Effects of Application of papain on the Muscle protein of livestock and Poultry

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Abstract: Papain is a kind of enzyme degradating protein which was extracted from papaya latex. Muscle fibrin, connective collagen fibrin and elastin were strongly hydrolyzed and broken by the papain. Part of protein turned Soluble. The content of coarse protein in the enzymolytic solution were much higher than control. The best dosage for tendering slice meat block meat by meat tenderizer made from papain should be at the concentration 0.05-0.1%. 0.2-0.5% for 10-20 min.

Key words: papain, meat tenderizer

Tenderness is one of important meat quality index and basis for consumer choosing meat products. In the 1950's many scientists were interested in it and focused their attention on researches in change of temperature and humidity during meat store, mature period, ion level, electrical stimulation and variety selection. In the lately ten years plant tenderizer were used for meat tendering in commercial.

Papain was extracted from papaya (carica, papaya) emulsion. Muscle fibrin and Collagen fibrin could be strongly hydrolyzed and broken, degraded into amino acid in the most of condition.

This experiment is dealing with research on the effect of papain tenderness on muscle protein and on the methods for meat tendering.

Material and Method

1. Tenderizer

Meat tenderizer made by Beijing Agricultural University, 0.3% enzymolytic solution was made by pure papain with activity 6000 VSP-V/mg.

2. Materials

Beef and adult hen meat.

3. Method

(1) Ten grams of meat sample from each were dipped in 10ml 0.3% enzymolytic solution for 30 min (control dipped in distiled water). The content of coarse protein, dry materials of each sample, enzymolytic solution and water solution were analysed seperatelly.

(2) The content of proline in enzymolytic solution and water solution of meat sample was analysed with automatic analyzer of amino acid (modle 835)

(3) Some small pieces meat samples were dipped in 0.3% enzymolytic solution for 5, 15 and 30 min. The muscle fibre structure and its changes was observed with microscope after the meat was heated and cut into slices.

(4) Some meat tenderizer were made (tenderizer meat 0.05%, 0.6%, 0.2% and 0.5% w/w), and dipped for 10-20 min.

(5) Sensation evaluation of tenderness, texture and flavor after frying and cooking.

Results and discusstion

1. Shear force

Table 1 shear force of chicken meat and beef

Group	material	treatment of tendering		method	shear value
		ratio	time min		(%)
Treatment	chicken chest meat	0.05	10	mixed with powder	3221
Control	chicken chest meat	/	/	/	4297
Treatment 1	chicken chest meat	0.5	10	pointed with needle well mixed with powder	4945
Treatment 2	chicken chest meat	0.05	10	pointed with needle well mixed with powder	5556
Control	chicken chest meat	/	/	/	6072
Treatment	beef	0.5	10	mixed with powder	3252
Control	beef	/	/	mixed with powder	4999

The average shear value of 15 meat sample reduced about 500-1500g after treatment with tenderizer. However, the tenderness increased by 25% in chicken chest meat and by 35% in beef. There were significant differences (level 0.01) between treatment and control by t test.

2. Sensation evaluation of meat tenderness

Sensation evaluation is still animportant method of meat tender. In this experiment 5 grades were used for quality evaluating.

(1) Tenderness of cooking chicken block and their eating quality.

Cut chicken into 3X4cm pieces, mixed with tenderizer and standed for a while, then put them into water, boiling for 25 min. (see table 2)

Table 2 Tenderness of chicken block and its sensation evaluation.

group	material	tendering treatment				cooking		sensation evaluation
	weight	ratio	weight	time	method	method	time	grades
1	340g	0.2%	0.7g	20 min	powder mixed	boil	25min	6.2 slightly tough
2	360g	0.5%	1.8g	20 min	powder mixed	boil	25min	7.0 good, tender
3	350g	1.0%	3.5g	20 min	powder mixed	boil	25min	8.7 muscle fibre degraded and become unclear too tender
control	340g	/	/	/	/	boil	25 min	4.8 too tough to bite

Usually old hen was difficult to cook down and digest because its muscle fibre and connective tissue increased. However, old hen's meat, treated with 0.2-0.5% tenderizer, for 25 min is nearly done. The control boiling needed cooking 90 min to reach the same level. Proper readjust the dosage of tenderizer and extended the treatment time could increase tenderness of the old hen's meat.

2. Tenderness and sensation of fry beef.

Good beef from the butcher was cut into 6.5cm×3cm slices. Tenderizer was diluted with water and put the beef slices into the solution.

Table 3 Tenderness of fry beef and its sensation evaluation.

group	meat weight	tendering treatment				cooking method	grade
		ratio	weight	time	method		
treatment 1	270g	0.05%	0.15%	20 min	dipping	fry	8.5
treatment 2	270g	0.2%	0.2%	20 min	dipping	fry	9.5
control	270g	/	/	/	/	fry	7

The fibre of beef without tendering was coarse and slightly tough. However, the beef treated with 0.05% tenderizer was tender with good flavour and texture. The fibres of treatment 2 were broken and too tender to bite.

(3) Tenderness of fry meat and its sensation evaluation.

Cut meat into small pieces; mixed with tenderizer and fried with oil.

The sensation evaluations of chicken shreds of four sample were same. The result showed that tenderizer could make meat tender and the tendering time should be controlled well, otherwise muscle fibre would be broken because of strongly hydrolysis and the meat would loss its quality and flavour. The dosage of tenderizer should be at the concentration of 0.05-0.1%.

Table 4 Tenderness of beef shreds

group	meat	tendering		treatment			sensation evaluation
	weight	ratio	weight	time	method	grade	
treatment 1	125g	0.05%	0.075g	20min	mixed with powder	8.3	tender, good quality
treatment 2	125g	0.12%	0.12g	20min	mixed with powder	8.0	fibre slightly broken, grains on surface, good quality
treatment 3	125g	0.3%	0.1g	20min	mixed with powder	9.5	too tender on the surface, no meat odor, mealy
control	125g	/	/	/	/	6.5	a little firm and rough

3. Changes in dry material content of Muscle sample were taken from different positions with or without hydrolysis and the dry materials of them were analysed. (see table 5)

Table 5 Measurement of content of Dry materials of meat and hydrolyzed meat

position	A	hydrolyzed Dry materials		difference		
	Dry %	B water solution	C enzymolytic solution	A - B	A - C	B - C
shoulder	23.20	19.82	16.09	3.38	7.11	3.73
tenderloin	24.21	21.12	15.26	3.09	8.95	5.86
longissimus muscle	24.19	20.39	16.35	4.1	8.14	4.04
round	24.34	21.39	15.93	2.59	8.41	5.46
shank	23.18	19.22	14.88	3.96	8.30	4.34
	42.73	35.91	24.65	6.82	18.08	11.26

Table 5 showed that some of water soluble materials of meat dissolved in water during dipping into water, so the remain dry materials decreased by 2.95-4.1%. However, the remain materials obviously reduced by 7.11-8.95% because of a strongly hydrolysis of skeletal muscle protein through the degradating, comparing with of hydrolysis remains, the content of materials with enzymolytic hydrolysis was lower than those dipping in water. The difference is 3.73-5.86%.

The change in content of dry materials of sinew was more clear, the difference was 7.06% between A and C treatment, the difference was 11.25% between B and C treatment.

4. Change in content of coarse protein.

It was reported that skeletal muscle protein could be hydrolyzed and broken into small pieces and that 8-10% of the total nitrogen could be ultrafiltrated.

The content of coarse protein was analysed according to Kjeldhl method.

Table 6 The content of coarse protein of meat and hydrolysis solution

	position	meat	hydrolysis solution		A/B
		%	enzymolytic (A)	water (B)	
Muscle	shoulder	19.58	6.47	2.36	2.47
	tenderloin	19.9	6.09	2.44	2.50
	longssimus muscle	20.4	5.08	2.39	2.13
	round	18.55	4.88	2.06	2.37
	shank	19.27	6.10	2.10	2.9
Sinew		12.71	9.84	1.01	9.7

Table 7 The content of coarse protein of beef and chicken meat

name	dry	meat		enzymolytic solution		water solution		A/B
	material %	fresh %	dry %	fresh %	dry %	fresh %	dry %	
round	25.93	20.41	78.71	6.28	23.91	2.26	8.72	3.02
shank	23.95	21.16	88.35	6.89	28.77	2.19	9.14	3.15
chicken leg	23.16	19.24	83.07	7.61	32.86	2.52	10.88	3.02
sinew	12.67	32.32	75.74	11.75	27.54	2.47	5.79	4.76

Table 6 showed that skeletal muscle could be strongly hydrolyzed by the enzyme. The

content of coarse protein in enzymolytic extracting solution was 1.82-6.17% and it was 2.1-2.9-fold of those in water solution. Table 1 showed that the content of coarse protein in enzymolytic solution was 6.28-6.33% and it was about 3-fold of those in water solution. The content of enzymolytic solution of chicken leg was 7.16% and it was higher that those in round beef meat. It was more clear that the content of coarse protein calculated in dry weight. It suggested that enzyme would be more effective to degrade chicken meat than beef. The content of coarse protein of chicken meat and beef in water solution was at most same.

It was more clear that the effect of enzyme on degradating of connective tissue of sinew. The results showed that the content of coarse protein of sinew in enzymolytic solution was 9.84-11.78% and it was 4.76-9.7-fold of those in water solution. It suggested that treatment of enzymolytic solution, could increase the effect on degradating skeletal especially on connective tissue.

5. Change in content of proline of muscle

Proline is a special amino acid in collagen fibrin and elastin fibrin. Through Measuring proline content, the content of connective tissue could be estimated and grade the tenderness of meat.

There was a close relationship between tenderness and hydroproline and proline. Tenderloin was the tenderest. The shear force was 2.26-3.42 kg. Shank meat was tough. The shear value was 8 kg. Shear value is positively related with the content of proline and hydroproline.

The content of proline in hydrolysis solution of meat was analysd by automatic analyzer of Amino Acid. see table 8.

Table 8 The content of proline in hydrolysis solution

	position	water solution A	enzymolytic solution B	A/B
Muscle	shoulder	0.184	1.176	6.39
	tenderloin	0.145	1.093	7.54
	longssimus muscle	0.150	1.29	8.6
	round	/	1.41	/
	shank	0.14	1.907	13.62
Sinew		0.001	15.96	15.96

Table 8 showed that the proline content of enzymolytic solution was much higher than those in water solution through degradating of the enzyme. The ratio of B and A treatment in muscle fibrin was 6.39-13.62. The ratio of A and B in sinew was 15.99.

The content of proline in enzymolytic solution is positively related with shear force of meat except for shoulder (sample error). The lower of proline content the less of connective tissue and the more tender of meat.

To simplified the measuring method colorimetric analysis was used to measure proline content according to the reaction betweent acetone and Indole quinone.

The change of proline content was similar with the results analysed by autmatic analyzer of Amino acid.

The proline content in the water solution of sinew could not be analysed. And the proline content in enzymolytic solution was 15.96mg/ml. It indicated that the effect of enzyme on sinew was stronger than skeletal muscle. It is a method to evaluation meat tenderness through proline analysis.

6. Change in structure of muscle fibrin samples put into enzymolytic solution for 5.15, 30 min seperately. Then washed the samples with water and made frozen slices. Under microscope (3×40) the grains of muscle fibrin was unclear and broken into small pieces.

The longer of the treatment time, the more broken pieces. The muscle fibrin of control was in order.

The results indicated that muscle fibre protein could be strongly hydrolyzed by papain and tenderizer. Even the meat of old livestock and poultry could also be turned tender through proper dosage of tenderizer treatment. The content of dry materials reduced and part of protein became soluble after hydrolysis of meat.

The results suggested that the papain would be more effective for degradating connective tissue than skeletal muscle protein. The content of coarse protein and proline in enzymolytic solution of sinew were higher than those in other parts.

It showed that the content of proline had a positively relation to tenderness of meat.

The effect of enzyme on degradating and breaking muscle protein was clear. However the effect of enzyme on cellular protein and its control condition was not clear, especially on the degradating of collagen protein and elastin protein. It is a challenge that is how to apply enzyme to control degradating and denaturation of protein in practice.

It is very important subject to further study the effect of enzyme on nutrition and flavour of meat and to look for the application methods in meat product processing.

Papain could degrade meat protein and turn them into petides and amino acids which would be easy to utilize for human, especially easy to digest for old man and children. Therefore proteinase would have bright future in food processing industry, especially in tendering meat and producing meat products.