HIGH MARBLING COOKED PORK LOIN PROVIDES UNSATURATED FATTY ACIDS ASSOCIATED WITH DESIRABLE AND UNDESIRABLE EATING SENSORY TRAITS

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Abstract – Marbling level influence on oleic, linoleic, and linolenic acids and cooked pork loin eating sensory traits was investigated. For each of five replications, nine pork loins were visually evaluated 24-h postmortem and categorized into low, medium, and high marbling. Crude fat, pH, fatty acid composition, and descriptive sensory analysis were evaluated. Analysis of variance and Pearson's correlation coefficients were determined. No difference in pH (p>.05) was found, but crude fat differed (p<.05) among the samples. High marbling pork had higher (p<.05) oleic, linoleic and linolenic acid contents, and was more associated with sweet and umami tastes and cardboard aroma. High marbling pork provides desirable aroma flavors, but also easily developed undesirable oxidized flavors due to fatty acid composition.

Key Words – intramuscular fat, trained sensory panel, meat aroma flavor

I. INTRODUCTION

Marbling or intramuscular fat (IMF) and its fatty acid (FA) composition have been well accepted as important factors affecting pork palatability [1]. FA composition of IMF can be varied depending on such factors as breed, sex, age, diet, fatness, or cooking method [2, 3]. It is an interest for pork industry in Thailand to understand how marbling level affects pork eating characteristics and its FA composition. Cooked meat aroma/flavor is developed through Maillard reaction, lipid oxidation, interaction between products of both reactions, and vitamin degradation [4]. Lipids may contribute to cooked meat flavor through thermal oxidation, reaction with lean tissue components, or acting as solvent for aroma compounds [3]. High level of linoleic and linolenic acids was reported to cause an undesirable flavor in meat-like model system, while oleic acid increased the amount of many Maillard compounds [5]. We investigated the influence of marbling level on oleic, linoleic, and linolenic acid contents and their relation to pork eating sensory traits.

II. MATERIALS AND METHODS

For each of five replications, nine boneless pork loins (*Longissimus dorsi*; LD) were obtained from left side of Duroc castrated male carcasses (110.0±10 kg slaughter weight). At 24-h postmortem (PM), each LD was fabricated, visually evaluated between the 10^{th} and 11^{th} ribs, and categorized into low (LM, score=1 or 2), medium (MM, score=3 or 4), and high (HM, score=5 or 6) marbling levels [6]. LD was vacuum-packaged, placed in styrofoam containers with ice, and transported to Meat Technology Research Network Center, KMITL and stored in a walk-in cooler. After 48-h PM, each LD was evaluated for pH (Mettler Toledo, Germany), cut into chops, individually vacuum packaged, and kept frozen (-20°C) until analysis. Crude fat [7] and cooked LD FA composition [8] were determined. At 5-d PM, overnight thawed 3.5-cm thick LD chops were cooked at 180°C (EO-42K, Sharp Corporation, Japan) to 71°C internal temperature and cut into 1.3-cm^3 cubes for descriptive sensory analysis. Eight highly trained panelists, who affiliated with Kasetsart University Sensory and Consumer Research Center, evaluated sensory traits using a 15-cm line scale (score "0 = none" and "15 = extremely high"). Analysis of variance, Duncan's multiple range test, and correlation among variables were performed [9].

III. RESULTS AND DISCUSSION

From Table 1, no difference (p>.05) in pH values was observed. Expectedly, crude fat increased (p<.05) as marbling increased. HM cooked pork LD chops had higher (p<.05) oleic, linoleic, and linolenic acid contents than MM and LM. But no difference (p>.05) was found between MM and LM with respect to linoleic and linolenic acids. In contrast, no influence of marbling level on oleic acid in cooked pork was reported, while HM cooked pork was found to have less linoleic acid [1]. FA composition in cooked meat can be varied due to breed, sex, age, diet, fatness, or cooking method [2,3]. Results from descriptive sensory analysis showed that HM pork was rated higher (p<.05) for brothy aroma, cardboard aroma, and sweet taste than (p<.05) MM and LM. HM was also rated higher (p<.05) for umami taste than LM. Lipid oxidized products such as alcohols, aldehydes, ketones, or 2 alkylfurans can interact with amino acids or reactive protein residues in Maillard reaction resulted in heterocyclic aroma compounds contributing to cooked meat flavors [4]. Pearson's correlation coefficients (Table 2) showed that marbling level was (p>.05) associated with desirable sensory traits including sweet taste (r=.863), and umami taste (r=.981), and with oleic (r=.917), linoleic (r=.842), and linolenic (r=.913) acid contents. The content of these specific FA was (p>.05) also highly correlated to sweet and umami tastes as well as brothy aroma (r=.652 to r=.994). Moreover, linoleic acid content was significantly associated with sweet taste (r=.999, p<.05). A significant correlation between phospholipid linoleic acid content and sweet aroma of fried (female) pork chops was reported [3]. In meat-like model system, however, oleic acid was reported to increase the desirable Maillard compounds, but high level of linoleic and linolenic acids reduced the compounds [5]. While marbling level was moderately correlated (r=.406, p>.05) to undesirable cardboard odor, the three FA contents tended (p>.05) to be more associated (r=.736 to r=.835) with this odor trait. This emphasizes the roles of FA composition in marbling in the development of lipid oxidized warm-off flavor. The n-3 polyunsaturated FAs are vulnerable to oxidation resulting in free radical oxidation initiation of more saturated acids and increase the level of n-6 and n-9 FA breakdown products [4].

Table 1 Influence of marbling level on oleic, linoleic, and linolenic acid contents and sensory traits of cooked pork LD.

parameter	low marbling (n=15)	medium marbling (n=15)	high marbling (n=15)	SEM	p-value
pH value	5.60	5.65	5.68	0.11	.09
crude fat (%)	2.55^{c}	4.03^{b}	6.11^{a}	0.13	**<.001**
unsaturated fatty acid (mg/100 g of cooked meat)					
oleic acid (C18:1n-9c)	$1,409.3^{c}$	$1,771.0^{b}$	$2,893.9^{a}$	53.64	**<.001**
linoleic acid (C18:2n-6c)	347.43^{b}	358.01^{b}	475.2^{a}	8.35	**<.001**
linolenic acid (C18:3n-3)	15.94^{b}	18.31^{b}	26.10^{a}	0.67	**<.001**
eating sensory traits					
brothy aroma	2.68^{a}	2.48^{b}	2.82^{a}	0.19	**.00**
card board aroma	2.40^{b}	2.22^{b}	2.59^{a}	0.18	**.00**
sweet taste	1.30^{b}	1.32^{b}	1.44^{a}	0.06	**.01**
umami taste	2.09^{b}	2.19^{ab}	2.32^{a}	0.11	**.01**

a b c Least square means within row with different superscript letters are different (p<.05).

SEM = standard error of means

Table 2 Pearson's correlation coefficients between marbling level, eating sensory attributes, oleic, linoleic, and linolenic acid contents.[a]

variables	marbling	brothy aroma	card board aroma	sweet	umami	oleic acid	linoleic acid	linolenic acid
marbling	**1**							
brothy aroma	0.296	**1**						
card board aroma	0.406	0.993	**1**					
sweet	0.863	0.738	0.812	**1**				
umami	0.981	0.477	0.576	0.945	**1**			
oleic acid	0.917	0.652	0.736	0.993	0.977	**1**		
linoleic acid	0.842	0.765	0.835	**0.999**	0.931	0.987	**1**	
linolenic acid	0.913	0.660	0.743	0.994	0.975	**1.000**	0.989	**1**

[a] Values in bold are different from 0 with a significance level alpha=.05.

IV. CONCLUSION

Further investigation comparing the roles of other aroma flavor precursors and FA composition on the observed desirable sensory descriptors in high marbling pork is of interest. Marbling level weakly to moderately associates with desirable brothy and undesirable cardboard aromas, but oleic, linoleic, and linolenic acid contents are highly associated. Careful cooking and handlings to prevent further development of undesirable oxidized flavors in high marbling pork containing high oleic, linoleic, and linolenic acid contents are suggested.

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