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Nitrite residue and malonaldehyde reduction in *dendeng* — Indonesian dried meat — influenced by spices, curing methods and precooking preparation

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ABSTRACT

This research was conducted to reduce nitrite residue and malonaldehyde (MDA) content of dendeng through modifying the formulation of spices, curing technique and precooking preparation. The result showed that spiced fried dendeng was likely to contain high total phenolics and antioxidant activity. Wet cured dendeng combined with spices containing 2.0% coriander and 10.0% garlic and preparation by soaking before frying was effective to produce dendeng that had no detected nitrite residue and low MDA. In conclusion, the spice formulas used in this study could reduce nitrite residue and MDA level of dendeng, and the treatment prior to frying, by soaking the dendeng briefly in water, lowered MDA of non-spiced dendeng, but no effect of soaking was observed in spiced samples due to the very low MDA found in the samples.

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1. Introduction

Dendeng, the Indonesian traditional dried meat, is commonly produced by using some spices and sugar at various levels. Therefore its flavour is sweet and spicy, and it is stable for several weeks at room temperature. The spices added in dendeng are coriander, garlic, galangal, pepper, tamarind, cinnamon, cumin and lime. The main spices were generally coriander, garlic and galangal. Pepper, tamarind, cinnamon, cumin and lime are the additional spices that are sometimes added by producers in dendeng industries (Suryati, Astawan, Lioe, & Wresdiyati, 2012). These spices were reported to have an antioxidant activity (Tangkanakul et al., 2009). It is known that one of garlic component, S-oxodiallyl disulfide, has an ability to inhibit *N*-nitrosodimethylamine formation and to scavenge nitrite reactivity (Choi, Chung, Lee, Shin, & Sung, 2007). Therefore the use of spices in dendeng processing was considered to be able to reduce nitrite residue and malonaldehyde (MDA) level. The presence of nitrite residue in commercial dendeng (Bintoro, Morit, Mikawa, & Yasui, 1987) could be due to the curing agent used in dendeng industry. Curing with sodium or potassium nitrate, well known as saltpeter, is applied in industrial dendeng processing (Suryati et al., 2012) to obtain a stable red color and to extend its shelf life.

Besides sodium nitrate, sodium nitrite could also be used as a curing agent at lower concentration than sodium nitrate (Directive, 2006) because of the high reactivity of sodium nitrite (Honikel, 2008; Sebranek & Bacus, 2007). Nitrate or nitrite salt could form an intermediate nitrosating agent, N_2O_3, and then formed other nitrosating agents, NO and NO_2 (Honikel, 2008; Rostkowska, Zwierz, Rozanski, Moniuszko-Jakoniuk, & Roszczenko, 1998; Skibsted, 2011). Reactive NO could be reacted with myoglobin to yield nitrosylmyoglobin that yield the characteristic red color of cured meat, and its denatured pink form, nitrosylhemochromogen pigment, contributed to cooked cured meat color (Skibsted, 2011). NO group could react with secondary and tertiary amines to form carcinogenic compounds, nitrosamines (Rostkowska et al., 1998; Skibsted, 2011). But the reactivity of NO could be prevented through the stabilization of N_2O_3 by a role of antioxidants, such as ascorbic acid (Skibsted, 2011). Antioxidant activity of dendeng spices could be considered to stabilize N_2O_3 and prevent the reactivity of NO.

In addition to the potent hazard due to nitrite residue excess, MDA is another potent hazard that could be formed in dendeng as a result of lipid oxidation in meat. MDA is a secondary product of lipid oxidation that had contribution to the off-quality of meat product (Fernandez, Perez-Alvarez, & Fernandez-Lopez, 1997). MDA can also be reacted with DNA to form DNA adducts which are mutagenic (Marnett, 2000). Therefore it is needed to control MDA formation. The use of

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antioxidant-rich spices has been reported to be able to reduce MDA in meat products, such as hamburger (Li et al., 2010). Thus, the use of spices and curing, besides the benefit to give color and flavor, is expected to effectively reduce MDA content.

Dendeng is usually prepared by soaking in water for a moment to rehydrate it before frying, so that it does not result burnt flavor during frying that could decrease its palatability. In addition to that, soaking before frying is done to produce tender fried dendeng. There is no standard of duration of soaking before frying of dendeng. However whether the precooking preparation has a further effect on the reduction of nitrite residue and MDA content is not known. This research was conducted to evaluate the use of spices at different concentrations, and the application of different curing technique and precooking preparation to reduce the nitrite residue and MDA level in fried dendeng.

2. Materials and methods

2.1. Materials

Meat in this study was obtained from the round of Brahman cross cattle 1.5 yr. The spices i.e. galangal, coriander, garlic, tamarind, pepper were bought from local market, Indonesia. Analyses were conducted by using chemicals of analytical grade: absolute methanol, Folin–Ciocalteu, gallic acid, vitamin C, thiobarbituric acid (TBA) from Merck (Merck KGaA, Germany), and 1,1-diphenyl-2-picrylhydrazil (DPPH), propylgallate (PG), ethylenediaminetetraacetic acid (EDTA), 1,1,3,3-tetraethoxypropane (TEP), 1-(N)-naphthylethylenediamine dihydrochloride and sulfanilamide from Sigma (Sigma Aldrich Co., USA).

2.2. Dendeng production and sample preparations

Dendeng was produced using two different formulas of spices, formula I and II, as presented in Table 1. Spice formula II contained garlic and coriander at 2-fold the level of formula I. Garlic and coriander are the main spices in dendeng that have played a role factor on reduction of nitrite reactivity and antioxidant activity, and the use of them in commercial dendeng is of various levels, 1%–15% for garlic and 1%–4% for coriander (Suryati et al., 2012). Therefore, in this study garlic and coriander were used at low and medium levels, garlic was used 5% (formula I) and 10% (formula II), and coriander was used 1% (formula I) and 2% (formula II). The frozen beef was thawed and trimmed and then sliced about 5 mm thickness. For wet curing treatments, meat slices (1 kg) were soaked in sodium nitrite solution (150 mg/L potable water) for 12 h at room temperature. Then the nitrite cured meat was mixed with other ingredients as appropriate for spices treatments I and II (Table 1), and held for 12 h, this gave the total time for wet curing process of 24 h. The cured and spiced meats were finally dried using oven at 60 °C for 3 h, and it was reversed in such a way that the bottom side is in up position, and the drying was continued at 70 °C for 5 h.

In dendeng with dry curing, sodium nitrite (150 mg/kg) was added to meat slices by mixing the nitrite salt with other ingredients prior to the application on meat, then these were applied to the meat by manual stirring for 30 min. The marination process lasted for 12 h at room temperature. In addition to spiced dendeng, non-spiced dendeng was made as a control treatment. The process of uncured dendeng (without sodium nitrite curing) was similar to that of dry curing, given that the meat slices were mixed readily with ingredients mix but without soaking in sodium nitrite solution at first.

After drying and before frying, dendeng was stored at room temperature for 24 h then kept at refrigerator until frying process was conducted (about a week). Fried dendeng were prepared with and without soaking in potable water for 5 min and were drained and left for 15 min before frying. Frying was done by using vegetable oil at 150 °C for 1.5 min. Oil was not repeatedly used for frying. Two litres of palm oil was used for frying 300 g dendeng. Fried dendeng samples were ground and homogenized by using a blender, then it were packed and stored at −25 °C prior to analysis.

Table 1
Ingredient composition of dendeng.

Materials	Formula			
	I		II	
	(%)[a]	Weight (g)	(%)[a]	Weight (g)
Beef		1000		1000
Salt	2.5	25	2.5	25
Galangal	8.5	85	8.5	85
Coriander [b]	1.0	10	2.0	20
Garlic [b]	5.0	50	10.0	100
Brown sugar	16.5	165	16.5	165
Sugar	16.5	165	16.5	165
Tamarind	0.3	3	0.3	3
Pepper	0.3	3	0.3	3
$NaNO_2$ (150 mg/kg)[c]	0.03	0.3	0.03	0.3

[a] Based on meat weight.
[b] Formula II had 2-fold higher coriander and garlic, compared to formula I.
[c] $NaNO_2$ added to curing treatment; $NaNO_2$ was not added to uncured treatments.

2.3. Moisture and pH determination

Moisture and pH on fried dendeng were measured as additional variables to explain the condition in dendeng system (nitrite residue forming and oxidation reaction). Moisture was determined by oven-drying at 105 °C according to AOAC (2005). pH was measured by a pH meter Hanna HI 99163 (Romania, Europe).

2.4. Total phenolics, antioxidant activity and capacity

The determination of total phenolics, antioxidant activity and capacity was carried out on fried dendeng by following procedure as described by Tangkanakul et al. (2009) with modification in extraction procedure. Compounds in 1 g of sample were extracted with 2.5 mL of 100% methanol at room temperature for 24 h. After filtration, the filtrate was separated in other tube and 2.5 mL of methanol was added into retentate. The first filtrate was stored for 24 h in −25 °C in a capped tube. After 24 h, the filtrate from the second filtration was separated and mixed with the filtrate of the day before in 10 mL volumetric flask, and methanol was added into these until the volume reached 10 mL. Extracts were stored in −25 °C prior to analysis of total phenolics and antioxidant activities. Total phenolics were expressed as mg gallic acid equivalent (GAE) per 100 g dry matter (DM) of dendeng. Antioxidant activity was determined by the percentage of scavenging activity on radical DPPH, and antioxidant capacity was determined based on the inhibition of vitamin C at some concentrations (in a linear calibration) on radical DPPH. Antioxidant capacity was expressed by mg vitamin C equivalent (VCE) per 100 g DM of dendeng.

2.5. Nitrite residual analysis

Residual nitrite in fried dendeng was analysed according to the method described by AOAC (2005). Nitrite residual was expressed as mg nitrite per kg DM of dendeng.

2.6. Malonaldehyde (MDA) analysis

Malonaldehyde analysis for fried dendeng was carried out using analysis of thiobarbituric acid reactive substances (TBARS) according to the method as described by Sørensen and Jørgensen (1996) with a little modification. The modification was the homogenization of sample before the addition of PG and EDTA solution. TBARS analysis by spectrophotometer (GeneQuant 1300, Sweden) was done after 5 mL of sample distillate was reacted with 5 mL TBA 0.02 M and then incubated at

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