the ground beef dendeng has a large surface area so that the moisture content is absorbed more one of the components of the seasoning used in the processing of beef dendeng is sugar.

Producers often use high amounts of added sugar in the processing of beef dendeng. Due to the characteristics of beef dendeng that are identical with sweetness. The addition of sugar in high amounts can affect the quality of the moisture content of

the beef dendeng produced. This is following the research of Evanuarini and Huda (2011) which states that the addition of sugar in each treatment has a high moisture content value. It is assumed that the addition of sugar to food preservation will bind water in the foodstuff.

Water Activity

The average activity value of ground and sliced beef dendeng water activity can be seen in Table 2. The water activity value of ground beef dendeng and sliced beef dendeng ranged from 0.69-0.84. The highest average water activity value of beef dendeng is in sample G4 with 0.84, while the lowest average water activity value of beef dendeng is in sample G1 and S3 with 0.69.

Table 2. Water activity of commercial beef dendeng in Malang city

Sample Code	Water Activity $\pm$ SD
G1	0.74 $\pm$ 0.01
G2	0.69 $\pm$ 0.01
G3	0.78 $\pm$ 0.02
G4	0.84 $\pm$ 0.05
S1	0.75 $\pm$ 0.01
S2	0.75 $\pm$ 0.03
S3	0.74 $\pm$ 0.01
S4	0.77 $\pm$ 0.01

The sample G1 and S3 have very low water activity values. The water activity values of these two samples are also not included in the IMF product requirements which range from 0.60-0.90. Things that affect the value of low water activity are the drying process and the addition of sugar. There are two types of drying methods used in the processing of beef dendeng, which is using an oven and dried in the sun drying using sunlight is considered a low cost to reduce the value of water activity.

However, this method is slow because it depends on the weather (Erkmen and Osman, 2016). The low value of water activity in a food ingredient also has a role in the number of microbes in that food. Sliced beef dendeng and ground beef dendeng are different. Ground beef dendeng has a wider surface so it is more likely to be

contaminated by microbes. The low value of water activity in a food ingredient also has a small amount of water which will inhibit the growth of microbes in the foodstuff (Putri *et al.*, 2018).

Bacteria generally grow and thrive only in media with a high-water activity value (0.91). Yeast requires a lower water activity value (0.87-0.91) and lower mold (0.80-0.87) (Buckle *et al.*, 1987).

Total Calories

The average total calorie value of ground beef and sliced beef dendeng can be seen in Table 3. The total calorie value of ground beef and sliced beef dendeng ranges from 93.38 to 136.77 kcal. The highest average total calorie value of beef dendeng is in the S2 sample with 136.77 kcal, while the lowest average value of beef dendeng is

in the S1 sample with 93.38 kcal. The results of the research show that ground beef dendeng tends to have a higher calorific value compared to sliced beef dendeng. The difference in the caloric value of the type of meat used is that ground beef dendeng per 100 g has a caloric value of 276 calories, while the caloric value of sliced beef dendeng is 149 calories. A calorie is a

general term for the energy unit of the metric system. Our bodies need calories from the food we eat as a source of energy to carry out daily activities without sufficient calories. We will definitely feel as weak as a car without gasoline (Kurniali and Abikusno, 2007). Calories for raw beef in 100 g is 205.5 kcal. Roast beef has 267 kcal and dendeng beef has 200 kcal.

Table 3. Total calories of commercial beef dendeng in Malang city

Sample Code	Total Calories $\pm$ SD
G1	113.53 $\pm$ 0.28
G2	127.86 $\pm$ 0.26
G3	128.59 $\pm$ 0.56
G4	124.55 $\pm$ 0.23
S1	93.38 $\pm$ 0.42.
S2	136.77 $\pm$ 0.21
S3	96.51 $\pm$ 0.42
S4	111.83 $\pm$ 0.06

Calories can be obtained from the intake of foods that contain nutrient such as carbohydrates, fats, proteins and others. Each person's calorie needs vary depending on age, height and weight as well as activities or activities carried out per day. Excess calories or lack of calories in the body are not good for health. Excess calories can lead to obesity. Commercial beef dendeng in Malang City have a low caloric value. Low calorie foods also have benefits for consumers including reducing energy intake and weight loss.

Fat Content

The average fat content of ground and sliced beef dendeng can be seen in Table 4. The fat content ranges from 3.43-6.77%. The average value of the highest fat content of beef dendeng is in sample G1 with 6.77%. While the average value of the lowest fat content of beef dendeng is in sample S3 with 3.43%.

Based on the fat content value of ground beef dendeng which is listed in Table 4. The sample code of ground beef dendeng G3, S1, and S3 is within the range required by Indonesian National Standard (SNI) (2013), which is a maximum of 3%. While

G1 has a fat content value above the average SNI which is 6.77%. The high fat content value in the G1 sample was caused by several factors, one of which is the selection of raw materials. The part of beef that can be used in the processing of beef dendeng is the round or the hamstrings of the beef. This section has a fibrous, dense texture and a fairly low-fat content of 7% and the protein content in the round section is 27% (Hosain *et al.*, 2015).

Based on the results in Table 4. it is known that the fat content of the beef dendeng has an average value ranging from 3.43-6.77%. The highest fat content value is found in the G1 sample of beef dendeng, which is 6.77%. The processing of beef dendeng generally uses the curing technique. This technique is considered to give the characteristics and delicious taste in the result of the beef dendeng product. The curing technique is the mixing of all condiments for the beef dendeng including salt. Excessive addition of salt can cause the fat content of the beef dendeng to increase, salt binds water and water-insoluble fat so that the less water content in the product causes the fat content to increase (Pusudarsono *et al.*, 2015). The analysis of

the fatty acid profile of beef dendeng was carried out to determine the average value of the amount and type of fatty acids contained

so that it can be used as a reference for the acceptable quality of beef dendeng by consumers.

Table 4. Fat content of commercial beef dendeng in Malang city

Sample Code	Fat Content (%) $\pm$ SD
G1	6.77 $\pm$ 0.11
G2	6.40 $\pm$ 0.57
G3	3.90 $\pm$ 0.01
G4	4.82 $\pm$ 0.10
S1	3.85 $\pm$ 0.06
S2	5.42 $\pm$ 0.14
S3	3.43 $\pm$ 0.14
S4	4.63 $\pm$ 0.06

Fatty Acids Profile

The fatty acid profile of sliced and ground beef dendeng varies. This is presumably due to differences in the quality of the materials used percentage and composition of the constituent materials used the processing and storage. The fatty acid profile of the beef dendeng circulating in Malang city samples tested was S3 sample. Sample S3 has a good nutritional value seen from the test of water content, water activity, total calories and good fat

content so that the S3 sample can be further tested by the fatty acid profile test.

Based on their chemical structure, fatty acids are divided into saturated fatty acids (SFA), namely fatty acids that do not have double bonds. While fatty acids that have double bonds are referred to as unsaturated fatty acids, differentiated into mono unsaturated fatty acid (MUFA) with one double bond and polyunsaturated fatty acid (PUFA) with one or more double bonds.

Table 5. Saturated fatty acids of commercial beef dendeng in Malang city

No.	Fatty Acids	Content (mg/kg)
		average
1	Butyric Acid	0.001895
2	Caproic Acid	0.0425
3	Caprylic Acid	0.4879
4	Capric Acid	0.2897
5	Undecanoic Acid	0.00171
6	Lauric Acid	1.79255
7	Tricanoic Acid	0.07575
8	Myristic Acid	0.0055
9	Pentadecanoic Acid	0.00715
10	Palmitic Acid	0.66495
11	Heptadecanoic Acid	0.01115
12	Stearic Acid	0.32485
13	Arachidic Acid	0.01105
14	Heneicosanoic Acid	0.00184
15	Benehic Acid	0.00162
16	Tricosanoic acid	0.001665
17	Lignoceric acid	0.00161

Table 6. Monounsaturated fatty acids profile of commercial beef dendeng in Malang city

No.	fatty acids	content (mg/kg)
		average
1	Myristoleic acid	0.0055
2	Cis-10-pentadecanoic acid	0.00715
3	Palmitoleic acid	0.0234
4	Cis-10- heptadecanoic acid	0.01115
5	Trans-9- elaidic acid	0.0063
6	Oleic acid	0.75415
7	Cis-11- eicosanoic acid	0.00148
8	Erucic acid	0.00386
9	Nervonic acid	0.00169

Table 7. Polyunsaturated fatty acids profile of commercial beef dendeng in Malang city

Number	fatty acids	content (mg/kg)
		average
1	Linolelaidic acid	0.0655
2	Linoleic acid	0.1389
3	γ Linolenic acid	0.1389
4	Linolenic acid	0.0551
5	Cis11-14- eicosadienoic acid	0.001575
6	Cis-8- 11-14- eicosatrienoic acid	0.0031
7	Cis11-14-17- eicosatrienoic acid	0.001795
8	Arachidonic acid	0.01105
9	Cis13-16- dokosadieno acid	0.0016
10	EPA	0.00146
11	DHA	0.00225

In general, foods originated from animals (fatty meat, cheese, butter, and milk cream) in addition to containing saturated fatty acids also contain cholesterol. Based on the results of laboratory analysis of the 17 types of saturated fatty acids analyzed, 11 of them has results $<0.1\%$. This is influenced by the length of the saturated fatty acid chain, where the shorter the saturated fatty acid chain, the more easily the saturated fatty acid will be damaged due to heat exposure (Sartika, 2008).

The highest saturated fatty acid was lauric acid at 1.78%. According to the research of Setiaji and Prayugo (2006) states that lauric acid is a medium chain fatty acid that plays a role in maintaining health including the function of killing various types of microbes whose cell membranes come from fatty acids. According to

research by Denke and Grundy (1992), lauric acid can increase the concentration of total and LDL cholesterol compared to oleic acid. Below is described the average value of the fatty acid profile from one of the sliced beef dendeng samples in Table 5, 6 and 7.

Rancid processed food products can experience color changes and lose nutritional value due to the oxidation of unsaturated fatty acids which has an impact on quality degradation. McClement and Decker (2000) stated that factors that can affect the speed of oxidation include the amount and type of oxygen, the chemical structure of lipids, the presence of antioxidant and prooxidant compounds, storage temperature and the properties of packaging materials. The unsaturated fatty acid profile values in Table 7 have relatively

low values. The highest value for unsaturated fatty acids is 0.75% oleic acid. The double bonds in unsaturated fatty acids are easily oxidized with oxygen. SFAs are fatty acids that contain single bonds in their hydrocarbon chains.

Palmitic acid is the main component in saturated fatty acids, which is 53-65% of total saturated fatty acids (Ozugul and Ozugul, 2007). The low unsaturated fatty acid value is due to its instability during the dendeng oven process. According to Little *et al.* (2000) research states that unsaturated fatty acids are less resistant to heat with their instability increasing along with the degree of saturation. Combined with oxygen PUFA degradation occurs more rapidly and PUFA experiences a visible oxidative effect. Linoleic acid is a double-bonded unsaturated fatty acid that can help inhibit the risk of thrombosis, lower blood pressure, maintain cell membranes and maintain cholesterol balance (Harris *et al.*, 2009).

CONCLUSION

This research concludes that the chemical characteristics of slice beef dendeng and ground beef dendeng in Malang city are different. This is influenced by the quality of the meat, the ingredients used and the varying process of making dendeng from each producer. The chemical characteristics of beef dendeng products in Malang city are according to national standard (SNI 2908:2013) with a blackish-brown color, a relatively thin sheet of meat, with no white spots caused by a fungus, and a water content of 20-40%.

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