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The Effect of Cooking Method on the Nutritional Characteristics of "*Dendeng Kariang*" as a Traditional Minangkabau Food

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***Abstract*— This study aims to determine the effect of cooking methods on the nutritional characteristics of *dendeng kariang*. After preparations, *dendeng kariang* was fried in vegetable oil by using two methods of frying. The methods are the vacuum frying method (75^{o}C) and the conventional frying method (175^{o}C). Protein characteristics are evaluated by analyzing the total protein content, amino acid profiles (UPLC), protein profiles (SDS-PAGE), and fatty acid profiles (GC-MS). The results showed that the vacuum frying method had higher total protein content (63.78%). All amino acid profiles are higher in the vacuum frying method than the conventional frying method, respectively 674,487.98 mg/kg and 629,588.51 mg/kg. The protein profiles showed that the vacuum frying method had 14 polypeptide bands, while conventional frying had 15 polypeptide bands. Total fat content with the vacuum frying method was found higher than conventional frying, respectively 18.16% and 10.65%. The fatty acid profile showed that the vacuum frying method had higher unsaturated fatty acid content, which is oleic acid 3.8297%, linoleic acid 0.9448%, and linolenic acid 0.0207%, while the conventional frying method had oleic acid 3.4996%, linoleic acid 0.9297%, and linolenic acid 0.0197%. The total unsaturated fatty acid in the vacuum frying method is higher than the conventional frying method, respectively 5.0166% and 4.6541%. These numbers concluded that cooking methods affect the nutritional characteristic of *dendeng kariang*, and the vacuum frying method had better nutritional characteristics.**

***Keyword* —*dendeng kariang*; conventional frying; vacuum frying; nutritional characteristics.**

I. INTRODUCTION

In Indonesia, the West Sumatra Province, known as Minangkabau, is very famous for its culinary diversity [1,2]. Traditional Minangkabau foods are generally processed with herbs and spices available locally, thus making it difficult to imitate in other regions or countries. Therefore, traditional food has its characteristics. One of the traditional dishes in Minangkabau is called *dendeng*. *Dendeng* is one of the authentic traditional food originates in the Minangkabau. There are two types of *dendeng*, *dendeng lambok* (moist) and *dendeng kariang* (dry) [3]. The basic ingredients of *dendeng* are beef slices (silverside), which are thinly sliced and processed using various herbs spices. The main herbs used generally are coriander, garlic, galangal, pepper, tamarind, and spices like cinnamon, cumin and lime are additional seasonings added by producers in the *dendeng* industry [4].

Various researches have been done on *dendeng lambok,* yet none has been done on *dendeng kariang*. *Dendeng kariang* is cooked by frying to obtain better color, taste, aroma, and texture [5]. Before the frying process is done, the beef slices are dried in the sun until the water content reaches 10% ± 15%, resulting in raw *dendeng kariang*. Before consumption, raw *dendeng kariang* must be fried in the vegetable oil until it becomes brown-colored, had a crispy texture, and exuded a specific aroma.

Usually, the conventional frying temperature can reach 150-200^{O}C. The high-temperature cooking process has potentially affected proteins' characteristic by triggering a cross-linking, bending, and aggregating process, thus influencing protein susceptibility to enzymatic hydrolysis of the gastrointestinal and also affected the release and bioavailability of amino acids and polypeptides [6]–[10]. Furthermore, proteins will also experience racemization, resulting in lysinoalanine and lanthionine which cannot be digested by digestive enzymes in the human body [11]. Whilst frying, the fat and oil in the raw dendeng and the vegetable oil as the frying medium could become oxidized in the high temperature, especially the unsaturated fatty acid.

To minimize the damage to the nutritional value of *dendeng kariang*, especially protein, a vacuum frying method can be used. Vacuum frying is a frying process that is carried out at the pressure far below atmospheric levels [12]. At a lower pressure, the frying process will cause the boiling point of cooking oil to be lower than 100^{O}C. The main factor that affects frying products is the combination of the temperature of the frying time cooking process, where

the right combination is needed to get the food products that can attain the best physical attributes and nutritional value [13].

In this research, we studied the benefits of using vacuum frying on *dendeng kariang* products' nutritional characteristics by comparing the protein profile, amino acid profile, and fatty acid profile to those of fresh meat as the raw material and *dendeng kariang* fried with conventional high-temperature frying. This study's results could give more information on the nutritional content of the vacuum fried *dendeng kariang* and that the vacuum frying method is one of the alternative ways of producing healthier foods. The results of this study will also support the data on the wide use of vacuum frying technology in maintaining the quality of food products produced by the frying process.

II. MATERIALS AND METHODS

Fresh meat, spices, and cooking oil in this study were obtained from Bandar Buat market, Padang, Indonesia. The equipments used for cooking *dendeng kariang* is listed as follows: Vacuum fryer used is Agrowindo type PV-1.5 with the capacity of 1.5 kg/process and 20 liters of cooking oil. The vacuum frying equipment is shown in Fig 1. The Ultra-Performance Liquid Chromatography (UPLC) used is UPLC PDA Waters Acquity H-Class to analyze amino acids profiles in the meat. Electrophoresis for analyzing the molecular weight of polypeptide bands is *Mupid-Exu brand electrophoresis, by using the* SDS-PAGE method. Soxhlet brand Buchi type Extraction Unit E-812 is used to analyze the fat content in meat. The research was conducted at the Laboratory of the Faculty of Agricultural Technology, Andalas University; the Laboratory of the Faculty of Animal Husbandry, Bogor Agricultural Institute (IPB); the Laboratory of GMSK IPB Bogor, and the Saraswanti Indo Genetech Laboratory, Bogor.

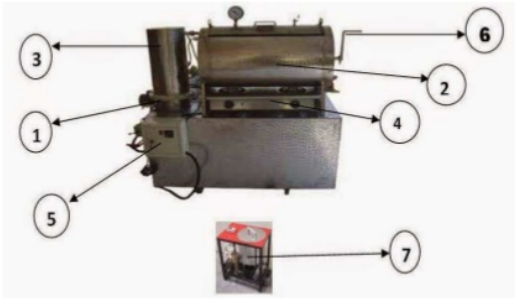

Fig 1 The vacuum frying equipment ((1) vacuum water jet pump, (2) frying tube, (3) the condenser, (4) heating unit, (5) operation control unit: functions as a device for activating vacuum machines and heaters, (6) fryer stirrer, (7) spinner: serves to drain oil content in *dendeng kariang*).

A. Sample Preparation

Dendeng kariang was produced by using two different cooking methods, which are conventional frying and vacuum frying. Before the frying process, the meat is sliced and smeared with various spices, and sundried resulted in raw *dendeng kariang*. This raw *dendeng kariang* is then fried in vegetable oil. It is fried with deep-fat frying for 5 minutes (175^0C) for the conventional frying method and fried for 20 minutes (95^0C) and 12 mmHg pressure for the vacuum frying method. The processing is presented in Fig 2.

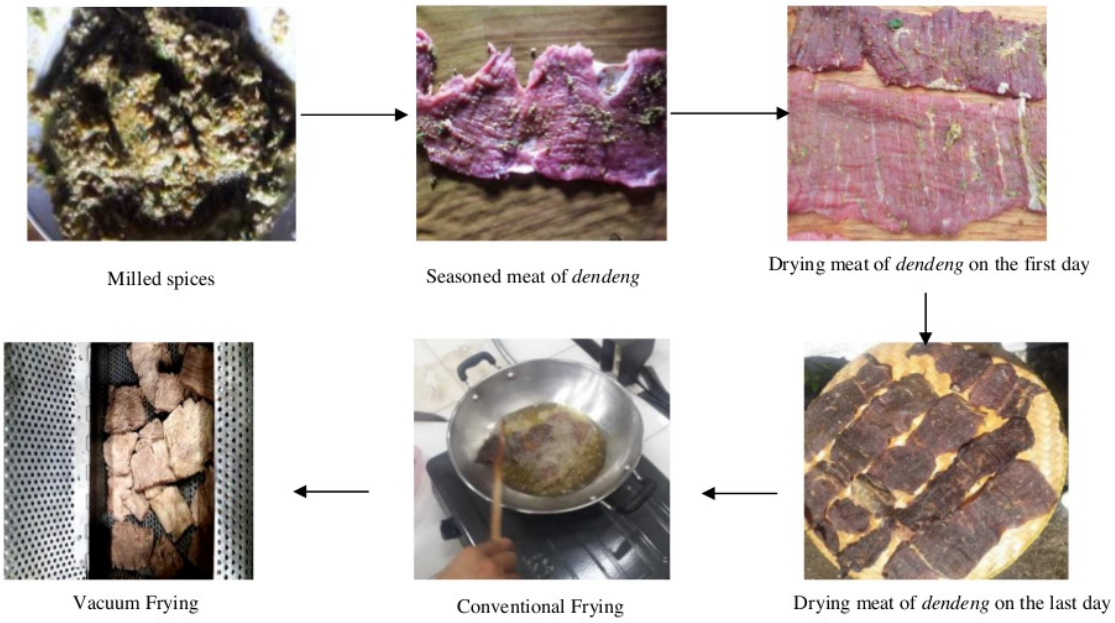

Fig. 2 The processing of *dendeng kariang* with conventional frying (CF) and vacuum frying (VF)

B. Water content

Water content in *dendeng kariang* is measured by using an oven at 105°C based on the methods available in the Association of Official Analytical Chemists (AOAC) [14].

C. Amino Acids Profile Analysis

The amino acid profile analysis is done by using the Ultra Performance Liquid Chromatography (UPLC) method. The sample weighed 0.1 g was crushed and put into a closed test tube. The sample solution was added with 6 N HCl as much as 5-10 mL, hydrolyzed in an oven at 110°C for 22 hours, then cooled down at room temperature and was transferred to a 500 mL measuring flask. After that, aqua bidets were added to the boundary markers, filtered with a filter of 0.45 µL, and piped 10 µL, and added with 70 µL *AccQ Fluor Borate divortex*. Then, 20 µL of Flour reagent was added to the vortex, let stand for 1 minute, and incubated for 10 minutes at 55°C. Then, 1 µL of this mixture is then injected to the UPLC using the ACCQ-Tag Ultra C18 column, temperature 49°C, a mobile phase of the PDA gradient detector composition system, a flow rate of 0.7µL/min, and wavelength 260 nm.

Amino Acid SDS-PAGE Profile, The separating gel used are 12.0% polyacrylamide gel [*acrylamide: bisacrylamide* with a ratio of 37.5: 1 (w/w), SDS 0.10% (w / v), TEMED 0.05% (v/ v), ammonium persulfate 0 , 05% (w / v), and Tris -HCl, pH 8.8 0.384M)] and 4.0% polyacrylamide gel [acrylamide: *bisacrylamide* or 37.5: 1 (w/w), SDS 0.10% (b / v), TEMED 0.10% (v/v), *ammonium persulfate* 0.07% (w / v), and Tris-HCl, pH 6,80,125M] is used as preparation gel. The amount of dissolved protein in samples from various treatments was mixed with SDS sample buffer (Tris-HCI 50.0mM, pH 6.8; 2% SDS; 10% glycerol; EDTA 12.5mM; 0.02% bromophenol blue; 1% (v / v) 2β-*mercaptoethanol*) which was kept for 15 minutes at 70 ° C for denaturation process. Following these steps, the samples molecular markers (Standard Precision Plus Protein ™ , All Blue) and were cooling and inserted into the Bis-Tris gel (0.75mm x 10) which has been prepared in the *BioRad* Mini-PROTEAN® 3 Casting Frame. Electrophoresis was carried out on Mini-Protean III electrophoresis (Bio-Rad Laboratory, Hercules, CA) using SDS buffer (Tris-HCI 25mM, pH 8.6; glycine 192mM; SDS 0.1%) at room temperature (21°C ± 2.0) at 150 V for 15 hours. The gel was washed three times in dH20 for 5 minutes and stained in 20 mL of GelCode® Blue Stain Reagent (Pierce) for 1 hour with a gentle vibration on the rocker [27].

D. Analysis of Fatty acids

Fat was extracted by the soxhlet method [28]. Fatty acid extraction and transmethylation into fatty acid methyl esters (FAME) were then carried out based on the study by Syukri et al. [29]. Analysis of fatty acid methyl esters was carried out using GC chromatography Peri 2100 (Perichrom Society, Saulx-Les-Chartreux, France) equipped with CP-Sil 88 glass capillary columns (Variant, Palo Alto, CA; length = 100 m; still = 0.25 mm). H2 carrier gas. Total Fas is measured using C19: 0 as standard.

III. Results and Discussion

A. Chemical Composition

The results of the analysis of the chemical composition of fresh meat, *dendeng kariang with conventional frying, and vacuum frying* are shown in Table 1. After the frying process, the water content in each frying method of *dendeng kariang* was decreased, while the fat content, protein content, and ash content were increased. Vacuum frying samples showed the highest percentage of protein content. This shows that proteins are affected by the increase in temperature [16].

Frying is a process that involves simultaneous heat and mass transfer where the cooking oil is a medium of heat transfer, which made the water contained inside came out, and oil is absorbed into the food [17]. This study also found that minerals were relatively preserved by frying. High temperature (165–185°C), short cooking time, and spices' addition increased the ash content slightly in the product [18].

TABLE I
WATER CONTENT, FAT CONTENT, PROTEIN CONTENT, ASK CONTENT AND CARBOHYDRATE OF *DENDENG KARIANG* (MEAN ± SD)

No.	Composition	Fresh Meat	Conventional Frying	Vacuum Frying
1	Water content (%)	71.66 ± 2.62	9.23 ± 0.44	9.55 ± 0.47
2	Fat content (%)	0.99 ± 0.07	10.65 ± 0.08	18.16 ± 0.04
3	Protein content (%)	6.47 ± 0.23	58.71± 1.55	63.78 ± 0.23
4	Ash content (%)	3.68 ± 1.43	4.53 ± 0.47	5.13 ± 1.45
5	Carbohydrate (%)	17.6 ± 0.82	16.47 ± 0.53	3.38 0.13

B. Amino Acid Profile

The component of the free amino acids in *dendeng kariang* is shown in Fig. 3. The analysis showed an increased level of all amino acids found in *dendeng kariang* than fresh meat. The main amino acids found are glutamic acid, aspartic acid, lysine, arginine, and alanine. Amino acid level in *dendeng kariang* made by the vacuum frying has increased more than conventional frying. This is due to the differences in frying conditions. Vacuum frying is done at a temperature of 95^0C and a pressure of 12 mmHg, whereas conventional frying temperatures can reach 175^0C.

An increase in frying temperature can reduce levels of amino acids in beef sausage frying [19]. While the decrease can occur because the process of frying causes the formation of heterocyclic aromatic amines [18], resulting in hard and dry surfaces in meat [21] which make meat proteins difficult to hydrolyzed during amino acid analysis [22]. The changes in the amino acid profile mostly caused by the high temperature from the frying process [23]. There were possibilities of significant disappearance in hydroxyproline, histidine, arginine, glycine, and threonine during the frying process. The amino acid degradation could be caused by the

denaturation of protein and Millard reactions [24]–[26]. It was stated that damage in the composition of amino acids can be caused by reactions between the side chains of several amino acids that are bound to one protein with another or with other molecules present in food.

C. Fatty acids profile

Results of the analysis of fatty acids profile in *dendeng kariang* are presented in Table 2. The results showed that *dendeng kariang* contains unsaturated fatty acid, 5.0166% in vacuum frying, and 4.6541% in conventional frying, namely oleic acid, linoleic acid, linolenic acid, and others in a small amount. Saturated fatty acid was found 4.5484% in vacuum frying and 3.5034% in conventional frying, namely palmitic acid, stearic acid, myristic acid, tridecanoic acid, lauric acid, acid, and others in a very small amount. The decrease in saturated fatty acid might be due to the destruction of double bonds due to oxidation and polymerization. An increasing amount of fat and oil can be found due to the frying process and vegetable oil as the frying medium.

TABLE II
COMPOSITION OF FATTY ACIDS IN RAW BEEF AND PRODUCED *DENDENG KARIANG*

Fatty acids (%)	Raw beef	Vacuum frying	Conventional frying
Linolenic acid	0.0188	0.0207	0.0193
Linoleic Acid	0.0951	0.9448	0.9297
Oleic acid	1.7742	3.8297	3.4996
C 17: 1 (heptadecenoic acid)	Not detected	0.0311	0.0347
C 16: 1 (palmitoleic acid)	0.1359	0.0709	0.0466
C 20: 4 w6 (arachidonic acid)	0.023	0.0608	0.0637
C 8: 0 (caprylic acid)	Not detected	0.0202	Not detected
C 15: 1 (pentadecanoic acid)	Not detected	0.032	0.035
Omega 6 fatty acids	0.1264	1.0057	1.0015
C 14: 1 (miristoleic acid)	0.0366	0.013	0.0069
C 13: 0 (tridecanoic acid)	0.123	0.3625	0.0172
Polyunsaturated fat	0.1398	1.0264	1.0208
DHA	Not detected	Not detected	Not detected
Omega 3 fatty acids	0.0134	0.0207	0.0193
C 18: 0 (stearic acid)	1.1438	1.0523	0.6195
C 20: 3 w6 (eicosatrienoic acid / w6)	Not detected	Not detected	0.0081
C 17: 0 (heptadecanoic acid)	Not detected	Not detected 0.02	0.0155
C 12: 0 (lauric acid)	0.0373	0.0478	0.0406
C 16: 0 (palmitic acid)	1.4879	2.8217	2.6609
Unsaturated fats	2.1418	5.0166	4.6541
Omega 9 fatty acids	1.7742	3.8297	3.4996
C 15: 0 (pentadecanoic acid)	0.0356	0.0205	0.0112
AA		0.0608	0.0637
C 14: 0 (myristic acid)	0.3071	0.1324	0.0996
C 20: 1 (eicocyanic acid)		0.0134	0.0104
Monounsaturated fat	2.002	3.9902	3.6333
C 10: 0 (capric acid)		0.0168	0.0073
C 20: 0 (arachidic acid)	0.0102	0.0312	0.0263

D. Protein Profile by SDS-PAGE

The effects of the cooking method on the protein profile of *dendeng kariang* are presented in the SDS-PAGE electrophoretogram in Fig 4. From the results of the analysis, the vacuum frying method had 14 polypeptide bands with the highest molecular weight was 150.57 kDa, and the lowest was 9.87 kDa. In comparison, the conventional frying had 15 polypeptide bands with the highest molecular weight are 150.57 kDa, and the lowest is 8.35 kDa. There are 3 polypeptide bands in conventional frying with molecular weight 130.45 kDa, 55.18 kDa, and 8.35 kDa that did not appear in the vacuum frying method. Conversely, there are 2 polypeptide bands with molecular weight 43.45 kDa and 16.71 kDa that did not appear in conventional frying. The high temperature in the conventional frying method can hydrolyze the peptide bonds resulting in polypeptides with lower molecular weight. Thus, easier digested by digestive enzymes.

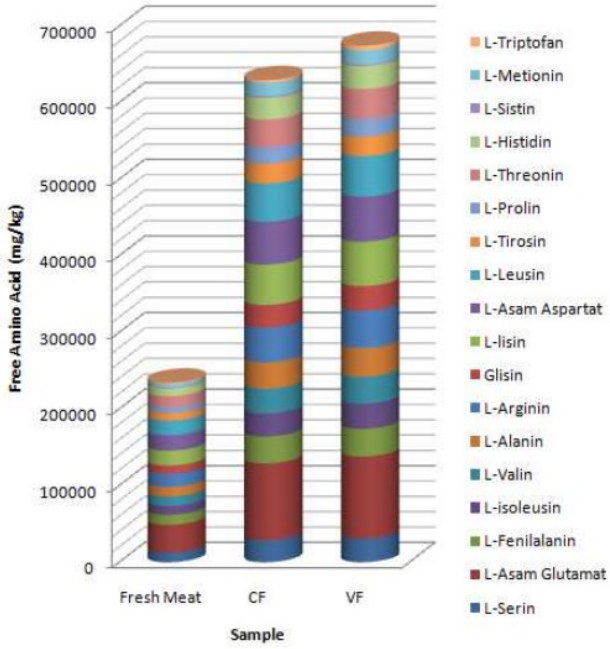

Fig 3. The concentration of free amino acid from fresh meat, conventional frying (CF), and vacuum frying (VF) of *dendeng kariang*.

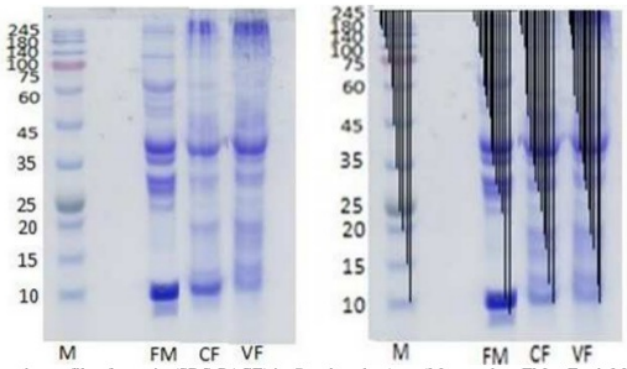

Fig 4.The Effect of t frying method on the profile of protein (SDS-PAGE) in *Dendeng kariang* (M = marker, FM = Fresh Meat, CF= Conventional Frying, VF = Vacuum Frying).

IV. Conclusions

This study concluded that the cooking method affected the nutritional characteristics of *Dendeng kariang* as a traditional Minangkabau food. This study also found that the vacuum frying method has better nutritional features than the conventional frying method. The characteristics include total protein, amino acid profile, protein profile, and even fatty acid profile.

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