

Pork quality is correlated with muscle fatty acid composition and plasma metabolites



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Introduction

- Improvement of pork quality traits is often involved many biochemical and physiological mechanisms.
- Therefore evaluation and prediction of ultimate pork quality must have a comprehensive investigation of many biochemical, sensory, and physiological parameters in one population (Huff-Lonergan et al., 2002).
- Meat fatty acid composition is of particular interest because of its implication for meat quality such as marbling and human health (Wood et al., 2003).
- Variation in the blood (plasma) metabolites might influence variation in the meat quality.
- The **objective of this study** is to investigate the relationship between fatty acid composition in meat and pork quality measurements. In addition we measured variation in blood metabolites at the time of slaughter and their relationship with pork quality.

Materials and Methods

➤ Subjects



Korean Native Pig (KNP) x
♀ (n=16)

X



Yorkshire.....F0
♂ (n=8)

KY x KY: F1 (n=81)
KKYY: F2 (n=350)

This study was used with 350 pigs (F2) Produced from KNP and Yorkshire breeds.

Table 1. Composition of fatty acids in adipose tissue from KNP and Y breeds

Fatty acid	KNP					Y			p-value
	#1	#2	#3	#4	#5	#6	#7	#8	
Capric acid (C10:0)	0.60	0.14	0.00	0.61	0.00	0.00	0.40	0.00	0.2573
Lauric acid (C12:0)	0.90	0.87	1.01	0.70	0.63	0.72	0.83	0.73	0.1189
Myristic acid (C14:0)	9.5	10.2	9.3	9.6	8.0	9.3	11.6	8.8	0.7856
Myristoleic acid (C14:1)	0.39	0.45	0.00	0.00	0.00	0.00	0.34	0.48	0.9778
Pentadecenoic acid (C15:1)	0.59	0.44	0.00	0.64	0.44	0.66	0.74	1.12	0.1634
Palmitic acid (C16:0)	152	1544	116	147	125	153	193	142	0.5563
Palmitoleic acid (C16:1)	15.1	17.4	13.7	14.8	10.0	13.2	15.7	16.0	0.3846
Margaric acid (C17:0)	2.7	1.9	2.0	2.8	2.3	3.6	3.7	4.9	0.0921
Heptadecenoic acid (C17:1)	2.4	1.8	2.4	2.8	2.1	3.0	3.0	4.3	0.1934
Stearic acid (C18:0)	79	73	58	72	71	96	107	59	0.3524
Oleic acid (cis 9-C18:1)	254	245	184	293	213	286	322	272	0.3983
Vaccenic acid (trans11-C18:1)	1.9	1.8	17.5	2.4	1.4	2.0	3.1	2.0	0.4062
Linolelaidic acid (tC18:2)	0.42	0.77	0.00	0.47	0.76	0.85	0.79	0.9	0.0788
Linoleic acid (C18:2n6)	83	82	68	75	62	97	101	107	0.2576
Alpha-linolenic acid (C18:3n3)	0.55	1.03	0.00	1.44	0.98	1.45	1.34	1.46	0.1725
Gamma-linolenic acid (C18:3n6)	6.2	5.6	13.1	5.6	5.3	7.1	6.6	7.6	0.6464
Eicosanoic acid (C20:0)	1.1	0.8	5.6	1.9	6.2	0.8	1.8	0.6	0.9856
Eicosenoic acid (C20:1)	0.85	1.17	1.08	0.78	0.00	1.45	0.53	0.75	0.4179
Eicosadienoic acid (C20:2)	8.0	6.6	0.0	11.4	0.0	8.1	9.2	7.1	0.9067
cis-11,14,17-Eicosatrienoic acid (C20:3n3)	1.26	1.03	1.05	0.98	3.67	2.96	1.80	2.35	0.0262
cis-8,11,14-Eicosatrienoic acid (C20:3n6)	3.7	3.1	16.8	4.2	2.4	4.0	4.8	4.0	0.4119
Arachidonic acid (C20:4)	1.45	1.60	0.94	1.30	0.76	0.80	0.77	0.89	0.0325
Heneicosanoic acid (C21:0)	0.85	0.46	2.36	0.68	0.56	0.73	0.38	0.37	0.2747
Behenic acid (C22:0)	0.53	0.45	2.98	0.73	0.00	0.57	0.91	0.50	0.3520
Tricosanoic acid (C23:0)	3.02	3.67	0.94	3.09	4.34	2.43	0.31	1.67	0.6518
Lignoceric acid (C24:0)	0.26	0.34	3.08	0.45	1.40	1.04	1.71	0.97	0.7463
Nervonic acid (C24:1)	0.73	0.68	1.60	0.26	0.00	0.00	0.76	0.68	0.2430
Total	632	617	523	655	522	697	795	648	0.4037

➤ Traits

- Measured after 24 h of slaughter
 - Proximal analyses: Moisture, fat, protein & ash
 - Muscle pH: Mettler Delta 340, Mettler-Toledo, Ltd., UK
 - Water holding capacity (WHC): centrifuging method
 - Drip loss: 2.5 cm thick *longissimus* chop was wrapped and placed in a cooler for 24 h
 - Cooking loss: weights of uncooked and cooked chop (2.5cm thick) were recorded and expressed as a percentage

➤ Standard for color evaluation

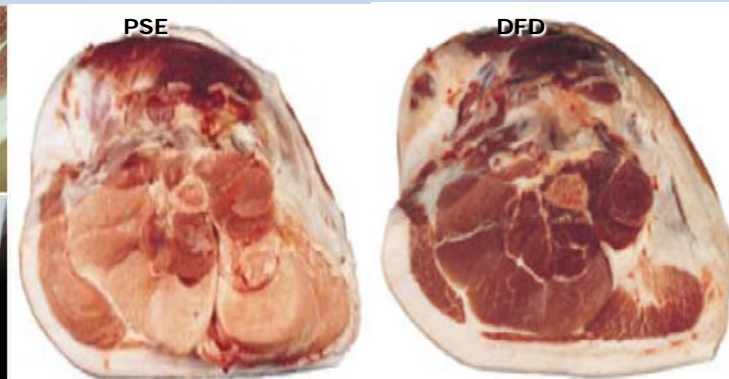
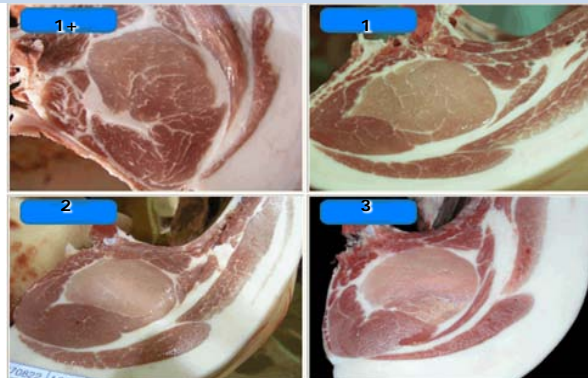
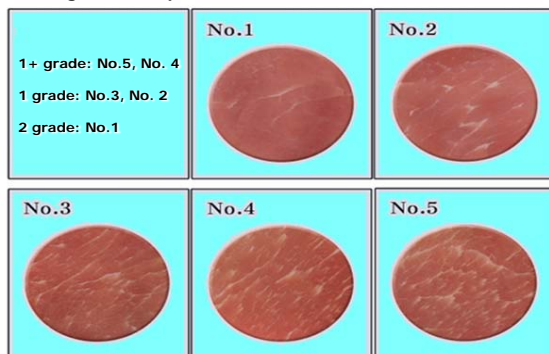


- Shear force: Sun rheometer (Compac-100, Sun Scientific Co. Ltd., Japan).
- Hunter color: Spectro colorimeter (Model JX-777, Color Techno. System Co., Japan)
- Subjective evaluation: marbling, color, texture & overall acceptability
- Sensory panel test: Tenderness, juiciness, flavor & overall acceptability
- Fatty acid composition: GC using a fused silica capillary column (100m×0.25 mm, i.d.×0.20μm, thickness, Supelco, SPTM-2560,USA).

■ Measured upon slaughtered

- Blood compositions: Total-cholesterol, Total lipid, Ester-cholesterol, Glucose, Total-protein, TG, Insulin

●Marbling scores in pork



Results

Table 2. Means and standard deviation of traits measured in pork from Korean native pig x Yorkshire cross F2

	KNP x Yorkshire cross F2 (n=350)				
	Mean	SD		Mean	SD
Chemical composition (%)			Fatty acid composition (%)		
Moisture	73.96	1.71	C16:0	21.10	2.61
Protein	22.18	1.59	C16:1	3.90	1.66
Fat	2.49	1.45	C18:1	31.95	5.41
Ash	1.05	0.13	C18:2	15.35	3.97
Meat quality characteristics			C20:4	0.22	0.28
Water holding capacity (%)	58.03	6.34	Blood composition		
24-h pH	5.63	0.25	Total-cholesterol (mg/dl)	93.47	12.78
Drip loss (%)	5.11	1.81	Total lipid (mg/dl)	312.51	151.49
Cooking loss (%)	32.26	3.53	Ester-cholesterol (mg/dl)	79.51	12.26
Shear force (kg)	1.73	0.43	Glucose (mg/dl)	145.79	52.43
Lightness (Hunter L*)	52.69	5.50	Total-protein (g/dl)	7.66	0.87
Redness (Hunter a*)	5.72	2.03	TG (mg/dl)	27.24	5.59
Yellowness (Hunter b*)	7.43	1.80	Insulin (mg/dl)	7.21	6.10
Cholesterol (mg/100g)	142.02	84.38	Sensory panel test**		
Subjective evaluation*			Tenderness	3.06	0.30
Marbling	2.39	1.01	Juiciness	3.06	1.34
Color	3.06	0.49	Flavor	2.99	0.39
Texture	2.86	0.42	Overall acceptability	3.00	0.46
Total acceptability	2.91	0.30			

*Marbling, 1: extremely low in intramuscular fat, 5: very abundant in intramuscular fat

Texture, 1: extremely bad in texture, 5: very good in texture

Meat color, 1: very pale, 5: very dark

Total acceptability, 1: extremely undesirable, 5: extremely desirable

**1: very tough, very dry, very mild, very unacceptable

5: very tender, very juicy, very intense, very acceptable

Table 3. Correlation between subject evaluation, drip loss, cooking loss and sensory characteristics of porcine *longissimus* muscle

Items	pH	Color	Texture	Marbling	Drip loss	Cooking loss	Tenderness	Juiciness
Color	0.08 (0.15)							
Texture	0.18 (0.001)	0.23 (0.001)						
Marbling	-0.01 (0.81)	0.14 (0.01)	-0.03 (0.54)					
Drip loss	-0.45 (0.001)	-0.26 (0.001)	-0.26 (0.001)	0.12 (0.03)				
Cook loss	0.06 (0.23)	0.17 (0.01)	0.09 (0.07)	-0.04 (0.35)	0.13 (0.01)			
Tenderness	0.01 (0.85)	0.16 (0.01)	-0.06 (0.21)	-0.37 (0.001)	0.04 (0.41)	-0.10 (0.06)		
Juiciness	0.04 (0.50)	0.06 (0.27)	0.03 (0.61)	-0.01 (0.82)	-0.06 (0.24)	0.03 (0.57)	0.25 (0.001)	
Flavor	-0.01 (0.99)	0.23 (0.001)	-0.06 (0.24)	0.21 (0.001)	-0.01 (0.74)	-0.06 (0.24)	0.51 (0.001)	0.15 (0.01)

Upper row = phenotypic correlations, bold values indicate significant correlations.
P-values for difference from zero in parentheses.

Table 4. Correlation between pork quality, biochemical and optical measurements

Items	Color	Texture	Marbling	Drip loss	Cooking Loss	Tenderness	Juiciness	Flavor	pH
Moisture	-0.12 (0.05)	-0.09 (0.06)	-0.63 (0.001)	-0.03 (0.53)	0.33 (0.001)	-0.43 (0.001)	-0.08 (0.13)	-0.30 (0.001)	0.11 (0.05)
Protein	-0.05 (0.31)	0.09 (0.07)	0.16 (0.01)	0.01 (0.95)	-0.30 (0.001)	0.22 (0.001)	0.01 (0.939)	0.24 (0.001)	-0.07 (0.88)
Fat	0.14 (0.01)	-0.01 (0.96)	0.62 (0.001)	0.09 (0.08)	-0.07 (0.15)	0.37 (0.001)	0.11 (0.05)	0.19 (0.004)	-0.00 (0.40)
Ash	-0.24 (0.001)	-0.10 (0.05)	-0.01 (0.21)	0.07 (0.16)	-0.10 (0.06)	-0.15 (0.01)	0.03 (0.52)	0.20 (0.001)	-0.07 (0.59)
Hunter L*	-0.50 (0.001)	-0.29 (0.001)	0.22 (0.001)	0.30 (0.001)	-0.17 (0.01)	0.10 (0.05)	-0.02 (0.68)	0.01 (0.97)	-0.01 (0.12)
Hunter a*	0.27 (0.001)	-0.27 (0.001)	0.53 (0.001)	0.21 (0.001)	-0.20 (0.01)	0.39 (0.001)	0.01 (0.85)	0.20 (0.001)	-0.17 (0.01)
Hunter b*	-0.22 (0.001)	-0.30 (0.001)	0.47 (0.001)	0.33 (0.001)	-0.25 (0.001)	0.31 (0.001)	-0.01 (0.80)	0.11 (0.05)	-0.16 (0.01)

Upper row = phenotypic correlations, bold values indicate significant correlations.
P-values for difference from zero in parentheses.

Table 5. Correlation between fatty acid composition and pork quality characteristics

Items	WHC	Color	Texture	Marbling	Drip loss	Cooking loss	Tenderness	Juiciness	Flavor	pH
16:0	0.10	-0.07	0.10	0.07	0.03	0.04	-0.01	0.09	-0.02	0.00
	(0.14)	(0.28)	(0.14)	(0.32)	(0.66)	(0.53)	(0.86)	(0.17)	(0.81)	(0.97)
16:1	0.08	-0.01	-0.03	-0.02	-0.06	-0.02	0.04	-0.05	-0.01	0.12
	(0.24)	(0.83)	(0.64)	(0.74)	(0.36)	(0.76)	(0.51)	(0.48)	(0.84)	(0.06)
18:1	0.11	0.12	0.02	0.52	0.01	-0.10	0.41	0.15	0.29	0.14
	(0.09)	-0.06	(0.80)	(0.001)	(0.88)	(0.13)	(0.001)	(0.03)	(0.001)	(0.03)
18:2	-0.08	0.11	-0.07	-0.37	0.07	0.12	-0.42	-0.11	-0.35	-0.24
	(0.23)	(0.09)	(0.31)	(0.001)	-0.31	(0.07)	(0.001)	(0.09)	(0.001)	(0.001)
20:4	-0.11	0.09	0.03	-0.04	0.01	0.12	0.06	-0.03	0.02	-0.01
	(0.20)	(0.31)	(0.73)	(0.65)	(0.95)	(0.16)	(0.51)	(0.73)	(0.85)	(0.89)

Upper row = phenotypic correlations, bold values indicate significant correlations.
P-values for difference from zero in parentheses.

Table 6. Correlation between pork quality traits and plasma metabolites

Items	WHC	Color	Texture	Marbling	Drip loss	Cooking loss	Tenderness	Juiciness	Flavor	pH
Total lipid	-0.43	0.16	0.09	-0.15	-0.10	0.05	0.02	0.19	0.18	0.26
	(0.001)	(0.001)	(0.11)	(0.01)	(0.07)	(0.01)	(0.77)	(0.001)	(0.001)	(0.001)
Ester cholesterol	-0.25	0.06	0.08	0.00	-0.07	0.19	-0.11	0.04	-0.08	0.22
	(0.001)	(0.29)	(0.19)	(0.95)	(0.22)	(0.001)	(0.05)	(0.50)	(0.19)	(0.001)
Total cholesterol	0.01	-0.07	0.01	-0.05	0.02	-0.03	-0.04	0.01	0.04	0.13
	(0.89)	(0.24)	(0.83)	(0.37)	(0.76)	(0.62)	(0.49)	(0.80)	(0.53)	(0.05)
Glucose	0.03	-0.19	-0.20	-0.03	0.33	0.00	-0.01	-0.11	-0.08	-0.30
	(0.65)	(0.001)	(0.001)	(0.61)	(0.001)	(0.97)	(0.82)	(0.07)	(0.20)	(0.001)
Total protein	-0.30	0.06	0.11	0.08	-0.10	0.21	-0.05	0.01	0.01	0.30
	(0.00)	(0.32)	(0.07)	(0.18)	(0.08)	(0.001)	(0.41)	(0.88)	(0.80)	(0.001)

Upper row = phenotypic correlations, bold values indicate significant correlations.
P-values for difference from zero in parentheses.

Conclusion

- Pork quality measurements include many complex biochemical, physical and physiological parameters.
- Knowing the comprehensive relationships of these parameters is important to develop improvement strategies for pork quality.
- Our data suggest that fatty acid composition and plasma metabolites play important roles in the variation of pork quality.
- Furthermore molecular genetic analyses is underway to elucidate the underlying biological mechanisms for controlling pork quality traits.

Thank you!!