

LIPOLYSIS AND LIPIDS OXIDATION OF JINHUA HAM DURING TRADITIONAL PROCESSING

J. H. Zhang^{1,2}, G. H. Zhou^{*1,2}, Z. Y. Zhen^{1,2}, Y. Liu^{1,2}, T. Zeng^{1,2}

1. Key Lab of Meat Processing and Quality Control, Ministry of Education; 2. Key Lab of Food Processing and Quality Control, Ministry of Agriculture, Nanjing Agricultural University, Nanjing, 210095, China

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Introduction

Lipolysis and lipids oxidation in dry-cured ham are affected by processing conditions such as temperature, humidity, salt content and processing time (Vestergaard, *et al.*, 2000). Lipolysis products, free fatty acids (FFAs), are precursors for the formation of flavor compounds and have decisive effects on forming flavor compounds of dry-cured ham (Timón, *et al.*, 2001). Adipose tissue, especially subcutaneous fat, is an important component of dry-cured ham and its color and texture could largely influence consumers' acceptability. Lipolysis and lipids oxidation could affect the sensory traits, especially the color and taste of dry-cured ham.

Jinhua ham is the most famous Chinese traditional dry-cured ham. It is largely different from the Mediterranean dry-cured ham because of its special process conditions. However, there are limited studies about the lipolysis and lipids oxidation of Jinhua ham currently. The objective of this paper was to study lipolysis and lipids oxidation in subcutaneous and intramuscular fats and its correlations with temperature, humidity and salt content during traditional process.

Materials and Methods

The central fractions of the *biceps femoris* muscle and its subcutaneous adipose tissue from Jinhua hams at six processing points (raw, end of salting, end of sun-drying, middle of moderate temperature fermenting, middle high-temperature ageing and end of ageing) were taken as samples for lipids analysis. The Jinhua hams for experimentation were produced by Jinhua Lanxi Yongxing ham factory. All hams were from commercial available Taihu×Duroc×York crossbreed pigs, slaughtered at 90-110 kg. Jinhua hams were manufactured by the traditional process: dry-curing for 35 days at 3-12 °C consisting of five salting, sun-drying for 13 days at 6-12.5 °C, low-temperature dehydrate for 20 days at 10-15 °C, moderate temperature fermenting for 100 days at 15-30 °C, and high-temperature ageing for 40 days at 30-37°C.

Lipids were extracted according to the method of Folch, *et al.* (1957). FFAs were separated using the procedure described by García-Regueiro, *et al.* (1994). The methyl esters of FFAs were obtained by heating for 30 min at 60 °C and cooling for 30 min at 18 °C with 10% BF₃ in methanol (w/w). Heptadecanoic acid methyl ester (100 µg/ml) was used as internal standard, FFAs were analyzed by gas chromatograph and quantified by standard curves equation built with standards of each fatty acid. The lipid oxidation was determined using the method described by Klein (1970). The ratios of A₂₃₂/A₂₁₅ and A₂₇₅/A₂₁₅ were defined as diene and carbonyl values respectively. TBARS value was determined using the method described by Salih, *et al.* (1987).

Results and Discussion

Subcutaneous fat and intramuscular fat showed different tendency of the total FFAs (Σ FFA) change during traditional process ($p < 0.01$). Σ FFA in subcutaneous fat significantly increased with temperature ($p < 0.01$), but it decreased at earlier stages in intramuscular fat, then increased and reached the peak at the middle of fermenting. The increase of temperature caused the decrease of moisture content and the increase of NaCl content in ham ($p < 0.05$). High-temperature ageing resulted in high lipase activity, but its activity could be inhibited by high content of NaCl (Coutron-Gambotti, *et al.*, 1999). Σ FFA slightly decreased in intramuscular fat and

significantly increased in subcutaneous fat ($p<0.01$) in fermenting-ageing process because of the difference of substrate concentration.

Table 1 Lipolysis, lipid oxidation and The changes in NaCl contents, temperature during Jinhua ham process

Measured item	Manage group average*	Process points of Jinhua ham**						
		Raw	End of salting	End of sun-drying	Middle of fermenting	Middle of ageing	End of ageing	
ΣFFA (ug/mg)	BF ¹	63.11 ^a	74.17±8.65 ^{bc}	40.97±3.27 ^d	27.45±1.29 ^e	79.48±3.82 ^b	78.30±7.83 ^b	78.25±7.59 ^b
	SC ²	39.10 ^b	5.68±0.45 ^g	7.99±0.65 ^g	18.17±0.68 ^f	30.09±2.26 ^e	69.36±5.07 ^c	103.3±5.86 ^a
TBARS	BF	0.25 ^b	0.07±0.02 ^g	0.34±0.07 ^{cde}	0.39±0.06 ^{bcd}	0.31±0.06 ^{de}	0.17±0.06 ^{fg}	0.23±0.07 ^{ef}
	SC	0.46 ^a	0.08±0.01 ^g	0.33±0.13 ^{de}	0.45±0.09 ^{bc}	0.48±0.08 ^b	0.67±0.09 ^a	0.76±0.13 ^a
Diene value	BF	0.42 ^b	0.32±0.04 ^{gh}	0.28±0.02 ^h	0.43±0.06 ^{fg}	0.44±0.05 ^f	0.51±0.04 ^{def}	0.51±0.05 ^{def}
	SC	0.73 ^a	0.46±0.04 ^{ef}	0.62±0.08 ^{cd}	0.67±0.12 ^c	1.15±0.19 ^a	0.89±0.11 ^b	0.58±0.10 ^{cde}
Carbonyl value	BF	0.11 ^a	0.08±0.01 ^c	0.09±0.01 ^c	0.10±0.01 ^c	0.10±0.01 ^c	0.12±0.01 ^b	0.14±0.03 ^a
	SC	0.04 ^b	0.02±0.00 ^g	0.03±0.00 ^{fg}	0.04±0.01 ^{bc}	0.06±0.01 ^d	0.05±0.01 ^e	0.04±0.01 ^{ef}
NaCl (%muscle)			0.16±0.04 ^d	3.38±0.58 ^c	3.55±0.51 ^c	5.651±0.52 ^b	5.85±0.54 ^b	8.02±0.63 ^a
H ₂ O (%muscle)			71.88±3.80 ^a	66.47±3.31 ^b	62.89±2.79 ^{bc}	62.77±2.16 ^{bc}	61.02±2.48 ^c	52.46±2.49 ^d
Temperature ³ (□)			7.5	8.3	8.6	22.1	34.3	34.9

Means with different letters in per measured item presented significant difference. Significance levels between the average of manage groups per measured item: * $p<0.01$; Significance levels among six process points per measured item: ** $p<0.05$.

1. Lipids in biceps femoris muscle; 2. Lipids in subcutaneous fat; 3. Average temperature of ten day before process points .

Polyunsaturated fatty acids C18:2 significantly decreased and monounsaturated fatty C16:1 and C18:1 significantly increased ($p<0.01$) in intramuscular fat during high-temperature ripening, but these unsaturated fatty acids in subcutaneous fat all significantly increased ($p<0.01$). Saturated fatty acids C14:0, C16:0, C18:0 slightly increased in intramuscular fat and markedly increased ($p<0.01$) in subcutaneous fat. This difference between subcutaneous and intramuscular fat indicated that lipolysis and lipids oxidation were regulated not only by temperature and but also affected by substrate concentration.

TBARS in subcutaneous fat was positively correlated ($R^2=0.768$), but negatively correlated ($R^2=0.834$) in intramuscular fat with temperature during fermenting-ageing process. The diene and Carbonyl value markedly decreased ($p<0.05$) in subcutaneous fat and increased in intramuscular fat during fermenting-ageing process. These results suggested that long-time high temperature could accelerate FFAs oxidation and carbonyl compounds could be further oxidized to organic alcohol and carboxylic acid.

4. Conclusion

Lipolysis and lipids oxidation in subcutaneous fat are more intensive than in intramuscular fat during fermenting and ripening process of Jinhua ham. High-temperature ageing could accelerate the reaction of lipolysis and lipids oxidation, and further oxidize carbonyl compounds to carboxylic acid and other volatile flavor compounds. These reactions are regulated by temperature, substrate concentration and NaCl content.

References

1. Coutron-Gambotti, C., Gandemer, G., Rousset, S., Maestrini, O., & Casabianca, F. (1999). Reducing salt content of dry-cured ham: effect on lipid composition and sensory attributes. *Food Chemistry*, 64, 13–19.
2. Folch, J., Lees, M., & Stanley, G. H. S. (1957). A simple method for isolation and purification of total lipids from animal tissues. *J. Biology Chemistry*, 226, 487–509.
3. Klein, R. A. (1970). The detection of oxidation in liposome preparations. *Biochemistry Biophysics Acta*, 210, 486–489.
4. Salih, A. M., Smith, D. M., & Price, J. F. (1987). Modified extraction 2-thiobarbituric acid method for measuring lipid oxidation in poultry. *Poultry Science*, 66, 1483–1488.
5. Timón, M. L., Ventanas, J., Carrapiso, A. I., Jurado, A., & García C. (2001). Subcutaneous and intermuscular fat characterization of dry-cured Iberian hams. *Meat Science*, 58, 85–91.
6. Vestergaard, C. S., Schivazappa, C., & Virgili, R. (2000). Lipolysis in dry-cured ham maturation. *Meat Science*, 55, 1–5.