STUDIES ON EATING QUALITY OF MEAT FROM CHINESE LOPING, LANDRACE AND THEIR CROSS BREED PIGS

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INTRODUCTION

At the present time, the majority of the commercial animal pigs in china are produced by the crossing of local breeds as sows with foreign breeds as boars.This type of pig production has improved carcass traits,growth speed and feed availability of local breeds, but brought certain problem in meat quality at the meantime.Out of the practical demand,chinese meat scientists have made extensive reseacches in meat quality traits of different breed pigs,and in heretidy rules of those traits in next generation.On the hand,it was proved that meat quality of local breed pigs are superior to that of foreign breeds, through the analyses of PH,marbling, colour, tenderness, water-holding capacity, intramuscular fat and dry matter. On the other hand, several crossing groups which could create meat-nice muscular commercial pigs were selected,and certain indexes which could predict meat quality in early stage were affirmed.Until the last five years,meat scientists in china have begun further to explore flavor biochemical bases of different breed pigs. LIU YUEFU(1986), LAN YUHUI(1989), LIU JIAZHONG(1989) et al compared fatty acid composition and water-soluble flavor precursors in local breed pig's meat with foreign breed pig's. However, what these studies got could not still perfectly explain the characteristics of "nice-odour, delicious-taste" meat of local breeds. Based on the previous researches,this study: (1)analysing both water-soluble and lipid-soluble flavor precursors; (2)combined with chinese traditional cooking, modern processing course and sensory evaluation;(3)selecting typical chinese breed--Loping,foreign breed--Landrace and their cross breed pigs, expected to explore the biochemical bases of"nice-odour, delicious-taste" characteristics of local breeds. Said concretly, there were following aims:

(1)Studying the exist features of free amino acids(FAA), reduced sugars and intramuscular fat in meat of those three breed pigs.(2)Studying the different changes of above biochemical constituents of different breed pig's meat in cooking and processing. (3)Summarily evaluating the flavor, nutrition and hygien character of meat from different breed pigs, in accordance with analysing results, cooking and processing losses, and sensory properties.

MATERIALS AND METHODS

1.Experamental animals and meat samples: 18 weaners (6 pigs every breed)of Loping,Landrace and their cross breed were fed and managed in the same circumstance until when every Loping pig weighted 75± 2.5Kg,and when every Landrace and cross breed pig weighted 90±2.5 Kg. These three breed pigs had similar feeding time.

As soos as slaughter, whole 1.dorsi and bone-out steak(containing lean and adipose tissue) from 8th to 13th rib were taken from the left carcass of every pig.Then,the two types of meat were again divided into smaller samples for cooking,processing and analysing respectively.The steak located from 13th to 14th rib was set lean tissue apart from subcutaneous fat for measuring the proportion of these two tissue.

2.Cooking and processing methods:according to the heating ways of chinese tradional cookery and the course of modern process,the following three cooking and processing methods were worked out. Meat samples were stored in 2℃ cooler for 24 hours before cooking and processing.

(1)ZHAO(Heating in short time, with strong fire and with animal fat oil):250g meat samples,taken from 4th to 13th thoracic vertebrate,were cut along with muscle fibres into slices of 6mm thickness,four of which were marked and determined in length and weight. When the temperature of 100g fat oil reached 200℃, poured the slices into a pot heated with liquified gas oven, constantly turned over by a spade for 50 seconds.After cooled with air in porcelain plate, those marked four slices were determined in length and weight, and retained for analysing FAA, reduced sugar in ZHAO meat.

(2)SHAO(Heating in long time, with weak fire and with water): 250g rib steaks, naturally containing lean tissue and subcutaneous fat,were placed in a pot which had 400ml water. After water boiling with a 500W electronic stove, meat samples continued to be heated with a 1000W electronic stove,and turned over one time in the midway of heating course.Weighted the lean tissue of the cooled steak,and took 100g Of it for analysing fatty acid composition, water and intramuscular fat content in SHAO meat.

(3)Ham processing: 250g 1.dorsi located from 4th to 13th thoracic vertebrate, after removed visible fat and connective

tissue, were processed with a comman method of ham process(containing the double effects of heating and curing). 100g of ham meat was taken for analysing moisture, reduced sugar, FAA, intramuscular fat and fatty acid composition in ham meat.

3.Determinating methods:

(1)comman meat quality indexes:1.dorsi color, water-holding capacity, marbling, preservation losses were determined in accordance with ((The Modified Methods of Pig Meat Quality Evaluation in China)). Shear force value were obtained on three cores (0.8cm in diameter)from each 1.dorsi using a Shear Force Mearurer made by East-Northern Agricultural colleage.

(2).Moisture and intramuscular fat content:determined with the common way of drying at 105℃ oven and extraction with ethyl ether respectively.

(3).Fatty acid composition:5g samples(respectively from 1.dorsi, rib steak, SHAO meat and ham) were stored at -30℃ cooler until treated, analysed at one time. Ground samples, dried with no air heating oven in high speed,were extracted by benzene petrolem ether(1:1) 2ml for 1.5hr., and then methylated by 0.4N KOH-methanol for 10 minutes.The methylated fatty acids were seperated by GC-9A Gas-Liquid Chromatograph.

(4)Reduced sugar content: 1g samples(respectively from stored 1.dorsi,ZHAO meat and ham) were mixedwith 8ml distilled wter, 1ml 2/3N H_2SO_4 and 1ml Na_2Wo_3, then ground and centrifuged. 1ml supernatant liquid was taken for reduced sugar analysis of OTB colorimetric method introduced by ((biochemical experiment)) edited by Lanjing university.

(5)FAA content: 5g samples(respectively from stored 1.dorsi, ZHAO meat and ham)were stored in -30℃ cooler. The methods of treating samples and analysing FAA was in "Direction of 835-50 Amino Acid Auto-Analyser".

(6)Sensory evaluation:A eight-member panel, who having been gone in for meat science for many years or are rich in cooking technology, evaluated ZHAO meats from 2 pigs every breed for tenderness, flavor, juiciness, colour and overall palatability using three-point structured scales(-1,0,+1).

ANALYSING RESULTS

1.FAA contents in stored 1.dorsi,ZHAO meat and ham from Loping,Landrace and their cross breed pigs were given in table 1. The losses of total FAA contents(based on fresh weights) were given in table 2.

Table 1: FAA contents (mg/100g)

FAA	Loping meat			Crossbreed meat			Landrace meat		
	raw	ZHAO	ham	raw	ZHAO	Ham	raw	ZHAO	ham
ASP	ND	0.082	0.087	0.102	0.11	0.12	0.11	0.112	0.13
THR	16.84	14.23	13.13	17.10	15.07	14.58	16.94	15.62	15.39
SER	3.67	4.31	4.27	3.65	4.54	4.27	2.75	4.49	4.54
GLU	5.41	5.23	4.17	4.38	5.58	4.02	4.24	6.52	4.03
GLY	5.79	6.64	6.67	6.03	7.15	7.06	5.90	7.17	7.08
ALA	15.58	11.13	10.29	15.29	12.16	10.24	14.37	13.55	11.52
CYS	0.82	0.73	0.62	0.62	0.74	0.73	0.66	0.79	0.74
VAL	4.28	3.09	3.00	3.93	3.47	3.28	2.39	3.46	3.51
MET	0.14	ND	ND	1.11	1.04	0.61	2.02	1.02	1.02
ILE	2.96	1.84	1.51	2.25	1.96	1.54	1.83	1.93	1.97
LEU	2.97	2.02	1.61	2.48	2.54	1.80	2.65	2.86	2.18
TYR	1.14	0.97	0.80	1.11	1.11	1.12	1.09	1.2	1.27
PHE	4.94	5.11	5.15	4.54	5.09	5.23	4.65	5.24	5.05
LYS	6.16	6.42	6.27	6.22	6.15	6.06	6.49	6.16	6.13
HIS	1.00	1.81	1.63	0.98	1.34	1.15	0.70	1.30	1.07
ARG	2.11	2.31	2.03	1.80	1.93	2.10	1.50	1.81	2.05
PRO	2.82	1.77	0.96	2.87	1.84	1.81	1.95	1.84	1.97
TOTAL	76.63^{c}	67.69^{x}	62.2^{c}	74.46^{b}	71.84^{y}	65.72^{r}	70.24^{a}	73.8^{y}	69.65^{q}

Table 2: The losses of total FAA contents(%)

breed	treatment	the losses percent
Loping	ZHAO cooking	29.65^{c}
	ham processing	40.04^{z}
cross	ZHAO cooking	26.49^{b}
breed	ham processing	35.66^{y}
Landrace	ZHAO cooking	19.18^{a}
	ham processing	29.45^{x}

2.The contents and cooking ,processing losses of reduced sugar in stored 1.dorsi, ZHAO meat and ham from pigs were given in table 3.

Table 3: reduced sugar contents and cooking, processing losses(mg/g,%)

breed	raw meat	ZHAO meat	ham meat	ZHAO losses	processing losses
Loping	0.98^{a}	1.02^{a}	0.95^{a}	18.29^{a}	23.59^{a}
cross	1.27^{b}	1.30^{b}	1.11^{b}	18.77^{a}	35.66^{b}
Landrace	1.30^{b}	1.34^{b}	1.16^{b}	20.72^{a}	36.45^{b}

3. Intramuscular fat contents and properties:

(1) Intramuscular fat contents in raw, SHAO and ham meat of different breeds and retentions during cooking and processing (given in table 4).

Table 4: intramuscular fat contents and retentions (RT) (%)

breed	1.dorsi rib Steak	SHAO meat	ham meat	SHAO processing RT	RT
Loping	7.17^{c}	8.43^{c}	26.51^{a}	8.89^{c}	249.26^{a} 92.38^{a}
cross	4.78^{b}	5.33^{b}	25.99^{a}	6.41^{b}	366.98^{b} 97.91^{a}
Landrace	2.47^{a}	4.32^{a}	24.81^{a}	3.75^{a}	412.46^{c} 107.99^{b}

In the course of ham processing, intramuscular fat in meat from Loping, Landrace and their cross breed pigs lossed rarely under the surrounding of muscular and connective tissue, but tended to had some losses as intramuscular fat increased from 2.47% to 7.17%.

SHAO meat in this study was cooked with subcutaneous fat on, and through a long time's boiling. This process could be the main reason which caused intramuscular fat retention of SHAO lean tissue reaching 200%. (1) Subcutaneous fat liquified during heating, and migrated into adjacent lean; (2) Liquified fat sticked on the surface of lean tissue or was absorbed by the lean tissue through water, so intramuscular fat contents in SHAO meat became great higher more than in raw meat of those three breed pigs.

(2) Intramuscular fat composition and their changes during cooking and processing (given in table 5).

Table 5: Fatty acid compositions of raw, SHAO and ham meat (%)

fatty acids	C10:0	C12:0	C14:0	C16:0	C18:0	C18:1	C18:2	C20:2	S/U
Loping 1.dorsi	0.054	0.069	1.78	31.42	9.38	47.08	8.82	1.37	0.75^{b}
cross 1.dorsi	NO	NO	1.47	29.89	7.53	51.72	8.14	1.24	0.94^{a}
Landrace 1.dorsi	NO	NO	1.47	30.23	6.95	52.09	8.00	1.15	0.63^{c}
Loping ribs	0.067	0.08	1.75	30.24	8.75	48.60	9.01	1.48	0.69^{c}
cross ribs	0.029	0.05	1.46	29.11	8.62	50.26	9.05	1.37	0.65^{b}
Landrace ribs	NO	NO	1.38	28.91	6.79	51.87	9.77	0.96	0.59^{a}
LP.SHAO lean meat	0.06	0.076	1.73	30.01	8.77	47.48	10.48	1.29	0.69^{c}
CR.SHAO lean meat	NO	0.034	1.45	28.92	8.54	49.69	10.18	1.16	0.64^{a}
LD.SHAO lean meat	NO	0.025	1.49	30.05	7.73	48.26	10.94	1.35	0.68^{c}
Loping ham meat	NO	0.075	1.87	31.59	9.43	47.13	8.79	1.29	0.75^{b}
cross ham meat	No	NO	1.43	31.34	7.26	51.40	7.62	0.99	0.66^{a}
Landrace ham meat	NO	No	1.33	30.90	6.50	51.11	9.21	0.97	0.63^{a}

It is dicovered from table 5 that the saturation degree (S/U) of fatty acids did not basically change during cooking and processing. Even if lean tissue had had some intramuscular fat lossed, the loss opportunities of every fatty acid was nearly equal. Only in SHAO cooking, C18:1 proportion had certain changes. Maybe, it was concerned with the phenomenon that subcutaneous fat migrated lean tissue, for only C18:1 proportion to all fatty acids in adipose tissue was significantly lower than in lean tissue.

4. The losses of cooking and processing, and the shrinkage of heating muscle fibres were given in table 6.

Table 6: (%)

breed	ZHAO losses	SHAO losses	processing losses	muscle fibre shrinkage
Loping	20.44^{a}	20.19^{a}	25.58^{a}	18.46^{a}
cross	23.78^{b}	24.74^{b}	27.18^{b}	21.43^{b}
Landrace	23.15^{b}	28.13^{c}	28.83^{bc}	20.54^{b}

5. Common meat quality indexes and moisture contents of different breed pigs (given in table 7).

Table 7: (%, scores)

breed	pressured losses	shear force value	colour	marbling	preservated losses	moisture raw	moisture SHAO ham
Loping	10.31^{a}	2.59^{b}	3.5^{b}	4.0^{b}	4.86^{a}	68.66^{a}	47.14 58.13
cross	11.88^{b}	2.42^{a}	3.33^{b}	3.92^{b}	6.08^{b}	71.6^{b}	47.74 58.44
Landrace	13.11^{b}	2.55^{a}	2.55^{a}	2.42^{a}	6.13^{bc}	74.43^{c}	48.35 58.42

6. Sensory evaluation: Eight-member panel made sensory evaluation for 2 pigs' ZHAO meat every breed. Their total scores were given in table 8.

7.The correlation of intramuscular fat with other meat quality traits (given table 9).

Table 8:sensory scores

breed	color	flavor	juiciness	tenderness	overall palatability
Loping	8	10	10	10	8
cross	8	8	8	8	8
Landrace	4	1	5	3	3

DISCUSSIONS

1. Relationship of intramuscular fat to meat eating quality:

Intramuscular fat content of local Loping pig's meat was 4.7% higher than Landrace's, and 2.37% higher than cross breed's(table 4).The necessary amount of intramuscular fat could enhance the palatability traits of meat products(C.A.Reitmier, 1987). Combined with sensory evaluation, this study also found that Loping and cross breed pig's meat products containing the two higher levels of intramuscular fat received higher scores for tenderness,juiciness, flovor and overall palatability (table 8). With the increase of intramuscular fat content among those three breed pigs, water-holding capacity of raw meat increased, cooking and processing losses decreased, and the heating shrinkage of muscle fibres decreased(table 9). The content of intramuscular fat had no significant effect on shear force value of raw meat(table 9).

What role intramuscular fat plays in the producing of odour compounds in cooking is of particular interest to meat scitenests.Wasserman(1972)suggested that carbonyl compounds arise principally from lipids and the former may produce many aromatic compounds through the Maillard Reaction with FAA. Pippen(1968) reported that lipids as a solvent stored flavor compounds in cooking , and released the latter when cooking gas pressure reach certain level. These basic researches could be used for explaining thecontribution of high intramuscular fat to the "nice-odour,delicious-taste"characteristics of local breed pigs.

As the increase of lean tissue perception in carcass, intramuscular fat level and its composition in meat has greatly changed also. According to this study, intramuscular fat level was significantly correlated with the saturation degree of fatty acids(+) and oleic acid(-), but not significantly with linoleic, eicosadienoic and palmitic acid(table 9).Fatty acid composition did not basically change during cooking and processing(given in table 5). Concerned studies indicated that the fat containing higher proportion of unsaturated fatty acids is easy to acdify and drip oil during preservation, so Loping pig's fat quality should be better than other two breed's.

2. The changes of FAA content during cooking and processing, and relationship to meat flovor:

According to this study, Local Loping pigs had more FAA in raw meat, but less in cooked and processed meat than both landrace and cross breed pigs.Total FAA contents were 76.63,74.46,70.24 in raw meat; 53.90, 54.73,56.75 in cooked meat(based on fresh weight);46.04,47.87,49.53mg/100g in ham (based on fresh weight)for Loping,cross breed and Landrace pig respectively. The levels of totalFAA and most individual FAA were dereased by heating and processing.Those individual FAA which contents were higher in raw meat,such as alanine, glycine and histidine, had greater losses also during heating and processing(table 1). Compared with shorter time's heating, processingcaused FAA greater losses.

Which factor led to the differences of cooking and processing losses of FAA among Loping,Landrace and cross breed pigs? Refered to concerned basic research, writer thinks it is possible that suitable micro-circumstances in muscle tissue(fat content and distribution,PH and fibre size)strengthen FAA degradation or interaction with other biochemical constituents.

Table 9: the correlated coefficients of intramuscular fat with other meat quality traits

quality indexes	coefficient	quality indexes	coefficients
moisture content	-0.9456**	preservating loss	-0.6533**
reduced sugar cont.	-0.8466**	proceesing loss	-0.7775**
FAA content	0.9507**	ZHAO loss	-0.7266**
S/U	0.7743**	SHAO loss	-0.8786**
C10+C12+C14	0.7722**	heating shrinkage of muscle fibres	-0.6303**
C18:2+C20:2	0.3161	C16:0	0.3794
C18:0	0.7457**	C18:1	-0.7154**
shear force	0.2013	marbling	0.7927**
colour	0.2780	water-holding CAP.	-0.7900**
fat retention of SHAO	-0.8622**	fat retention of processing	-0.8487**
FAA loss of ZHAO	0.9241**	FAA loss of HAM	0.7927**

FAA are important precursors of flavor compounds of meats. During cooking, FAA react with sugars and possibly lipid oxidation products to produce heterocyclic compounds that contribute to the flavor and aroma profiles of cooked meat (Shibamoto.T.,1980). And also the formation of carbonyls and pyrazines during heating were related with NH2- or N of FAA. THerefore,FAA heating degradation or reaction with others play a important role in flavor, and maybe in the characteristic of "nice-odour, delicious-taste" meat of local Loping pig for its higher FAA level in raw meat and greater FAA losses during heating.

3.The change of reduced sugar during cooking and processing, and relationship to meat flavor:

The level of reduced sugar in muscle was easily effected by the change of physiology state and circumstance condition. Accordiny to this study, reduced sugar content in both raw and cooked meat of local Loping was lower than Landrace and cross breed pigs(0.98,1.30,1.27 in raw meat; 1.02,1.34,1.30mg/g in ZHAO meat; 0.95, 1.16,1.11mg/g in ham for Loping, Landrace and cross breed pig respectively). Cooking and processing caused reduced sugar loss, and its losses were proportional to initial level.

At the meantime, reduced sugars are important precursors which contribute to meat flavor through the Maillard reaction with FAA. However, there were no parallel relationship of the degradated extent of reduced sugar to FAA among those three breed pigs, which maybe indicated that:(1)the degradation of FAA and reduced sugar do not entirely depend on Maillard reaction;(2)there are other compounds to take part in the reaction;(3)FAA and its similar constituents are necessary precursors in the reaction.

CONCLUSIONS

1.The high content of intramuscular fat was important biochemical basis of "nice-odour, delicious-taste" meat characteristics of local breed pigs.And FAA, as a flavor precursor, may improves the meat flavor of local breed pigs.

2.The sensory scales of cross breed pig's meat were near to local Loping's, but the objective values of the former's meat were near to Landrace's or in the middle of two original purebreeds. So the crossing of local Loping with Landrace not only improves the carcass traits and growth speed, but also remains the superior sensory properties of local breed pigs to some extent.

3.In comparison with Landrace and cross breed pigs, Loping pigs had lower losses of cooking and processing, and higher content of fat and dry matter in meat, and higher scores of sensory properties. So the conclusion may be infered that the nutrition and flavor of Local Loping's meat were better than other two breed pig's.Because the fat content and fatty acid saturation degree of Local Loping's meat were higher, however, its meat hygien seem to be worse than Landrace and cross breed according to recent concerned reports.

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