:9 Properties of meat as a raw material for comminuted meat systems

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INTRODUCTION

In Sweden more than 50% of a carcass is used for comminuted meat products. This meat is analyzed for protein, fat and water content and is sometimes standardized for chemical composition, but very little attention has been paid to what contribution the actual source of meat might make to variations in the structure and functional properties of the comminuted meat product. Furthermore, "bind values" for meat qualities are used in optimization programs for least cost formulations etc. in spite of the fact that these data are old and of questionable value.

A project was started in order to find out what differences in the microstructure and the functional properties of comminuted meat products could be caused by the type of meat raw material used. A preliminary investigation was first made of meat from well-defined muscles. However, well-defined muscles are rarely used in comminuted meat products so the investigation was continued with meat from trimmings separated during cutting and classification.

EXPERIMENTAL

Well-defined muscles

Meat from the following muscles were used: M. biceps brachii, M. biceps femoris, M. gastrocnemius and the anterior part of M. serratus. The muscles were taken from young bulls (11-12 months) 5-7 days after slaughter and frozen directly after cutting. Each muscle was vacuum-packed separately and the animal identity noted. The chemical composition of the muscles are shown in Table 1.

Table 1. Composition of the muscles.

Type of muscle	Composition (% by weight)			
	Fat (%)	Water (%)	Protein (%)	Collagen (%)
M. Biceps brachii	1.9	76.4	21.5	2.6
M. Biceps femoris	4.3	74.0	20.7	1.3
M. Gastrocnemius	2.0	76.2	21.5	1.6
M. Serraturs	1.8	75.8	20.7	1.7

Meat trimmings

Meat trimmings from the neck, shoulder, foreleg and hind leg were separated during cutting and classification. Batches of 25 kg were ground, blended, vacuum-packed and frozen. The chemical composition of the different meat trimmings is shown in Table 2.

Table 2. Composition of meat trimmings

Type of trimming	Composition (% by weight)			
	Fat (%)	Water (%)	Protein (%)	Collagen (%)
Neck	5.8	73.0	20.3	3.1
Shoulder	18.8	62.3	18.7	3.4
Fore leg	5.3	72.1	21.9	5.0
Hind leg	8.3	69.8	21.5	5.0

Composition and preparation of model sausages

The contribution of the different meat raw materials were tested in two formulas for a model sausage product containing meat, pork back fat, water and sodium chloride. The two formulas, coded 19 and 59, were based on the contents of protein, fat, and water. Formula 19 contained approximately 7.6% protein, 27.9% fat, 62.1% water and 2% sodium chloride, and formula 59 contained approximately 8.7% protein, 23.4 fat, 65.3% water and 2% sodium chloride. When the meat trimmings were used, the proportions of meat, pork back fat and water were adjusted according to their chemical composition. For the meat muscles with a more uniform composition, the proportions of meat, pork back fat and water were kept constant.

The amount of raw materials used for the two formulas can be seen in Table 3.

Table 3. Amount of raw materials used in the two formulas based on constant chemical composition

Meat raw material	Formula	Ingredients (% by weight)			
		Meat	Pork back fat	Water	Salt
Intact muscles	19	32.8	31.1	34.1	2.0
Neck meat	19	33.5	30.5	34.0	2.0
Shoulder meat	19	37.3	24.6	36.1	2.0
Fore leg meat	19	31.0	30.9	36.1	2.0
Hind leg meat	19	31.8	29.7	36.4	2.0
Intact muscles	59	39.1	25.6	33.3	2.0
Neck meat	59	40.0	24.8	33.2	2.0
Shoulder meat	59	44.5	17.8	35.7	2.0
Fore leg meat	59	37.0	25.3	35.7	2.0
Hind leg meat	59	37.9	24.0	36.1	2.0

The composition of shoulder meat deviated from the rest of the raw meat materials used. The recipes are constructed in such a way that the proportions of ingredients of formula 19 for shoulder meat corresponds to the proportions of ingredients of formula 59 for fore and hind leg meat.

All meat batters were made in a 25 l bowl chopper with 6 knives and a motor speed of 1500/3000 rpm (Rohwer-Kolbe). The batch sizes were 7 kg. Four replicates of every batch were made.

Before use, the meat and fat raw materials were slowly thawed at $0^{o}C$ over night.

The ingredients were added and mixed at low speed in the following order; meat (20 sec), salt (10 sec), water (3 x 20 sec) and fat (40 sec). The mixture was then chopped at high speed for 3 min or to a final temperature of $14\text{-}15^{o}C$.

Samples were taken for analysis of fat and water loss and for microstructure evaluation. The batter was then put into casings (Ø 50 mm) and cooked in a water bath at $80^{o}C$ for 45 min.

Fat and water loss

Fat and water loss on heating was determined according to the previously described "net test" (Hermansson and Lucisano, 1982). The outline of the test is shown in Figure 1. The sample is placed in the upper reaction tube and heated in a waterbath at $77^{o}C$ with a holding time of 20 min at $\geq 75^{o}C$ and then cooled to $39^{o}C$. Thereafter, the bottom rubber stopper is removed and the reaction tube attached to the middle section. This section has a net in the bottom to allow drainage of water and fat to the bottom section. The whole assemblage is put in a centrifugation tube and centrifuged for 10 min. The drip is chilled and the solidified fat can be removed and weighed. As can be seen from Figure 1 the balance is coupled to a microcomputer where the water, fat and total weight loss, as well as the corresponding standard deviations, are calculated.

4 grams of the samples and smaller test tubes were used for the intact muscles whereas 15 g samples and bigger test tubes were used for the batters with meat trimmings. The smaller tubes were centrifuged at 1800 rpm and the bigger tubes at 1500 rpm. This means that only values within an experimental series can be compared. Four replicates were made and the standard deviation for total weight and water loss was 1.2%

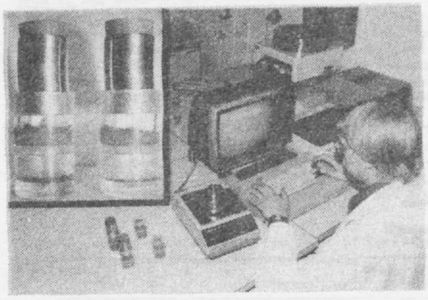

Figure 1. Outline of the "net test".

Frying loss

The model sausages were cut in 14 mm thick slices and heated in a double-sided contact griddle with a surface temperature of $180^{o}C$. The sample was weighed before and after heating. Eight replicates were made and the standard deviation was 1.6%.

Texture measurements

Texture measurements were made in an Instron Universal Testing Machine. Cylindrical samples with a height of 14 mm and a diameter of 25 mm were compressed until rupture with a speed of 10 mm/min. Texture parameters evaluated were the rupture force and the initial slope or the rigidity modulus. Six replicates were made.

RESULTS

Well-defined muscles

Weight losses of meat emulsions made from well-defined muscles were determined after heating at $77^{o}C$ according to the "net test" and after subsequent heating in the double-sided contact griddle. The results are shown in Table 4.

Table 4. Functional properties of comminuted products from well-defined muscles

Type of muscle	Weight loss according to the net test (%)		Weight loss on subsequent heating in the contact griddle (%)	
	Form. 59	Form. 19	Form. 59	Form. 19
M. Biceps brachii	30.8	20.7	13.8	10.2
M. Biceps femoris	39.5	36.3	21.0	15.8
M. Gastsocnemius	33.7	31.0	16.8	15.3
M. Serraturs	43.2	32.7	22.5	16.2
Maximal difference (%)	12.4	15.6	8.7	6.2

The results from the investigation with well-defined muscles show that big differences in weight loss can be obtained at various stages of heating due to the type of raw material used. The ranking order of the results are almost the same for both types of tests and both formulas used.

The highest yields were obtained with M. biceps brachii and the lowest with M. serratus. It can be noted that M. biceps femoris which has good properties when used as intact muscle, functioned poorly when used in comminuted meat products.

Meat from trimmings

The more extensive study of meat trimmings included the determination of fat and water losses according to the net test, subsequent weight loss on heating in the double-sided contact griddle as well as texture measurements. The texture measurements were made on samples at $15^{o}C$ and different results and ranking orders would probably have been obtained at higher temperatures when both the fat and gelatin phase were melted. Statistical evaluation was made by variance analysis followed by Duncan's test to identify which values were statistically different ($p \leq 5\%$). The results from the studies of the two different formulas are shown in Tables 5 and 6. The data are placed in ranking order and lines connect data that are not significantly different.

Table 5 Functional properties of comminuted products according to formula 59 made from meat trimmings.

Functional property	Ranking order of mean values (Lines connect data that are not sign. different)				Max diff.
Weight loss according to the net test					
Water (%)	Neck 25.1	Fore leg 31.0	Hind leg 32.2	Shoulder 32.4	7.3
Fat (%)	Fore leg 1.9	Hind leg 2.5	Shoulder 2.8	Neck 2.9	1.0
Weight loss on frying (%)	Neck 17.4	Hind leg 19.0	Fore leg 19.0	Shoulder 22.3	4.9
Texture parameters					
Rupture force (N)	Neck 28	Shoulder 32	Hind leg 35	Fore leg 39	11.0
Rigidity mod (N/mm)	Neck 1.9	Hind leg 2.1	Fore leg 2.2	Shoulder 2.8	0.9

Table 6 Functional properties of comminuted products according to formula 19 made from meat trimmings

Functional property	Ranking order of mean values (Lines connect data that are not sign. different)				Max. diff.
Weight loss according to the net test					
Water (%)	Neck 24.9	Hind leg 28.8	Fore leg 30.7	Shoulder 32.4	7.0
Fat (%)	Fore leg 1.9	Hind leg 2.1	Neck 2.3	Shoulder 3.5	1.6
Weight loss on frying (%)	Neck 16.5	Hind leg 18.2	Fore leg 18.3	Shoulder 22.2	6.1
Texture parameters					
Rupture force (N)	Hind leg 23	Neck 23	Shoulder 23	Fore leg 26	3
Rigidity mod. (N/mm)	Hind leg 1.3	Neck 1.6	Fore leg 1.7	Shoulder	0.8

The weight losses were similar regardless of the formulas used.

In both experimental series shoulder meat gave the lowest and neck meat the highest yield according to the net test and the frying test.

The maximum differences in water loss on cooking between the different meat trimmings were as high as 7% by weight and 4-6% on subsequent heating in the double-sided contact griddle.

The observed fat losses were small but shoulder meat resulted in a somewhat higher fat loss in one formula and fore leg meat gave a somewhat lower fat loss in the other formula. Similar observations were made by microstructure evaluation. Under the light microscope it was seen that the fat in the emulsions from fore leg meat was finely dispersed whereas the fat in emulsions from shoulder meat was poorly dispersed and fat separation was a common phenomenon. Separation of fat into big fat pools resulted in poor fat binding as well as poor water binding properties. It is interesting to note that both the anterior part of M. serratus and the more undefined shoulder meat gave the lowest yields.

The weight losses from the fore leg systems were not due to separation of fat. On the contrary, the fat was well dispersed in these systems. The fore leg trimmings had a high collagen content as can be seen from Table 2. This means that the distribution of collagen/gelatin is of importance for the microstructure and functional properties of these systems. Light micrographs showed that part of the gelatin melted out during cooking, which caused partial breakdown of the structure. The high collagen content and the state of the collagen/gelatin is probably the reason for the higher rupture forces of cold sausage samples of fore leg relative to the other samples.

Sausages made from shoulder meat had a significantly higher rigidity modulus than the other systems, which is a common feature of aggregated and partial phase separated protein gel systems.

CONCLUSIONS

The results have shown that the choice of meat raw materials has an important influence on the yield, texture and microstructure of comminuted meat systems, both when meat from well-defined muscles and when meat trimmings are used.

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REFERENCES

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