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The Effect of Sugar Cane Levels and Drying Methods on Chemical and Physical Qualities of Ground Beef “Dendeng”

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ABSTRACT

This study was conducted to investigate the effect of sugar cane levels and drying methods on chemical and physical quality of ground beef “dendeng”. The materials were ground beef, cane sugar, and spices consisting of salt, garlic, coriander, and galangal. The treatments were the sugar cane levels, consisting of 20, 30, and 40% (w/w of meat weight), and the drying methods, consisting of oven drying and sun drying. The oven drying was done at $50 \pm 2^\circ\text{C}$ for 15 hours, while sun drying was done at $40 \pm 2^\circ\text{C}$ for 6 hours per day for 4 days. The variables were tested on chemical quality (moisture, protein, and fat contents), and physical quality (pH and tenderness). Data were analyzed by analysis of variance of factorial pattern (3x2) of completely randomized design and continued by Duncan's new multiple ranges test. The results showed that there was an interaction between the sugar cane levels and the drying methods on the protein content and tenderness of ground beef “dendeng” ($P < 0.01$). Sugar cane levels had significant effects on protein content and tenderness ($P < 0.05$), but had no significant effect on moisture content, fat content, and pH value of ground beef “dendeng”. The drying methods had no significant effect on all chemical and physical variables of ground beef “dendeng”. In conclusion, there was an interaction between sugar cane levels and drying methods on the protein content and tenderness of ground beef “dendeng”. The addition of sugar cane at the levels of 40% yielded ground beef “dendeng” with the best tenderness. However, the methods of drying did not affect the chemical and physical qualities of ground beef “dendeng”.

Keywords : Chemical quality, “Dendeng”, Drying methods, Ground beef, Physical quality, Sugar cane levels

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Introduction

“Dendeng” is a food product that is shaped plate made of sliced meat or ground meat that has been given seasoning and dried. The “dendeng” can be produced from various meats, such as beef, buffalo, horse, goat, sheep, pig and chicken. The process of “dendeng” making includes curing and drying process. Curing is done by addition of a mixture of salt, sugar and spices.

Sugar is the main ingredient in “dendeng” which has two different effects on muscle protein. First, sugar can cause brown color by Maillard reaction. Second, sugar can stabilize proteins to heat denaturation (Rich and Foegeding, 2000). Researches on the effect of sugar on physical and chemical properties of foods have been conducted such as the effect of sucrose on chemical and sensory properties of intermediate-moisture meat product (pork jerky) (Chen *et al.*, 2002), the effect of sugar level on physical, biochemical characteristics of cantonese sausage (Qiu *et al.*, 2012), effect of sugar on physical

attributes of sweet-dried chicken (Wongwiwat and Wattanechant, 2014).

Drying is a very common preservation method used in foodstuffs and the quality of the final product is strongly dependent on the technique and the variable used (Doymaz, 2005). Drying also alters other physical, biological, and chemical properties of food (Demirhan and Ozbek, 2010). There are various type of drying method in making intermediate moisture meat products, such as natural drying (sun drying), hot-air drying, freeze drying and so on (Holdsworth, 1971). Hot-air drying is one of the most frequently used operations for food dehydration (Krokida and Maroulis, 1999). A major disadvantage associated with hot-air drying is that it takes long time even at high temperature, which may cause serious damage to the flavor, color, and nutrients in dried products (Ratti, 2001; Sharma and Prasad, 2003; Jing *et al.*, 2010). Recent years, there are a lot of study concerning to the effect of drying methods on physicochemical, biochemical and sensory characteristics of foods, such as the effect of oven drying on proximate composition (Agu *et al.*,

2016), the effect of oven drying on the functional and nutritional properties on whole egg (Ndife *et al.*, 2010), the effect of sun drying on nutritive and antioxidant properties of vegetables (Zoro *et al.*, 2015), the effect of drying methods on chemical quality of swine “*dendeng*” (Veerman *et al.*, 2011).

This study aims to determine the effect of sugar cane levels, drying methods, and interaction between sugar cane levels and drying methods on chemical and physical qualities of ground beef “*dendeng*”.

Materials and Methods

Materials

The materials used in this study were ground beef, sugar cane, kitchen salt, coriander powder, mashed garlic, galangal, belching, and cooking oil. Materials used in physical and chemical quality test were aquadest, buffer phosphat 7.00, buffer phosphat pH 4.00, H₂SO₄, K₂SO₄, CuSO₄, NaOH 40%, H₃BO₃ 4%, HCl 0.1N, BCG + MR indicator, and petroleum benzene.

Methods

Ground beef “*dendeng*” production. This research consisted of 2 treatments that were sugar cane levels and drying methods. Sugar cane levels were 20, 30, and 40% (w/w of meat weight). The drying methods were sun drying and oven drying. Ground beef was weighed at approximately of 200 g. Spices consisted of salt (2%), garlic (2%), coriander (2%), belching (0.05%) and galangal (1%), and sugar (as treatment) (20, 30, 40% w/w of meat weight). Ground beef was mixed with all mashed spices until being homogeneous. The dough was then cured for 1 night. The dough was then placed on a sheet coated by aluminum foil and flattened with a thickness of approximately 2 mm. The dough was then dried in the sun drying and oven drying. Sun drying was done for 6 hours a day for 4 days, with a temperature of approximately 40±2°C, while oven drying was done for 15 hours at 50±2°C.

Chemical quality. The chemical quality of ground beef “*dendeng*” included moisture content, protein content and fat content. The moisture content was tested graphometrically (AOAC, 1995). The moisture content is the difference of sample weight before heated at 105°C for 12 hours and after heated at 105°C for 12 hours. The protein content was determined by the Kjeldahl method (AOAC, 1995). The Kjeldahl method included destruction with H₂SO₄ to destroy all organic materials, then distillation with NaOH to release ammonium, and titration with HCl to determine the amount of nitrogen. The protein content was obtained by multiplying the nitrogen content (%) by the nitrogen conversion factor (6.25). Fat content was determined by using Soxhlet extraction method (AOAC, 1995). Soxhlet fat extraction used benzene petroleum for 16 hours or until the solution becomes clear. Fat is the material left in the soxhlet flask after dried at 105°C for 8 hours. Fat content

was obtained by dividing the fat weight by the sample weight and multiplying by 100%.

Physical quality. The physical quality of ground beef “*dendeng*” included pH value and tenderness. The pH value was tested according Bouton and Harris (1972). Ground beef “*dendeng*” sample was weighed at about 10 g and finely chopped, and then added with 10 ml of distilled water, and stirred until homogeneous. The pH value of the sample was measured with a pH meter calibrated with phosphate buffer pH 7.00 and phosphate buffer pH 4.00. The tenderness was tested by using Warner-Bratzler shear force (Soeparno, 2009). Tenderness is the energy needed to cut a sample with a certain cross-sectional area. Sample with a width of 1.5 cm, and a thickness of 0.67 cm and a length adapted to the meat fiber direction was cut with Warner-Bratzler shear force test. The tenderness was measured on three places of sample.

Data analysis

Data were analyzed by analysis of variance of factorial (3x2) pattern of completely randomized design. The mean differences were tested by Duncan new multiple range test (Steel and Torrie, 1980).

Results and Discussion

Chemical quality

Moisture content. The average of moisture content of ground beef “*dendeng*” with different sugar cane levels and drying methods was shown in Table 1. The statistical analysis showed that there was no interaction between sugar cane levels and drying methods on moisture content of ground beef “*dendeng*”. Furthermore, moisture content was not affected significantly by sugar cane levels. The moisture content of ground beef “*dendeng*” with sugar cane levels of 20, 30 and 40% was 10.67±3.01, 8.17±1.60, and 8.17±2.04%, respectively, The result of this study was not in accordance with the results of previous research conducted by Chen *et al.* (2002) which stated that the higher level of sucrose will decrease moisture content of pork jerky. In this study, the increase of sugar cane levels did not decrease the moisture content significantly. However, the moisture content showed quantitatively a decrease, from 10.67% to 8.17%. The not significant decrease was due to the hygroscopic nature of sugar that plays a crucial role in the decrease in moisture content of foods (Kitts, 2010). Drying method also did not affect the moisture content of ground beef “*dendeng*”. The moisture content of ground beef “*dendeng*” with the oven drying and sun drying was 9.33±2.83 and 8.67±2.18%, respectively. The moisture content of beef “*dendeng*” was affected by the temperature and the duration of the drying process. The oven drying temperature was 50±2°C, with 15 hours drying time. While, the sun drying temperature was 40±2°C, with 24 hours (4 days x 6 hours/day). The higher temperature and

Table 1. The moisture, protein, and fat contents of ground beef "*dendeng*" with different levels of sugar cane and methods of drying

Variables	Sugar cane levels (%)	Methods of drying		Average
		Oven drying	Sun drying	
Moisture content (%)	20	11.00±3.46	10.33±3.21	10.67±3.01
	30	8.67±2.08	7.67±1.15	8.17±1.60
	40	8.33±3.06	8.00±1.00	8.17±2.04
	Average	9.33±2.83	8.67±2.18	
Protein content (%)	20	35.89±0.15	36.39±1.62	36.13±1.13 ^a
	30	28.42±2.14	30.11±1.20	29.26±1.88 ^b
	40	28.00±2.43	25.89±1.30	26.95±2.16 ^c
	Average	30.77±4.12	30.79±4.62	
Fat content (%)	20	5.81±0.70	6.09±0.67	5.95±0.87
	30	5.50±0.61	5.89±0.60	5.69±0.61
	40	6.21±1.57	5.48±0.31	5.84±1.14
	Average	5.84±1.03	5.82±0.58	

a, b, c Different superscripts at the same column indicated significantly different ($P < 0.05$).

^{ns} Not significant.

the longer drying time decreased moisture content of the ground beef "*dendeng*". In addition, the moisture content of beef "*dendeng*" was also influenced by fat content of beef "*dendeng*". Moisture content is inversely proportional to the fat content, the higher fat content leads to decrease the moisture content (Soeparno, 2009). The moisture content of ground beef "*dendeng*" ranged from 7.67 to 11.00%. The moisture content of beef "*dendeng*" was within the range required by the National Standard of Indonesia (SNI) of a maximum of 12% (BSN, 2013).

Protein content. The average of protein content of ground beef "*dendeng*" with different sugar cane levels and drying methods was shown in Table 1. The statistical analysis showed that the sugar cane levels had a significant effect on the protein content of ground beef "*dendeng*" ($P < 0.05$), and the drying methods did not give a significant effect on the protein content of ground beef "*dendeng*". However, there was a very significant interaction between sugar cane levels and drying methods on protein content of beef "*dendeng*" ($P < 0.01$). This suggests that the interaction was more influenced by a single factor, i.e sugar cane level. Sugar cane levels had significant effect on protein content of ground beef "*dendeng*". The average of protein content of ground beef "*dendeng*" with sugar cane levels of 20, 30, and 40% was 36.13±1.13, 29.26±1.88, and 26.95±2.16%, respectively. In this study, the increase of sugar cane levels decreased protein content of ground beef "*dendeng*". It was due to the increase of sugar cane levels decreased the proportion of meat in the ground beef "*dendeng*". Meat is a main material of "*dendeng*" and has a high protein content. Chemical composition of meat includes: moisture 65-82%, protein 16-22%, fat 1.5-13.0%, non protein nitrogen 1.5%, carbohydrate 0.5-1.5%, ash 1.0%, and vitamins (Soeparno, 2009). This result agreed with the previous study reported by Chen *et al.* (2002) which stated that beef jerky with high sugar levels has lower protein content than sugar-free treatment. The protein content of oven drying and sun drying was not significantly different. The average of protein content of the drying method was 30.77±4.12% while the sun drying method was

30.79±4.62%. The result of this study was not in accordance with the research conducted by Veerman *et al.* (2011) which stated that oven drying causes higher water content than sun drying, because the temperature is evenly and stable so it requires faster drying time compared to sun drying with uncontrolled temperature. The protein content of ground beef "*dendeng*" ranged from 25.89 to 36.39%. The results of the study showed that the protein content was higher than required by the National Standard of Indonesia (SNI) of a minimum of 25% (BSN, 2013).

Fat content. The average of fat content of ground beef "*dendeng*" with different sugar cane levels and drying methods was shown in Table 1. The statistical analysis showed there was no interaction between sugar cane levels and drying methods on fat content of ground beef "*dendeng*". Furthermore, the fat content was also not affected by sugar cane levels and drying methods. The average of fat content of ground beef "*dendeng*" with sugar cane levels of 20, 30 and 40% was 5.95±0.87, 5.69±0.61, and 5.84±1.14%, respectively. The result was due to the same ingredients used except the sugar levels. The fat content was influenced by the type of meat, while sugar affected the protein (Suharyanto *et al.*, 2008), so there was no interaction between sugar and fat content of beef "*dendeng*". Drying methods had no significant effect on fat content of ground beef "*dendeng*". The average of fat content of ground beef "*dendeng*" with oven drying method was 5.84±1.03% while with sun drying method was 5.82±0.58%. This was due to the low fat content of beef used in making ground beef "*dendeng*" (Kim *et al.*, 2014). The fat content has an association with the moisture content. The fat content is inversely proportional to the moisture content (Soeparno, 2009). In this study, the moisture content of ground beef "*dendeng*" was not significantly different in term of drying methods. This was due to the fat content to be not significantly different. The fat content of ground beef "*dendeng*" ranged from 5.48 to 6.21%. This result was higher than standard required by National Standard of Indonesia (SNI) of a minimum of 3% (BSN, 2013).

Table 2. The pH value and tenderness of ground beef "dendeng" with different levels of sugar cane and methods of drying

Variables	Sugar cane levels (%)	Methods of drying		Average
		Oven drying	Sun drying	
pH value	20	5.50±0.16	5.54±0.21	5.52±0.18
	30	5.59±0.29	5.47±0.10	5.53±0.22
	40	5.53±0.26	5.59±0.15	5.56±0.21
	Average	5.54±0.24	5.53±0.16	
Tenderness (kg/cm ²)	20	5.63±1.40	6.57±1.41	6.10±1.41 ^a
	30	5.36±1.36	6.56±0.99	5.96±1.30 ^b
	40	5.09±1.06	4.84±0.85	4.97±0.94 ^c
	Average	5.36±1.30	5.99±1.33	

a, b, c Different superscripts at the same column indicated significantly different ($P < 0.05$).

^{ns}Not significant.

Physical quality

pH value. The average of pH value of ground beef "dendeng" with different sugar cane levels and methods of drying was presented in Table 2. The statistical analysis showed that sugar cane levels and drying methods had no significant effect on the pH value of ground beef "dendeng". The interaction between sugar cane levels and drying methods were also not significantly different. The average of pH value of ground beef "dendeng" ranged from 4.84 to 6.57. pH value of various "dendeng" ranges from 5.17 to 5.88 (Suharyanto *et al.*, 2008). These result similar to observation of Yang and Lee (2002) that reported the pH of commercial beef jerky was 5.4 to 5.8. The average of pH value of ground beef "dendeng" with sugar levels of 20, 30, and 40% was 5.52±0.18, 5.53±0.22, and 5.56±0.21, respectively. The average of pH value of beef "dendeng" with oven drying and sun drying was 5.54±0.24 and 5.53±0.16, respectively. Higher levels of sugar cane level did not affect the pH value. This study was not in association with the previous study conducted by Chuy and Bell (2006) stated that there was pH lowering effect when adding sucrose into phosphate system.

Tenderness. The average of tenderness (Warner-Bratzler shear force or WBSF) value of ground beef "dendeng" with different sugar cane levels and drying methods was presented in Table 2. The statistical analysis showed that there was interaction between sugar cane levels and drying methods on tenderness of ground beef "dendeng" ($P < 0.01$). The sugar cane levels affected significantly on the WBSF value of ground beef "dendeng" ($P < 0.05$). The drying methods had no significant effect on tenderness value of beef "dendeng". This suggests that the interaction was more influenced by a single factor, i.e sugar cane level. The average of WBSF value of ground beef "dendeng" with sugar cane levels of 20, 30, and 40% was 6.10±1.41, 5.96±1.30, and 4.97±0.94 kg/cm², respectively. The higher WBSF value means the greater the power required to cut the meat. The increase of sugar cane levels decreased WBSF value. In other words, the higher of sugar cane level, the "dendeng" was more tender. This study was in accordance with the previous study conducted by Chen *et al.* (2002) which stated that increase of sucrose decreased WBSF value because it reduced the moisture content. Sucrose is a chemical compound belonging to the

carbohydrate group, has a sweet taste, and white in color. Sugar (sucrose) serves as humectants, which helps the formation of texture and tenderness, gives flavor through browning and gives sweetness (Qiu *et al.*, 2012). The average of tenderness value of ground beef "dendeng" made by oven drying was 5.36±1.30 kg/cm² and the sun drying was 5.99±1.33 kg/cm². The WBSF is affected by drying temperature. Drying with higher temperatures will cause the myofibril protein to contract, and become hard, thus increasing WBSF value (Aberle *et al.*, 2001). The WBSF value is also in association with the moisture content. Higher moisture content will be more tender (Soeparno, 2009). Moisture content obtained from the result of two drying methods was not significantly different so that tenderness of ground beef "dendeng" was also not significantly different.

Conclusion

There was an interaction between sugar cane levels and drying methods on the protein content and tenderness of ground beef "dendeng". The addition of sugar cane at the levels of 40% yielded ground beef "dendeng" with the best tenderness. However, the methods of drying did not affect the chemical and physical qualities.

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