

SENSORY PROPERTY AND *Benzo(a)Pyrene* (Bap) LEVEL IN SE'I PROCESSED FROM CULL BALI COW BEEF

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Submitted 17 February 2020; Accepted 11 June 2020

ABSTRACT

The objectives of this experiment were to evaluate the effect of using meat obtained from cull Bali cows differing in body condition score (BCS) on sensory property and benzo(a)pyrene (BaP) level on se'i (Rotenese smoked beef). A completely randomized design 9x3 was used in this experiment. The nine treatments were BCS 2 with open smoking method (BCS2O), BCS 2 with close smoking method (BCS2C), BCS 2 given liquid smoke (BCS2LS), BCS 3 with open smoking method (BCS3O), BCS 3 with close smoking method (BCS3C), BCS 3 given liquid smoke (BCS3LS), BCS 4 with open smoking method (BCS4O), BCS 4 with close smoking method (BCS4C), and BCS 4 given liquid smoke (BCS4LS). Parameter measured were sensory property and *benzo(a)pyrene* (bap) content of se'i. The data of sensory property were analyzed using Kruskal-Wallis test followed by Mann-Whitney test. The data of benzo(a)pyrene (BaP) content was analysed using analysis of variance followed by Duncant test. Results showed that se'i produced from group BCS4LS possessed higher score on taste and tenderness, whereas the strongest aroma of se'i was found in se'i processed by both open and close smoking method in all BCS group. The highest benzo(a)pyrene content (0.0052 – 0.0055 ppm) was found in se'i processed by close smoking method in all BCS group, followed by se'i was added liquid smoke in all BCS group. It is suggested that meat of cull Bali cows with BCS4LS could be used to produce se'i with preferable taste,n tenderness and could lower the accumulation of BaP in se'i.

Key words: Benzo(a)pyrene; body condition score; sensory quality; smoking method

INTRODUCTION

Se'i is a traditional smoked beef from East Nusa Tenggara (NTT) which, as many other smoked beef, is strongly influenced by the quality of fresh meat. Low quality se'i found in local market is often due to the fact that meat used predominantly comes from thin cull Bali cows. Higher quality of se'i can be produced from cull cows of higher body condition score of fattened cull Bali cows which have higher body condition score (BCS) at slaughter.

These cows not only produce higher quantity of meat but also of higher quality (Jelantik *et al.*, 2014). Body condition directly affect body composition, *i.e.* water, protein, fat and mineral content (Otto *et al.*, 1991; Whitter *et al.*, 1993) which are known as the determinant factors controlling meat texture (Guzek *et al.*, 2013) which is one of dominant factor affecting the quality differences in processed meat.

The ultimate quality of se'i, however, is also highly depending upon the smoking technique applied. During smoking process, heat is transferred, and different chemical fractions are deliberately produced. In addition, different heating rate affects drying rate which has bactericidal consequences. Similarly, different substances are liberated during smoking have bacteriostatic and bactericidal effect which suppress bacterial growth during preservation.

Heating and smoking also contribute to aroma, flavor and color development of se'i. Other substances, however, have negative effect on smoked beef or even harmful for human health. As a result of incomplete burning, organic matter of wood produces polycyclic aromatic hydrocarbon (Rey-Salgueiro *et al.*, 2008), *e.g.*

benzo(a)pyrene (BaP) (Ramalhosa *et al.*, 2009) which has been known to possess carcinogenic, mutagenic, lipophilic and bioaccumulative effects.

Therefore, it is possible that different smoking techniques, *i.e.* open traditional smoking technique will differ in those aspects compared to close smoking technique as well as to smoking with liquid smoke. The differences are also possibly dependent upon the quality of fresh meat from different BCS of cull Bali cows. Therefore, the objectives of this experiment were to investigate the sensory properties and benzo(a)pyrene (BaP) level of se'i (Rotenese smoked beef) made of fresh meat from different BCS cull Bali cows then smoke in different techniques.

MATERIALS AND METHODS

Experimental design

A 9 x 3 completely randomized design (CRD) was used in this study. The nine treatments were BCS 2 with open smoking method (BCS2O), BCS 2 with close smoking method (BCS2C), BCS 2 given liquid smoke (BCS2LS), BCS 3 with open smoking method (BCS3O), BCS 3 with close smoking method (BCS3C), BCS 3 given liquid smoke (BCS3LS), BCS 4 with open smoking method (BCS4O), BCS 4 with close smoking method (BCS4C), and BCS 4 given liquid smoke (BCS4LS).

Se'i processing

Fresh meat (*i.e.* *Biceps femoris*) from cull cows having body condition score of 2, 3 and 4 (according to 5 scoring system) was obtained from Kupang slaughterhouse. Meat was separated from fat before being sliced into rope shape. The sliced meat was then added 2% (w/w) salt (NaCl) and saltpeter

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How to cite:

Malelak, G. E. M., Ratu, M. R. D., Lestari, G. A.Y., Benu, I., & Jelantik, I. G. N. (2020). Sensory Property and Benzo(a)Pyrene (Bap) Level in Se'i Processed from Cull Bali Cow Beef. *Jurnal Ilmu dan Teknologi Hasil Ternak*, 15 (2), 78-85

(KNO₃) 300 mg per kg meat. The saltpeter was diluted in 2 mL water before being added to the meat. Meat from each different BCS was divided into three to be smoked with three different techniques, i.e. open (O), close (C) or injected with 1% (v/w) kusambi (*Schleichera oleosa*) liquid smoke (LS). All meat was cured for 12 h and smoked for ±45 min. When the smoking was done, se'i was let to rest and samples were thereafter taken from each treatment for sensory evaluation and BaP content analysis.

Sensory evaluation and benzo(a)pyrene (BaP) content analysis

A twenty-five 25 untrained panelists from Animal Science Faculty of Nusa Cendana University involved in sensory evaluation. Hedonic scale was used for each sensory characteristic including aroma, taste and tenderness. For the aroma test, three 30 g cuts from each treatment were put into glass beaker and close tightly for 30 min. Panelist were asked to inhale and score using 5 scaling system (Bensink *et al.*, 1973) according to the criterion presented in Table 1. For taste and tenderness, three cuts (2×1 cm and 3 mm thick) for each treatment were placed on white plate. Panels were then asked to give hedonic score according to criterion presented in Table 1. Benzo(a)pyrene (BaP) content was analyzed following the procedure of Cho dan Shin (2012).

A 5 g sample was blended and mounted into extraction flask and extracted using 5 µg/kg 3-methylcholanthrene, and further saponified using 1 M KOH in ethanol at 80°C to isolate BaP. After cooling down, the samples were removed into 300-mL funnel separated using a mixture of 50 mL ethanol-*n*-hexane (1:1) and *n*-hexane. The residues were then extracted twice using 50 mL *n*-hexane and washed three times using 50 mL distilled water before being dried using Na₂SO₄ and concentrated using low pressure rotary evaporator until the aliquot became 2 mL at 35°C.

Statistical Analysis

Sensory evaluation data, i.e. aroma, taste and tenderness, were analyzed using Kruskal-Wallis test followed by Mann-Whitney test. Meanwhile, the data of benzo(a)pyrene (BaP) content were analyzed using analysis of variance followed by Duncan test (SPSS 20).

RESULTS AND DISCUSSION

Sensory property of se'i

Aroma. The aroma of se'i when smoked with liquid smoke produced inferior aroma in all BCS compared to other smoking techniques. This was possibly due to the infiltration of liquid smoke into meat during curing thereby tissue structures became loosen which further stimulated higher loss of volatile compounds and fat through evaporation and drip during smoking. The excessive drip of fat with application of liquid smoke caused se'i to lose its aroma. Rabe *et al.* (2003) reported that fat is mostly responsible in producing aroma.

Fat tissue produce volatile components such as acids, alcohols, aldehydes and ketones (Mottram, 1998). The lowest aroma score was shown in se'i made from meat of cull Bali cows with BCS4. Those differences were mainly caused by the difference in moisture, protein and fat content of fresh meat from cows differing in BCS. The content of water, protein and fat in fresh meat in BCS 2 was; 62.25%; 28.62%, and 6.42% respectively. In BCS 3 was; 65.36%; 25.59%, and 7.05%, respectively.

In BCS 4 was; 67.12%; 21.03%, and 8.96%, respectively. In general, aroma is detected by the olfaction organs through stimulation from different water-soluble compounds such as free amino acids and substances related to ATP (Ichimura *et al.*, 2017). However, Kinsella (1990) demonstrated that aroma was more affected by fat rather than water-soluble compounds. The result of this experiment was unexpected as meat from cull Bali cows with

BCS4 contained higher moisture (67.12%) and fat content (8.96%) compared to BCS3 (65.36% of moisture and 7.05% of fat) and

BCS2 (62.25% of moisture and 6.42% of fat) which should have produce se'i with highest aroma score.

Table1. Hedonic score for organoleptic test

Variable	Hedonic scale	Criterion
Aroma	5	extremely like
	4	like
	3	neutral
	2	dislike
	1	extremely dislike
Taste	5	extremely like
	4	like
	3	neutral
	2	dislike
	1	extremely dislike
Tenderness	5	extremely tender
	4	tender
	3	tender enough
	2	though
	1	extremely though

Table 2. Average score of aroma, taste and tenderness of se'i made from fresh meat of cull Bali cows smoked with different techniques

Treatment	Aroma	Taste	Tenderness
Body condition score 2, open smoke (BCS2O)	3.48±0.63 ^b	3.65±1.05 ^a	3.49±0.59 ^a
Body condition score 2, close smoke (BCS2C)	3.57±0.60 ^b	2.76±0.53 ^a	3.14±0.97 ^a
Body condition score 2, Liquid smoke (BCS2LS)	2.95±0.91 ^a	3.67±1.02 ^a	3.47±0.47 ^a
Body condition score 3, open smoke (BCS3O)	3.10±0.50 ^b	3.57±0.69 ^a	3.84± 0.86 ^a
Body condition score 3, close smoke (BCS3C)	3.38±0.30 ^b	2.81±1.45 ^a	4.09±1.76 ^a
Body condition score 3, Liquid smoke (BCS3LS)	2.62±1.24 ^a	3.10±1.80 ^a	4.24±0.93 ^a
Body condition score 4, open smoke (BCS4O)	2.95±0.45 ^b	3.48±0.86 ^a	3.57±0.52 ^a
Body condition score 4, close smoke (BCS4C)	2.95±0.53 ^b	4.71±0.93 ^b	3.64±0.46 ^a
Body condition score 4, Liquid smoke (BCS4LS)	2.52±0.77 ^a	4.14±0.98 ^b	4.33±1.04 ^b

Description: Values within similar column with different superscript shows significantly different (P<0.05)

One possible reason for this discrepancy is that in smoked beef, aroma is also stimulated by phenolic compounds found in the smoke. During smoking,

phenolic compounds are attached to meat surface and thereafter infiltrates into meat tissue to form hydrogen chains between hydroxyl groups and collagen (Daun, 1979).

However, some phenolic compounds are readily absorbed by fat compared to water (Doerr dan Fiddler, 1970; Issenberg *et al.*, 1971), and during smoking process, fat melted.

Therefore, the low aroma for se'i from BCS 4 was apparently due to the excessive loss of fat during smoking. This was indicated by fat content of se'i, which was comparable among different BCS, regardless higher fat content of fresh meat of cows with BCS 4. Results showed that highest score for taste was for meat from cull cows BCS 4 with close smoking (BCS4C) and liquid smoke (BCS4LS). This finding could be explained by the higher content of fat in BCS 4 and less fat loss with close smoking and the application of liquid smoke.

Fat is the predominant source of specific flavor (aroma and taste) in meat (Anandh and Lakshmanan, 2014) both in fresh meat (Wood and Enser, 1997; Calkins and Hodgen, 2007) or phospholipid in cooked meat (Gandemer, 1997). This finding is understandable as taste is determined by many components of meat such as the content of water-soluble components, nitrogenous compounds and

variety of minerals contained in sarcoplasm (Ichimura *et al.*, 2017). Similarly, Nishimura *et al.* (1998) reported that non protein compounds are also responsible to stimulate taste. However, the most important taste precursor is fat content. Therefore, it is expected that se'i from BCS 4 was tastier than others as it contained higher fat and more of other components.

As shown in Table 2 the highest score was shown in se'i made of BCS 4 treated with liquid smoke (BCS4LS). This appeared to be due to the higher fat content of meat from cows with BCS 4 compared to thinner cows (BCS 2 and BCS 3). Many factors are known to affect meat tenderness including genetic (Lian *et al.*, 2013), the amount of connected tissue and protein structure (Jukna *et al.*, 2008; 2010), collagen content (Nishimura, 2015), and particularly the degree of fatness (Ustener, 2017). In addition, heating temperature (Lepetit, 2008) and heating method (Munchene *et al.*, 2009) also determine meat tenderness. In the present study, it seems that liquid smoke which was injected into the meat during curing helped to loosen meat fiber and during smoking fat was melted and enter the meat fiber to replace water.

Table 3. Benzo(a)pyrene content of se'i

Treatment	Benzo(a)pyrene content (ppm)
Body condition score 2, open smoke (BCS2O)	0.0019±0.01 ^a
Body condition score 2, close smoke (BCS2C)	0.0053±0.02 ^c
Body condition score 2, Liquid smoke (BCS2LS)	0.0026±0.01 ^b
Body condition score 3, open smoke (BCS3O)	0.0019±0.01 ^a
Body condition score 3, close smoke (BCS3C)	0.0055±0.01 ^c
Body condition score 3, Liquid smoke (BCS3LS)	0.0030±0.02 ^b
Body condition score 4, open smoke (BCS4O)	0.0017±0.01 ^a
Body condition score 4, close smoke (BCS4C)	0.0052±0.01 ^c
Body condition score 4, Liquid smoke (BCS4LS)	0.0030±0.02 ^b

Benzo(a)pyrene content

The differences in the level of benzo(a)pyrene (BaP) in se'i are presented in Table 3. BaP content was significantly higher ($P < 0.05$) in se'i which was made by close smoking technique. This result was in line with the result reported by Ghazali *et al.*

(2014) when they found that smoking manyung fish (*Arius thalassinus*) by close system resulted in higher BaP (0.0078 ppm) compared to using liquid smoke (0.0041 ppm). Similarly, Lukitaningsih *et al.* (2001) also recorded higher polycyclic aromatic hydrocarbons (PHA) in traditional

smoked meat was 0.041 ppm which was higher than meat which was given liquid smoke (0.00103-0.00926 ppm). BaP is produced during smoking when fatty acids pyrolysis occurs and attached to the surface of smoked products (Gomaa *et al.*, 1993).

In the present study, the lower content of BaP in open smoking technique was probably due to less possibility of the smoke to attach to the meat surface. This also occurred with liquid smoke as meat was indirectly smoked. In addition, the BaP content of liquid smoke used in the present experiment was 0.0015ppm which is lower than 2 µg/kg as reported by Joint FAO/WHO Expert Committee on Food Additives (2001).

Nevertheless, all smoking technique produced se'i with BaP content close to the maximal level of 5 ppb or 0.005 ppm to be allowed in smoked beef (BPOM, 2009). This would be of concern since BaP is carcinogenic and one who smoke beef with close smoking technique to be causative.

CONCLUSION

Se'i made from meat of cull Bali cows with BCS 4 and added liquid smoke produce se'i with the best sensory quality while se'i made from meat of cull Bali cows with BCS 2, 3 and 4 and smoked in open method (BCS2O, BCS3O and BCS4O) contains the lowest level of benzo(a)pyrene.

ACKNOWLEDGMENT

Authors thank to the Kemenristek-DIKTI for funding support through "Penelitian Terapan Unggulan Perguruan Tinggi" in the year of 2019.

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