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Effect of Grilling and Roasting on Fatty Acids Methyl Esthers (FAME) in Beef and Pork

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Abstract: The process of cooking may affect the fatty acids methyl esthers (FAME) content in food. The objective of this study is to determine the effect of grilling and roasting on FAME in beef and pork. Lipids were extracted using the Soxtherm fat extraction instrument. The fats were then methylated by sodium methoxide and being examined by using a gas chromatography. Data was analyzed using a one-way ANOVA. The amount of fatty acids in pork is significantly higher than in beef. The treatments within beef, showed significantly different values between the treatments. However, raw and grilled pork treatments were not significantly different except for the roast treatment ($p<0.05$). Ratio of polyunsaturated to saturated fatty acids (PUFA:SFA) in raw, grilled and roasted beef treatment are 0.03, 0.04 and 0.01. While in pork, raw, grilled and roasted treatments gives ratios 0.37, 0.33 and 0.30. This showed that pork has more PUFA content compared to beef. Further research can be done by changing the metod of extraction to see any difference between the methods.

Key words: Fatty acid profile · Grilled · Roasted · Beef · Pork

INTRODUCTION

Halal is an Arabic word which means lawful or permitted in Islam. Meanwhile, the word *thoyyiban* means pure, hygiene, safe and clean. *Halalan thoyyiban* merely means allowed and permissible for consumption with relation to *Syariah* law as long as they are safe and not harmful [1]. The opposite of *Halal* is H*aram*/*non-Halal* which means forbidden and prohibited [2]. All foods are considered *Halal* except pork and its by-products and derivatives, improperly animals slaughtered or dead before slaughtering, alcoholic drinks and intoxicants, carnivorous animals, birds of prey and certain other animals, foods contaminated with any of the pork or its by-products [1]. Fatty acids are composed by almost entirely straight chain aliphatic carboxylic acids. Fatty acids have carbon chain lengths between 4 to 24 carbon atoms with zero to three double bonds [3] with usually an even number [4]. Usually, the fatty acids in meat are mainly medium to long chain fatty acids length. There are about 40% of fatty acids which are saturated (SFA), 40% are monounsaturated fatty acids and about 2%-25% are from polyunsaturated fatty acids (PUFA) [4]. Beef fat contains the highest level of saturated long-chained fatty acids followed by pork, poultry and fish [5].

That the cooking process can affect the lipid composition of meat, especially the fatty acid content, by changing the nutritional value of cooked products when compared with the raw samples [6].

The objective of this study is to identify fatty acids profile in the form of fatty acid methyl ester (FAME) in beef and pork with different cooking methods.

MATERIALS AND METHODS

Sample Preparation: Samples of beef and pork were obtained from local market. The cuts were subjected to the grilled and roasted cooking treatments, while the control cuts was sampled directly from the raw beef and pork samples [7].

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Cooking Methods: Both beef and pork sample were grilled at 225°C for 15 minutes and roasted at 190°C for 20 minutes using microwave oven.

Determination of Fatty Acid Methyl Ester (FAME)

Fat Extraction: Extraction of fat was done by using the soxtherm fat extraction system from Gerdhart (Königswinter,Germany). 3 g of raw,grilled and roasted beef and pork were weighed on a filter paper. Petroleum ether 40-60 was being used as solvent. The fat obtained was dried and total lipid was calculated by the gravimetric method.

Derivatisation from Fatty Acid to FAME: By following the method of Timms [8], lipid sample production from the extraction was diluted in 4 ml of hexane followed by the addition of sodium methoxide based on weight of lipid.

Determination of FAME by Gas Chromatography (GC): Analysis of fatty acid methyl esters was analyzed with a gas chromatography (Agilent technologies 7890A), equipped split injector (50:1), HP-88 column and quantified by flame ionization detector. The GC conditions were as follows: injection port temperature was 250°C; flame ionization detector temperature was program at 280°C. The oven temperature program initial temperature of 120°C was set for 1 minute, 10°C/min to 175°C, 10 minutes, 5°C/min to 210°C, 5 minutes 5°C/min to 230°C, 5 minutes. The carrier gas was helium gas. The column flow rate was 1.9 ml/min. In the detector, helium gas flowed at 30 ml/min. The sample size injected for each analysis was 1µL. Compounds were identified by comparison with the retention times of known standards of FAME [9].

Statistical Analysis: A one-way analysis of variance (ANOVA) was applied on the data. Statistical Analysis Software (SAS) Enterprise Guide 4.3 was used to calculate and tabulate the statistical data.

RESULTS AND DISCUSSION

Effect of Type of Meat to FAME Content: Based on Table 1, the fatty acids of pork in MUFA, PUFA, SFA, CIS, Oleic Acid and Linoleic Acid were significantly higher than in beef. In the previous study, the SFA had been reported to be the most abundant fatty acids in lamb [9, 10], beef and pork [9]. Generally, the amount of SFA in beef is the highest when compared to other types fatty acids. However, the *cis* fatty acid has the highest amount in pork.

Table 1: Scores Mean (Mean±SD) for The Effect of Type Of Meat to Fatty Acids Profile

Fatty Acid/ Type Of Meat	Beef	Pork
MUFA	3.3603±2.1892^{a}	8.5430±1.7996^{b}
PUFA	0.0865±0.2339^{a}	2.8643±0.7069^{b}
SFA	3.7509±2.6967^{a}	8.4808±1.9287^{b}
Cis	2.6408±1.7033^{a}	10.6435±2.2375^{b}
Trans	0.0234±0.0536^{a}	0.0371±0.0866^{a}
OA	2.6016±1.6767^{a}	7.8921±1.6796^{b}
LA	0.0392±0.0695^{a}	2.7511±0.6499^{b}
GLA	0.0473±0.2319^{a}	0.0401±0.0586^{a}

a-c:different superscript letter indicate the significant different ($p<0.05$) mean within row. MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids, SFA: saturated fatty acids, OA: oleic acid, LA: linoleic acid, GLA: γ-linolenic acid.

Table 2: The Effect of Cooking Treatment of FAME content in Beef and Pork

Treatment/Type Of Meat	Beef	Pork
Raw	3.2969±0.7656^{c}	43.4774±1.3148^{a}
Roasted	22.6437±1.5035^{a}	33.4425±7.5715^{b}
Grilled	11.7093±0.4281^{b}	46.8360±9.1142^{a}

a-c: different superscript letter indicate the significant different ($p<0.05$) mean within row.

Effect of Cooking Method on FAME contentin Beef and Pork: There was a significant difference ($p<0.05$) in the amount of total fatty acids in raw, grilled and roasted beef (Table 2). However, in pork treatment, the amount of total fatty acids of raw and grilled in pork showed no significant difference but in roasted pork, the amount of total fatty acids was significantly lower ($p<0.05$) compared to the raw and grilled treatment.

Ono *et al*. [11] stated that unsaturated fatty acids, especially PUFAs, are less affected by cooking since they are part of the membrane structure. The SFA amount in beef and pork in abundant amount consist of myristic acid (14:0), palmitic acid (16:0) and stearic acid (18:0). The C16:0 and C18:0 have been reported to be the most abundant fatty acids in lamb [9, 10], beef and pork [9]. According to Rowe *et al*. [10], myristic (C14:0) and C16:0 acid raise low-density (LDL) serum cholesterol, although C18:0 has little effect. Therefore, the high levels of C16:0 in the current study are not desirable, although this is countered by relatively high levels of PUFA.

Comparison of Fatty Acids in Beef and Pork According to Treatments and its Effect to Health: The amount of fatty acids profile where higher in pork than in beef (Table 3). Most saturated fatty acids can raise the blood cholesterol in human [12]. Since pork has higher amount of SFA than in beef, it is highly possible that it can raise the blood cholesterol that can lead to atherosclerosis.

Table 3: Ratio of PUFA:SFA in Beef and Pork

Type of Meat/ Treatment	Raw	Grill	Roast
Beef	0.03	0.04	0.01
Pork	0.37	0.33	0.3

LA is a PUFA and it is more prone to oxidation than in OA which is a MUFA [13]. The MUFA oleic acid (C18:1) has cholesterol-lowering activity [14] resulting in LDL's being less susceptible to oxidation [15, 16] and thereby having less atherosclerosis risks [17]. The amount of MUFA in pork in all 3 treatments was higher than in 3 treatments in beef. Nevertheless, the UK Department of Health [18, 19] have recommended that the ratio of polyunsaturated to saturated fatty acids (PUFA:SFA) in the diet should be about 0.4 and above. After calculation has being made, the ratio PUFA to SFA of beef in raw, grilled and roasted treatments are 0.03, 0.04, 0.01.Meanwhile, the ratios of raw, grilled and roasted treatment in pork were 0.37, 0.33 and 0.30. Thus it can be concluded that fatty acids in beef can give more harm in terms of saturation. However, higher degree of unsaturation may increase the susceptibility towards oxidative rancidity.

CONCLUSION

The amount of fatty acids in pork is significantly higher than in beef. In general, grilled treatment in pork gives the highest amount of fatty acids followed by roasted treatment. Meanwhile, roasted treatment within beef sample shows the highest amount of fatty acids followed by grilled treatment. Pork samples in those three treatments gives the ratio below than 0.33 while beef give the ratio below 0.05 for those three treatments. Further research can be done by changing the method of extraction to see any difference between the methods of fatty acids recovery and the effect towards unsaturation of fatty acids as influenced by grilling and roasting.

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