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Curing Ingredients, Characteristics, Total Phenolic, and Antioxidant Activity of Commercial Indonesian Dried Meat Product (Dendeng)

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ABSTRAK

Dendeng merupakan produk olahan daging kering Indonesia yang menggunakan rempah-rempah kaya antioksidan sebagai bumbu. Produksi dendeng pada tingkat komersial umumnya menggunakan garam nitrat/nitrit (sendawa) sebagai bahan *curing* untuk menghasilkan warna merah yang stabil. Penelitian ini bertujuan untuk meneliti komposisi bumbu rempah dan garam nitrat, karakteristik, total fenolat, aktivitas antioksidan dendeng komersial. Penelitian ini dilakukan melalui wawancara dengan beberapa produsen dendeng untuk memperoleh informasi tentang penggunaan sendawa dan komposisi bumbu yang digunakan. Hasil wawancara kemudian diverifikasi dengan pengujian sampel di laboratorium. Hasilnya menunjukkan bahwa penggunaan bumbu dan sendawa bervariasi antar produsen. Penggunaan sendawa pada penelitian ini tidak selalu menghasilkan warna merah yang stabil. Total fenolik dendeng dari produsen berkisar 42,47-102,00 mg EAG/100 g BK untuk dendeng mentah, dan 36,51-95,49 mg EAG/100 g BK untuk dendeng matang. Kapasitas antioksidan terhadap DPPH berkisar 79,35-379,40 mg EVC/100 g BK untuk dendeng mentah, dan 94,30-559,40 mg EVC/100 g BK untuk dendeng matang. Kapasitas antioksidan dendeng mentah 87,2% dipengaruhi oleh total senyawa fenolat, sedangkan pada dendeng matang hanya 59,0%. Kesimpulannya adalah bahwa dendeng memiliki aktivitas antioksidan yang nyata, meskipun setelah penggorengan, dan penggunaan sendawa pada penelitian ini tidak efektif untuk menghasilkan warna merah yang konsisten pada dendeng.

Kata kunci: dendeng, total fenol, aktivitas antioksidan, karakteristik dendeng komersial

ABSTRACT

***Dendeng* is Indonesian dried meat product that used spices rich in antioxidant component as ingredient. In addition, commercial *dendeng* usually use saltpeter (nitrate/nitrite salt) as curing ingredient to inhibit rancidity and to produce stable red color. The aims of this study were to investigate composition of spices and saltpeter added, characteristic, total phenolic, and antioxidant activity of commercial *dendeng*. This research was conducted through interview with some *dendeng* producers to get information about saltpeter adding and spices composition used in their products. Then the interview results were verified by laboratory analysis. The results showed that spices and saltpeter adding from some producers varied. The saltpeter added in curing process produced inconsistent red color on commercial *dendeng* in this investigation. Total phenolic of *dendeng* from producers ranged from 42.47 to 102.0 mg GAE/100 g DM for raw *dendeng*, and 36.51 to 95.49 mg GAE/100 g DM for fried *dendeng*. Antioxidant capacity against DPPH ranged from 79.35 to 379.40 mg VCE/100 g DM for raw *dendeng*, and 94.30 to 559.40 mg VCE/100 g DM for fried *dendeng*. Antioxidant capacity of raw *dendeng* was influenced by phenolic content about 87.2%, but in fried *dendeng* was only 59.0%. In conclusion, *dendeng* has a significant antioxidant activity, even after frying, and saltpeter addition was not effective to maintain stable red color in *dendeng* products.**

Key words: dendeng (Indonesian dried meat), total phenolic, antioxidant activity, commercial dendeng characteristics

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INTRODUCTION

Dendeng is traditional Indonesian dried meat product processed by added spices ingredient and drying. The ingredient added varied, but the *dendeng* that popular in Java has sweet and coriander flavor oriented predominantly. Bintoro *et al*. (1987) stated that the ingredient added in *dendeng* making was palm sugar, salt, coriander and caraway seed. Generally the ingredient of sweet *dendeng* that most popular in Java was palm sugar, white sugar, salt, garlic, coriander, galangal, sometimes tamarind, cumin and pepper was added also. Although there was no standard of ingredient for *dendeng* making, but the usual ingredient that used in *dendeng* making had antioxidant activity, such as garlic (Leelarungrayub *et al*., 2006; Gorienstein *et al*., 2008; Tangkanakul *et al*., 2009), coriander (Dragland *et al*., 2003; Tangkanakul *et al*., 2009), galangal (Vankar *et al*., 2006; Chan *et al*., 2008; Mahae & Chaiseri, 2009; Tangkanakul *et al*., 2009), pepper and tamarind (Tangkanakul *et al*., 2009). Bioactive compound of garlic reported also had nitrite-scavenging and nitrosamine forming inhibition (Choi *et al*., 2007).

Dendeng making at industry level add saltpeter (nitrate salt) to inhibit rancidity and to produce the heat stable red color. Some research showed that ingredient and nitrate/nitrite salt on meat product besides affect color (Honikel, 2008) and flavor (Toldra *et al*., 2009), also affect oxidation lipid (Sebranek & Bacus, 2007; Toldra *et al*., 2009). Nitrite added at curing process could form reactive compound NO that could bind to myoglobin and produce heat stable cure color. The NO molecule itself can easily be oxidized to NO_2 in the presence of oxygen. This means an oxygen sequestering and thus the antioxidant action of nitrite in meat curing process (Honikel, 2008). Unfortunately, because of its reactivity, NO form could also react with amine primer and secondary form carcinogenic nitrosamine (Rostkowska *et al*., 1998; Honikel, 2008).

Previous research about *dendeng* generally was the laboratorium research. Buckle & Purnomo (1986) reported browning on *dendeng* at laboratorium scale. Muchtadi (1987) evaluated the nutritional value of *dendeng*. Legowo *et al*. (2002) reported effect of betel leaf juice soaking on rancidity and sensory characteristic of *dendeng*. Chemical and microbiology analysis of *dendeng* samples from supermarket in Jakarta, Surabaya and Solo was reported by Bintoro *et al*. (1989). Spices used in *dendeng* need to be deeper investigated, therefore can explain the spices usage in *dendeng* as one of Indonesian heritage. This research intent was on exploring composition of spices and saltpeter added, characteristic, total phenolic, antioxidant activity (radical DPPH scavenging activity and antioxidant capacity against DPPH) of commercial *dendeng* from some producers.

MATERIALS AND METHODS

Data Collecting and Sampling Method

Information of spices and samples were collected from seven selected producers from West (producer of dendeng JB-1, JB-2, JB-3) and Central (producer of dendeng JT-1, JT-2, JT-3) Java, Indonesia. Samples produced at last batch from each producer when interviewed were analyzed to verify with interview results.

Sample Preparation

Dendeng obtained from some producers were stored in ambient temperature for a week, and then were stored in refrigerator for 3 weeks. Samples were evaluated in the form of raw and fried. Fried *dendeng* samples were prepared by soaking in water for 5 min before frying, and then after 15 min, 250 g of sample was fried in 2 L boiling vegetable oil (not over 150 ^{o}C) for 1.5 min. Vegetables oil only used for once frying. Raw and fried samples were extracted, except for color analysis: a value, were blended and homogenized. All of samples were stored at -25 ^{o}C for further analysis.

Analysis of a Color Value, Moisture Content and pH

Intensity of red color (a color value), pH and moisture content were measured as characteristic variables of *dendeng*. Intensity of red color was measured by using chromameter Minolta and manifested as “a” color value. Moisture content was analyzed by using AOAC method (2005). Value of pH was analyzed by meat pH meter Hanna.

Analysis of Total Phenolic and Antioxidant Activity

Raw and fried *dendeng* were extracted using method described by Tangkanakul *et al*. (2009) with some modification in extraction stage. Amount of 1 g fried *dendeng* was extracted twice by 2.5 ml methanol for 24 hr at room temperature. Filtrate from both extraction was mixed and added with methanol until volume reach 10 ml. Extracts were stored in -25 ^{o}C until further use for analysis of total phenolic, scavenging activity on radical DPPH (from Sigma Aldrich) and antioxidant activity. Analysis of total phenolic, scavenging activity on radical DPPH and antioxidant activity were done based on procedure described by Tangkanakul *et al*. (2009). Antioxidant activity was determined as antioxidant capacity measured based on calibration curve inhibition of vitamin C at some concentration on radical DPPH.

Data Analysis

Interview and laboratory data were analyzed by using descriptive analysis**.** Data correlations were made between total phenolic and antioxidant capacity.

RESULTS AND DISCUSSION

Curing Ingredients and Characteristics of *Dendeng* from some Producers

The kind and amount of spices added in *dendeng* industries varied among producers. Percentage of spices added in *dendeng* from the producers ranged from 1.67% to 22.0% (Table 1). The spices generally added were garlic, coriander, and galangal. Some producers added different spices such as: shallot, pepper, tamarind, cumin, cinnamon and lime. Saltpeter as nitrate salt added in curing process ranged from 1 to 5333 mg/kg, and 3 of producers stated did not use saltpeter in their *dendeng* making. Based on Indonesian regulatory (PERMENKES RI No.722/MenKes/Per/IX/88), the maximum level of nitrate salt allowed in meat processing was 500 mg/kg. Therefore 2 producers namely *dendeng* JB-2 dan JB-3 producers still used saltpeter above the maximum level allowed.

The red color intensity, moisture and pH of raw *dendeng* from Central Java producers were higher than those from West Java (Table 2). These facts probably correlated with *dendeng* drying time between these two places. Based on interview results, the *dendeng* producers from West Java dried their *dendeng* only one day (approx. 8 hr) in hot weather, while the *dendeng* producers from Central Java dried their *dendeng* for 3 d (approx. 24 hr) in hot weather. After frying process, the moisture of *dendeng* generally increased that was caused by soaking in the water before frying. The red color intensity of *dendeng* after frying decreased (Table 2), because frying process in *dendeng* produced non enzymatic browning as a result of Maillard reaction (Buckle & Purnomo, 1986; Zamora & Hidalgo, 2010). Sugar addition, especially white sugar, as dominant ingredient on *dendeng* processing caused Maillard reaction to be more intensive.

The saltpeter usage to produce consistent red color in *dendeng* was not proved in this research. Pink color as specific color of meat cured was formed by reaction between NO from nitrite or nitrate salt and meat myoglobin (Honikel, 2008). This fact was shown by *dendeng* JB-2 and JB-3, although the amount of saltpeter added was higher, but the red color intensity produced was lower than *dendeng* without saltpeter, such as *dendeng* JT-1 and JT-4. The red color intensity of *dendeng* JT-1 dan JT-4 was

Table 1. Curing ingredients used by some *dendeng* producers in Java

Curing ingredients	*Dendeng*							
	JB-1	JB-2	JB-3	JT-1	JT-2	JT-3	JT-4	JT-5
Spices (%)	18.13	1.67	1.69	13.32	21.00	21.00	3.15	7.80
Shallot (%)	10.00	-	-	-	-	-	-	-
Garlic (%)	0.63	-	-	4.20	15.00	15.00	2.00	2.00
Coriander (%)	asf	1.67	1.67	0.80	2.00	2.00	1.00	4.00
Galangal (%)	7.50	-	-	8.30	asf	asf	-	1.00
Tamarind (%)	-	-	0.02	-	asf	asf	-	-
Pepper (%)	-	-	-	0.02	-	-	0.05	-
Cinnamon (%)	-	-	-	-	2.00	2.00	-	-
Cumin(%)	-	-	-	-	2.00	2.00	0.05	0.40
Lime (%)	-	-	-	-	-	-	0.05	0.40
Salt peter (mg/kg)	-	3,333.00	5,333.00	-	1.00	1.00	-	200.00
Palm sugar (%)	40.00	20.00	6.70	33.30	35.00	35.00	5.00	22.50
White sugar (%)	-	10.00	10.00	-	-	-	20.00	7.50
Cooking salt (%)	3.13	0.25	2.33	asf	asf	asf	3.00	-

Note: Data based on interview with 7 *dendeng* producers. JB-1, JB-2 and JB-3 were *dendeng* from West of Java; JT-1, JT-2, JT-3, JT-4 and JT-5 were *dendeng* from Central of Java; asf= at sufficiently; percentage of ingredient based on meat weight.

Tabel 2. Red color intensity, moisture content and pH of raw and fried *dendeng* from some producers in West and Central of Java

No.	Sampel	Red color intensity (a)		Moisture (%)		pH	
		Raw	Fried	Raw	Fried	Raw	Fried
1	JB-1	7.88	8.89	33.09	31.87	5.46	5.74
2	JB-2	8.01	5.57	18.78	23.29	5.51	5.61
3	JB-3	9.45	7.88	29.45	29.38	5.66	5.90
4	JT-1	11.18	5.57	15.03	20.65	5.24	5.51
5	JT-2	12.32	5.74	14.12	21.19	5.13	5.21
6	JT-3	14.78	9.99	13.57	18.89	5.32	5.56
7	JT-4	14.26	8.90	14.59	23.33	5.22	5.66
8	JT-5	13.91	8.73	13.62	20.84	5.26	5.82

Note: JB-1, JB-2 and JB-3 are *dendeng* from West of Java; JT-1, JT-2, JT-3, JT-4 and JT-5 are *dendeng* from Central of Java.

not different with *dendeng* JT-2, JT-3 and JT-5 that used saltpeter in their manufactured (Table 2). This fact could be related with NO formation from saltpeter component and its interaction with antioxidant from spices. If NO form in *dendeng* was stabilized by antioxidant from spices, meat myoglobin could not react with NO, and the pink color as specific color of meat cured could not be formed.

Total Phenolic and Antioxidant Activity on Raw and Fried *Dendeng* from Some Producers

Total phenolic content of *dendeng* from some producers (Figure 1) did not correlate with percentage of spices added (Table 1). This was probably caused by the differences in total phenolic of each spices used. *Dendeng* JB-1 had the highest total phenolic content, followed by *dendeng* JT-1, JT-5, JT-3, JT-2, JT-4, JB-3, and JB-2. Although *dendeng* JB-1 used lower percentage spices than *dendeng* JT-2 and JT-3, but the spices added, such as shallot, galangal and coriander had phenolic content higher than garlic (Tangkanakul *et al*., 2009) used predominantly at *dendeng* JT-2 and JT-3. This explained why the *dendeng* JB-1 had the highest total phenolic.

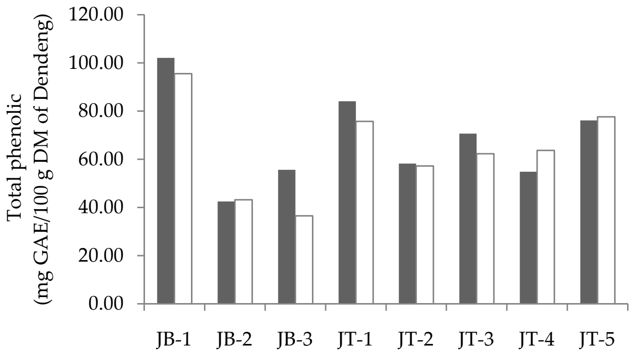

Figure 1. Total phenolic content of *dendeng* (■: raw and □: fried) from some producers. JB-1, JB-2 and JB-3 were *dendeng* from West of Java; JT-1, JT-2, JT-3, JT-4 and JT-5 were *dendeng* from Central of Java.

The activity of raw *dendeng* to scavenge radical DPPH was higher than fried *dendeng* (Figure 2). This fact showed that frying process decreased the activity of *dendeng* spices to scavenge radical DPPH. The mechanism could be explained that the frying process induced lipid oxidation (Baardseth *et al*., 2005; Choe & Min, 2007) that produced radical compounds as primer product of the reaction (Min & Ahn, 2005). These radical compounds could react with antioxidant compounds contained in *dendeng* that gave benefit as the inhibiting of lipid oxidation.

The antioxidant activity that measured as antioxidant capacity of all *dendeng*, except JB-3, increased after frying (Figure 3). These data had different pattern with scavenging against DPPH data; because antioxidant activity was determined by calculating the sample weight and moisture. The antioxidant capacity of *dendeng* JB-1 either raw or fried was higher than others, except fried JT-5. Tangkanakul *et al*. (2009) divided the activity of antioxidant of products based on antioxidant capacity into four groups: very high (> 500 mg VCE/100 g), high (200-500 mg VCE/100 g), medium (100-200 mg VCE/100 g) and low (< 100 mg VCE/100 g). Based on that classification, the antioxidant activity of raw *dendeng* JB-1, JT-1, JT-3 and JT-5 were high; JB-3, JT-2 and JT-4 were medium; while JB-2 was low. These conditions changed after frying, in which *dendeng* JT-5 was very high; JB-1, JT-1 and JT-3 were consistent high; JT-2 changed to high; JT-4 was still medium; while JB-2 and JB-3 changed to medium and low respectively.

The antioxidant activity of fried *dendeng* generally increased from the raw ones, except for *dendeng* JB-3. This indicated that antioxidant activity of *dendeng* was not only caused by spices antioxidant component, but also could be caused by formation of antioxidant component from nitrate salt or nitrite generated from saltpeter (Sebranek & Bacus, 2007; Honikel, 2008), and Maillard product that had antioxidant activity (Yilmas & Toledo, 2005; Gu *et al*., 2010; Sun *et al*., 2010; Zhuang & Sun, 2011; Dong *et al*., 2012; Miranda *et al*., 2012). Antioxidant activity of *dendeng* JB-3 was only affected by antioxidant component from spices that could be compared with total phenolic and scavenging activity on DPPH that also decreased after frying. Saltpeter added and Maillard

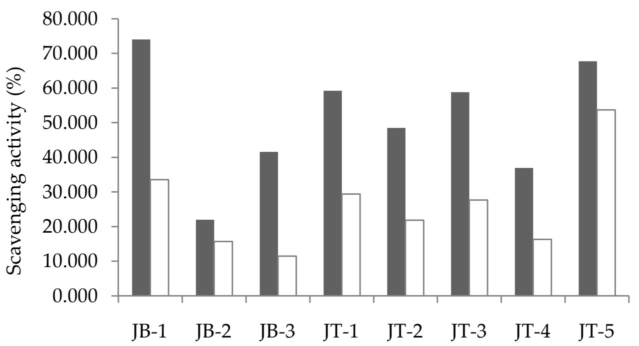

Figure 2. Scavenging activity on DPPH of *dendeng* (■: raw and □: fried) from some producers. JB-1, JB-2 and JB-3 were *dendeng* from West of Java; JT-1, JT-2, JT-3, JT-4 and JT-5 were *dendeng* from Central of Java.

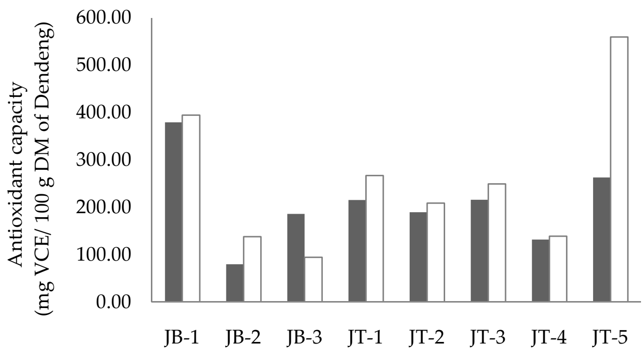

Figure 3. Antioxidant capacity of *dendeng* (■: raw and □: fried) from some producers. JB-1, JB-2 and JB-3 were *dendeng* from West of Java; JT-1, JT-2, JT-3, JT-4 and JT-5 were *dendeng* from Central of Java.

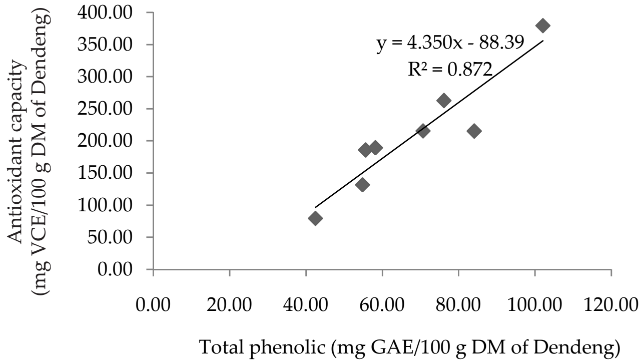

Figure 4. Correlation of total phenolic and antioxidant capacity of raw *dendeng* from some producers

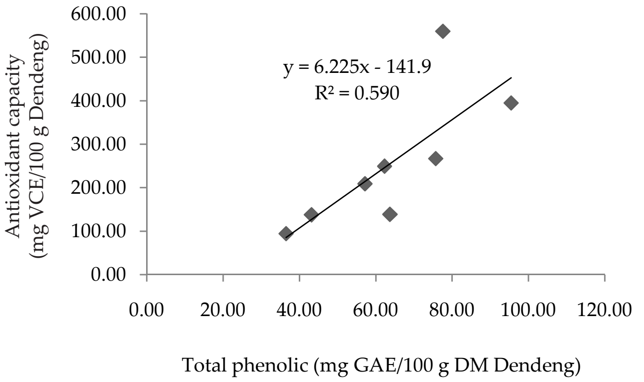

Figure 5. Correlation of total phenolic and antioxidant capacity of fried *dendeng* from some producers

product resulted in this *dendeng* were not contributed to its antioxidant activity. Based on Figure 1, 2 and 3, although the scavenging activity on DPPH decreased after frying, when total phenolic did not decrease significantly and used the optimum nitrate salt in curing process, the antioxidant activity would not decrease after frying.

Total phenolic compound affected significantly ($P<0.01$) antioxidant capacity of raw *dendeng* followed regression linier: y= 4.350X – 88.39; with R^2= 0.872 (Figure 4). Based on coefficient determination of the li-near regression implicated that 87.2% antioxidant capacity of raw *dendeng* was influenced by its total phenolic content, and 12.8% was influenced by others. The other factor could be NO from nitrate salt. Antioxidant activity of fried *dendeng* was different from raw *dendeng*, although regression linear between total phenolic and antioxidant capacity (Figure 5) was significant ($P<0.01$), but its coefficient determination was lower (R^2= 0,590) than raw *dendeng*. This indicated that antioxidant capacity of fried *dendeng*, 59.0% was affected by its total phenolic, and 41.0% was affected by other factors. Coefficient determination of linear regression in raw and fried *dendeng* was strong indication that the antioxidant activity in *dendeng* was not only caused by spice added, but also could be caused by oxidized NO from saltpeter added and Maillard product in *dendeng*.

CONCLUSION

The kind and amount of spices added in *dendeng* industries varied among producers and ranged from 1.67% to 22.0% with the main spices were garlic, coriander, and galangal. Total phenolic content of *dendeng* do not correlate to percentage of spices added. Saltpeter as nitrate salt added in curing process ranged from 0 to 5333 mg/kg, but in this investigation it was not effective to maintain stable red color in *dendeng* products. *Dendeng* products have significant antioxidant activity, even after frying.

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