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Evaluation of Moist Beef Jerky's (*dendeng lambok*) Nutrition as a Specific-Spiced Traditional Food at West Sumatera, Indonesia

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ABSTRACT

Moist beef jerky (*dendeng lambok*) is one of traditional food in Indonesia that potential to be introduced to the world. This kind of food is a form of diversification of processed beef products that use natural spices as ingredients that can improve the taste and nutritional value of beef. In this study, the nutritional changes of the beef on the production of moist beef jerky as a specific-spiced traditional food at West Sumatera, Indonesia were evaluated. The production of traditional moist beef jerky that treated with some specific spices prior to frying, might induced the nutritional compound of the raw beef therefore the nutritional properties such as proximate contents, amino acids, fatty acids and in-vitro protein digestibility of the raw beef was compared with the spiced-fried beef. The Association of Official Analytical Chemist's method, Ultra Performance Liquid Chromatography-Photo Diode Array Detection, Gas Chromatography-Flame ionization Detection and in-vitro enzymatic analysis were used to analyze proximate contents, amino acids, fatty acids and in-vitro protein digestibility of the samples respectively. As the result, the moisture content and carbohydrate content of fried beef decreased significantly compared to the raw beef while the protein and fat content increased. Moreover, the frying process of spiced beef could increased the amino acids, fatty acids and in-vitro protein digestibility of the beef. The present study showed that the quality characteristics of moist beef jerky were significantly improved compared to the raw beef especially on protein profile, fat profile and in-vitro protein digestibility. The utilization of specific spices and frying process on the production of moist beef jerky not only contribute to nutritional properties, but also contribute to its taste and flavor. The increment of amino acids and fatty acids might contribute to the emergence of specific aroma and flavor of produced moist beef jerky. Moreover, the specific study on the interaction of moist beef jerky's spices on its nutritional properties should be clarified further.

Keywords: Food diversification, food flavor, frying process, processed beef, protein digestibility, moist beef jerky, nutritional changes, specific spices.

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INTRODUCTION

In Indonesia, the effort on food diversification has pointed as one of the important sectors for increasing the tourism consumers with a special desire for specific traditional foods[1,2]. Beef jerky or *dendeng* is one of specific traditional food that is commonly credited to the Minang Kabau region at West Sumatra province, Indonesia. Beef jerky has known as the thinly sliced dried meat which preserved through a mixture of specific spices then dried via a frying process. The main spices that utilize on the production of dendeng are generally coriander, garlic, galangal, pepper, tamarind, cinnamon, cumin and lime[3]. These Spices has reported for their benefits not only as organoleptic enhancers in culinary but also potent for the health benefits[4].

Based on the processing process, dendeng can be divided into two types, namely moist beef jerky or *dendeng lambok* and dry beef jerky *(dendeng keriang)*[5]. Moist beef jerky is a kind of dendeng that produce from the raw beef that is boiled with specific spices, then beaten until flat and fried. On the other hand, dry beef jerky or *dendeng kariang* is prepared from rawly sliced beef, seasoned with spices without boiling process then dried using sunlight until a certain moisture content and subsequent fried. Therefore, moist beef jerky has a more distinctive flavor and become more famous than dry beef jerky or *dendeng kariang* because there is a process of combining spices into the processed beef.

The treatment of spices has been accepted for food adjuncts, affect flavor, pungency, antioxidant properties, and nutritional characteristics. However, due to the complex of chemical compounds in the spices, the presence of spices not only directly affected to the nutritional characteristics of the final products, but it will involve during the processing of the food. In the production of moist beef jerky, the frying process as the final step, it might contribute to the changes of nutritional characteristics of produced moist beef jerky as well as spices absorption. During the frying process of moist beef jerky that contained spices, some specific interaction could be occurred. Some chemical substances that presented in the product and frying oil will interact through chemical reactions and then absorbed in the fried food which involves subjecting oils at high temperatures. Since chemical reactions that occur in oil during the general frying process are not only limited to thermal oxidation and auto-oxidation, especially in frying process of the subject that contains complex chemical compounds, the interaction may be become more complex[6].

In the point of view the production of moist beef jerky that the raw beef has treated with some specific spices, there is no information about the effect of frying process on the beef due to the presence of absorbed spices. Therefore, the main objective of this study was to evaluate the nutritional changes of the beef that relate to the influence of spice addition and frying process. The proximate characteristics and specific traits of protein and lipid fractions present in raw beef and produced moist beef jerky were compared to indicate the quality.

MATERIALS AND METHODS

Materials

The raw cow beef and the spices were purchased in a local market and stored properly at a temperature of 6 ± 1ºC, and then transported to the laboratory for subsequent process and analysis.

Moist beef jerky preparation

The raw beef is cut into sizes 3 cm x 4 cm x 1 cm and then boiled using spices for 30 minutes. Then spiced beef was beaten until the size of the beef being 6 cm x 4 cm x 2 mm. Furthermore,the flat beef is then fried for 5 minutes with a high temperature approximately 175 ºC.

Proximate analysis

Moisture, ash, fat, and protein contents were determined by AOAC methods (Association of Official Analytical Chemists, 2010)[7]. Carbohydrate content was calculated by subtracting the total percentage of the other constituents from 100.

Amino acid analysis

Prior to amino acid analysis, samples were hydrolyzed with 25 mL of a 6 N HCl solution at 110 °C for 24 h. Amino acid analysis was carried out On basis of the AccQ.Tag™ method with a Waters UPLC System[8]. Briefly, 10 µL of either a standard amino acid mix solution, or a sample extract were mixed with 70 µL of Acc AccQ.Tag™ Ultra borate buffer, and 20 µL of AccQ.Tag™ reagent previously dissolved in 1.0 mL of AccQ.Tag™ Ultra reagent diluent was added. The reaction was allowed to proceed for 10 min at 55 °C. Liquid chromatographic analysis was performed on a Waters Acquity UPLC system, equipped with a binary solvent manager, an autosampler, a column heater and a PDA detector. The separation column was a Waters AccQ.Tag™ Ultra column (2.1 mm i.d. × 100 mm, 1.7 µm particles). The column heater was set at 55 °C and the mobile phase flow rate was maintained at 0.7 mL/min. Eluent A was 10% AccQ.Tag™ Ultra concentrate solvent A, and eluent B was 100% AccQ.Tag™ Ultra solvent B. The non-linear separation gradient was 0-0.54 min (99.9% A), 5.74 min (90.0% A), 7.74 min (78.8% A), 8.04-8.64 min (40.4% A), 8.73-10 min (99.9% A). A VanGuard™ Waters column (2.1 mm i.d. × 5 mm, 1.7 µm particles) was used as the guard column. One microliter of sample was injected for analysis. The PDA detector was set at 260 nm, with a sampling rate of 25 points/sec.

Fatty acid analysis

The residual lipid in samples was extracted according to Folch's method. Methyl-esterification of the fatty acids, purification of the methylated fatty acids and GC-FID analysis of methylated fatty acid were conducted according to method described by syukri et al [9]. Heptadecanoic acid (C17:0) was added as an internal standard to each sample (5 µg), followed by total fatty acid extraction, methylester derivatization, and purification using the fatty acid methylation/purification kit (Nacalai Tesque, Inc., Kyoto, Japan) according to the manufacturer's instructions. The methylester-derivatized fatty acid after purification was reconstituted with 150 µL of hexane for subsequent analysis. Fatty acids were analyzed using a gas chromatography coupled with a flame ionization detector (FID) (GC-2014, Shimadzu Co., Kyoto, Japan). The capillary column used for fatty acid separation was DB-WAX (30 m length × 0.25 mm inner diameter × 0.20 µm film thickness, Agilent, USA). The injector was set at 220 °C and then the column oven temperature was elevated from 120 °C to 260 °C, and the separated fatty acid methylester was detected using FID with detection temperature at 230 °C. The standard mixture of methylester fatty acids was obtained from Sigma–Aldrich. The retention times of the unknown samples of methyl esters were compared with the standards for identification purposes. We confirmed our data by repeating the whole experiment at least three times.

In-vitro protein digestibility

In vitro protein digestibility was determined according to the method of Akeson and Stahmanna[10]. One gram samples added to HCl (15 ml, 0.1 M), containing 1.5 mg pepsin then the incubated at 37°C for 3 h. The obtained suspension was neutralized with NaOH (7.5 ml, 0.2 M), then treated with 4 mg of pancreatin in 7.5 ml 0.2 M phosphate buffer (pH 8.0). One milliliter of toluene was added to prevent microbial growth and the mixture was gently shaken and incubated for additional 24 h at 37°C. After incubation, the sample was treated with 10 ml of 10% TCA to remove undigested protein and larger peptides and centrifuged at 50000 g for 20 min at room temperature. Protein in the supernatant was estimated using the Kjeldahl method [6]. The percentage of protein digestibility was calculated by the ratio of protein in supernatant to protein in sample as described by Afify et al [11].

Statistical analysis

For the analytical data, mean values and standard deviation are reported. The data obtained were subjected to one-way analysis of variance (ANOVA) and least significant difference (LSD) at $P<0.05$.

RESULTS AND DISCUSSION

Proximate Analyses

The proximate composition raw beef and fried beef that was spiced is presented in Fig. 1. The moisture was the predominant component, followed by carbohydrate, protein, ash and fat in the raw beef. However, the proximates composition have changed after frying process where moisture and carbohydrate decreased while fat and protein increased. During the frying process, food is immersed in an oil bath at temperatures above the boiling point of water which results in water evaporation and oil absorption on the product surface [12]. This opinion had clarity the changes of moisture content and the fat content between raw beef and fried ones. Furthermore, the increment of protein content in the final moist beef jerky product might due to the absorption of the spices prior to the frying process. In general, vegetables oil including palm oil that commonly uses for frying contain less amount of protein[13], therefore its less possibility during oil absorption the enhancement of protein occurred. Protein as a kind of primary metabolite is presence in all-natural produces including spices, therefore the increment of protein might relate to the spice's addition prior to frying process. In addition, the content of carbohydrates raw beef strongly interacts with lipids, especially with thermal and oxidative degradation products which described as a Maillard reaction that caused the reduction of the level of carbohydrates [14, 15]. Moreover, in the view of ash content, although there was a little increment of ash content, but in statically the increment was not significantly. Earlier studies have reported that the frying method had little or no effect on the elements of ash [16].

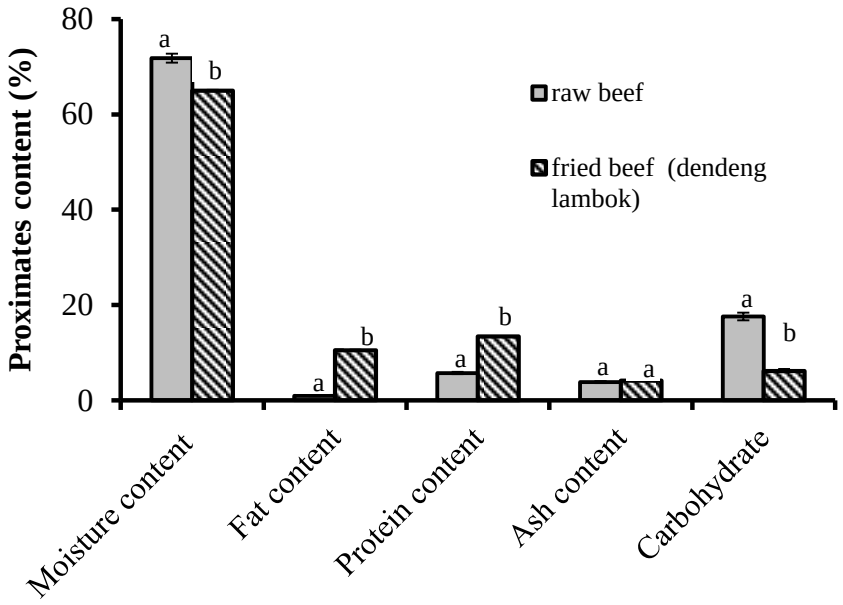

Fig. 1. The proximate composition of raw beef and produced moist beef jerky. Vertical lines represent standard deviation (n=3). Values with different letters were significantly different at 0 P<0.05.

Amino acids composition

The composition of the amino acid in the raw beef and fried beef is represented in Table 1. The main amino acids in the raw meat were found to be lysine, leucine, and L-Aspartic Acid whereas the less abundant amino acid was observed as methionine. In this study, in consistent with the protein changes in previous data, frying process resulted in significant (p< 0.05) changes on almost all amino acids. From raw to fried beef, the significant increment was observed for most of amino acids. It has reported that the alteration in amino acid composition in foods mainly rely on the processing treatments [17]. Amino acids are abundantly found in the food plants including spices [18]. On the production of moist beef jerky, the utilization of spices might induced the amount of amino acid prior to the frying process.

Although, many references indicated that there were significant losses in amino acid composition during heating which could be attributed to the denaturation of the protein and the Millard reaction [19, 20]. However, our result indicated that there were chemical components in the absorbed spices of moist beef jerky could inhibit the destruction of extended amino acids due to the heat. It can be suggested that the presence of spices that also contain essential oil in food raw material may cause the lowering of boiling point of the oil, the lowered boiling point of the frying process can cause less decomposition of food extended spiced food nutrient during heating [21].

Table 1: Composition of amino acid in raw beef and produced moist beef jerky.

Amino acid (mg.g^{-1})	raw beef	Fried beef (moist beef jerky)
L-Serine	12332.17 ± 12^{a}	13863.62 ± 23^{b}
L-glutamic acid	36762.20 ±05^{a}	59478.49 ± 13^{b}
L-phenylalanine	12953.22 ± 21^{a}	13888.13 ± 15^{b}
L-isoleucine	11605.44 ± 12^{a}	15785.92 ± 43^{b}
L-Valine	12364.96 ±15^{a}	16502.56 ± 12^{b}
L-Alanine	12646.59 ± 09^{a}	18342.35 ± 53^{b}
L-Arginine	17232.20 ± 12^{a}	20399.65 ± 13^{b}
Glycine	10873.01 ± 15^{a}	12152.14 ± 16^{b}
L-lysine	19213.29 ± 11^{a}	32908.27 ± 45^{b}
L- Aspartic Acid	20211.99 ± 31^{a}	34603.95 ± 42^{b}
L-Leucine	19459.23 ± 01^{a}	25815.31 ± 89^{b}
L-Tyrosine	9566.35 ± 64^{a}	10376.43 ± 25^{a}
L-Proline	7774.11 ± 11^{a}	10608.74 ± 34^{b}
L-Threonine	14488.61 ± 16^{a}	17442.76 ± 12^{b}

L-Hystidine	10066.86 ± 09 [a]	8499.85 ± 34 [b]
L-Cysteine	1057.14 ± 09 [a]	856.93 ± 12 [b]
L-Methionine	4904.38 ± 23 [a]	7956.16 ± 16 [b]
L-Triptophan	1589.72 ± 21 [a]	4138.68 ± 76 [b]

Values are expressed as mean ± SD of three determinations. Means with different letters were significantly different at $P<0.05$.

Fatty acids composition

Fatty acid compositions of the beef that treated on the production of moist beef jerky are indicated in Table 2. The polyunsaturated fatty acid was dominated by oleic acid (C 18: 1 W9C) as the most abundant omega-9 fatty acid. The Saturated fat was dominated by palmitic acid (C 18: 0) and stearic acid (C18: 0). Results showed that the most of all fatty acids of the raw beef increased significantly during moist beef jerky spicing and frying process. Oil uptake on the frying process of moist beef jerky is the most reason of the increment of fatty acid composition in the produced moist beef jerky. The fried samples showed great changes in the fatty acid profile when compared to the raw samples, possibly due to simultaneous oil absorption occurring during processing [22].

Table 2: Composition of fatty acids in raw beef and produced moist beef jerky

Fatty acids (μg.g^{-1})	raw beef	Fried beef (moist beef jerky)
Linolenic acid	126 ± 9[a]	315 ± 53 [b]
Linoleic Acid	724 ± 11 [a]	969.9 ± 56 [b]
Oleic acid	654.8 ± 18 [a]	370.31 ± 21 [b]
C 18:2 W6 (linoleic acid / w6)	724 ± 34 [a]	969.9 ± 89 [b]
C 18: 2 W6C (c-linoleic acid)	724 ± 21 [a]	969.9 ± 23 [b]
C 18: 1 W9C (c-oleic acid)	654.8 ± 29 [a]	3703.1 ± 121 [b]
C 24: 1 w9 (nervonic acid)	Not detected	Not detected
C 18: 1 W9T (t-oleic acid)	Not detected	Not detected
C 20: 5 w3 (eicosapentaenoic acid)	7 ± 0 [a]	138 ± 24 [b]
C 17: 1 (heptadecenoic acid)	81 ± 2 [a]	5 ± 0 [b]
C 23: 0 (trichosanoic acid)	Not detected	Not detected
C 16: 1 (palmitoleic acid)	41 ± 2 [a]	251 ± 22 [b]
C 20: 4 w6 (arachidonic acid)	206 ± 45 [a]	303 ± 23 [b]
C 8: 0 (caprylic acid)	Not detected	Not detected
C 15: 1 (pentadecenoic acid)	129 ± 1 [a]	298 ± 12 [b]
C 20: 3 w6 (eicosatrienoic acid / w6)	61 ± 2 [a]	77 ± 1[a]
Omega 6 fatty acids	101.5 ± 4 [a]	1011,6 ± 101 [b]
C 14: 1 (miristoleic acid)	99 ± 1 [a]	Not detected
C 20: 2 (eicosadienoic acid)	Not detected	Not detected
DHA	37± 1 [a]	56 ± 0 [b]
C 13: 0 (tridecanoic acid)	223.8 ± 2 [a]	645 ± 24 [b]
C 18: 3 W6 (linolenic acid / w6)	25 ± 0 [a]	38 ± 0 [b]
Omega 3 fatty acids	209 ± 10 [a]	472 ± 23 [b]
C 11: 0 (undecanoic acid)	Not detected	Not detected
C 18: 3 W3 (linolenic acid / w3)	101 ± 2 [a]	278 ±11 [b]
C 24: 0 (lignoseric acid)	Not detected	58 ± 2 [b]
Polyunsaturated fat	122.3 ± 2 [a]	1058.8 ± 212 [b]
C 4: 0 (butyric acid)	Not detected	Not detected

C 18: 2 W6T (t-linoleic acid)	Not detected	Not detected
C 22: 6 w3 (docosahexaenoic acid)	37 ± 1 [a]	56 ±1 [b]
C 6: 0 (caproic acid)	Not detected	Not detected
C 18: 0 (stearic acid)	353 ± 2 [a]	420.8 ± 21 [b]
C 20:3 w3 (eicosatrienoic acid / w3)	Not detected	Not detected
C 22: 2 (docosadienoic acid)	Not detected	Not detected
C 17: 0 (heptadecanoic acid)	224 ± 4 [a]	119 ± 23 [b]
C 22: 1 (erucic acid)	Not detected	Not detected
C 16: 0 (palmitic acid)	555.8 ± 2 [a]	2888.6 ±231 [b]
Unsaturated fats	851 ± 3 [a]	4836.5 ± 132 [b]
Omega 9 fatty acids	654.8 ± 11 [a]	3703.1 ± 129 [b]
C 15: 0 (pentadekanoic acid)	94 ± 1 [a]	54 ± 1 [b]
C 22: 0 (acid behenat)	Not detected	53 ± 2 [b]
AA	206 ± 4 [a]	303 ± 4 [b]
C 14: 0 (myristic acid)	819 ± 5 [a]	762 ± 21 [b]
C 21: 0 (heneicosanoic acid)	Not detected	25 ± 1 [b]
EPA	7 ± 0 [a]	138 ± 43 [b]
C 12: 0 (lauric acid)	193 ± 2 [a]	97 ± 0 [b]
C 20: 1 (eicocyanic acid)	Not detected	131 ± 23 [b]
Monounsaturated fat	728.7 ± 32 [a]	3777.7 ± 56 [b]
C 10: 0 (capric acid)	57 ± 0 [a]	29 ± 0 [b]
C 20: 0 (arachidic acid)	29 ± 0 [a]	288 ± 3 [b]

Values are expressed as mean ± SD of three determinations. Means with different letters were significantly different at $P<0.05$.

In-vitro protein digestibility

Table 4 presents the in-vitro protein digestibility in raw beef and the beef after spiced and fried. Although the statistical evaluation is not shown the significant difference of in-vitro protein digestibility between raw beef and fried beef, the data showed the increment of in vitro protein digestibility in fried beef compared to raw beef. The low digestibility of raw beef is presumably due to the high protein cross-linking. The digestibility improved when the beef was treated with specific spices that might contain proteolytic enzymes and interrupt the cross-lingking of protein with the presence of heat [10].

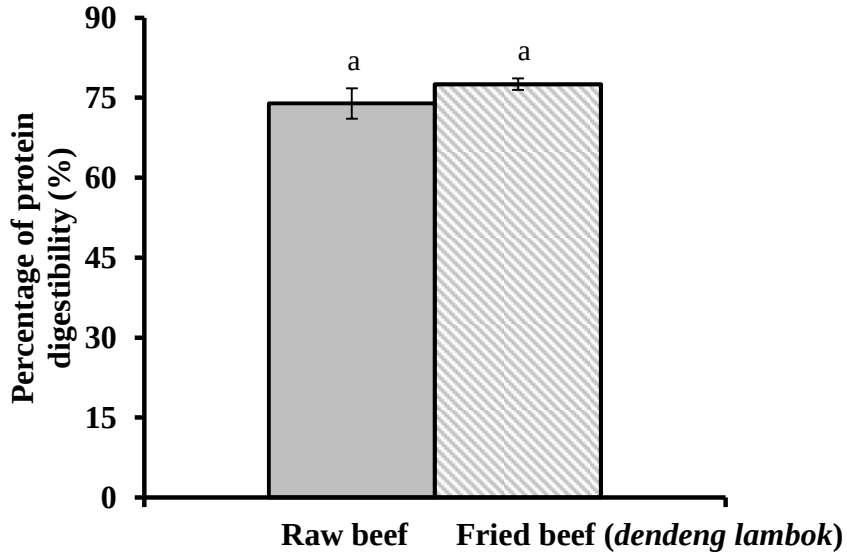

Fig. 2 in-vitro protein digestibility of raw beef and produced moist beef jerky. Vertical lines represent standard deviation (n=3). Values with same letters were significantly not different at 0 $P<0.05$.

CONCLUSION

Moist beef jerky is one of tradional food in Indonesia that potential to be introduced to the world. The utilization of specific spices and frying process on the production of moist beef jerky not only contribute to the taste and flavor, but also contribute to its nutritional properties. In general, the nutritional characteristics of moist beef jerky have significantly improved to the raw beef. Specifically, from this study it has been suggested that the utilization of specific spices on the production of moist beef jerky might induce the amount of protein and its relative amino acids, while also preventing them from degradation of heat during frying.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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