EFFECTS OF MEAT COMMINUTION METHODS ON THE STRUCTURE OF RAW-DRIED SALAMI

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INTRODUCTION

Meat comminution has long been in practice as a manner of processing lower value meats into products acceptable to consumers. The principle accepted generally implies that, at the moment of cutting, the still piece of meat resists a moving cutting surface. The most common cutting systems based on this principle are grinders and cutters. In grinders, meat cutting is performed as a result of translation with partial turning in the screw creating pressure on to a plate against which the blade of the knife rubs. As a result, meat drip is lost, and the shape and size of the particles obtained vary in a wide range. On cutter processing, cut particles are also different in size, softer tissues being apt to be beaten to the point of constituting sort of an emulsion. At the same time, connective tissue of insufficient comminution can be observed. Urschel-Comitrol Company have developed the flake cutting concept of meat cutting, i.e., meat cutting into flat pieces of the desired sizes. In this case, cutting blades are still, and meat pieces, as a result of centrifugal forces, attack the still cutting surfaces, the cutting process being performed in this way. Comminuted meat particles, in their greatest part, constitute small surfaces of a predominating, pre-set size. This contributes to a larger binding surface area in the manufacture of raw-dried salami.

In this work, we aimed to make comparative analyses, using micro- and macroscopic characteristics, of meat comminuted using a flaker or a grinder or cutter, and of salami manufactured from meat comminuted in accordance with that.

MATERIALS AND METHODS

The size of meat particles obtained using the Urschel-Comitrol flaker, was determined in the following way: Lean pork, semi-fat pork and beef were pre-cut using a grinder with plate openings of a diameter of 10 mm. They were frozen at a temperature of -3 - -5°C. and further cut using the flaker with cutting head No. 3K030120. Samples were removed of the meat cut in this way, which were fixed in absolute alcohol. Fixed material was layered in glass Petri dishes and photographed against a dark background. In the photographs, we measured the linear dimensions of 30 particles selected at random, for each type of meat.

Comparative studies were also made of the particle sizes of adipose and connective tissue in Diavena raw-dried salami manufactured by meat comminution using either cutter or the Urschel-Comitrol flaker. Photographs were taken of the cut surfaces of the two salami products. There, we took the maximum linear dimensions and worked the area of experimental and control adipose and connective tissue particles planimetrically. The results of all measurements were processed mathematically.

Microstructure analyses were performed on semi-fat pork and beef, flaked or ground. Blocks of the material under investigation sized 5 x 5 x 5 mm were frozen in isopentane cooled in liquid nitrogen, and cut using a Minotome cryostat. Sections of a thickness of 10 µm were stained with hematoxylin-eosine and observed using a Docuwal microscope.

RESULTS

The results of the measurements of individual particles of different meats comminuted using a flaker, are shown in Table 1. According to the manufacturer of the machine, the factors determining the size of resultant meat particles are: cutting meat temperature; the size of meat pieces; and the size of the openings of the still cutting blade. The meat pieces subjected to comminution were of a size of about 10 mm at a temperature of $-5^{o}C$. Cutting head No. 3K03120 was used. Under these conditions of comminution, the size of resulting particles was expected to be within the range of 3,05 to 4,19 mm.

On measuring, we obtained particle size following meat flaking, as follows: for lean pork, 2,90±0,33 mm; for semi-fat pork, 3,9±0,41 mm; and for beef, 3,35±0,30 mm. These results are within the expected range suggested by the manufacturer (3,05-4,19 mm). It is noteworthy that, apart from the temperature and the size of processed meat pieces and the cutting blade type, the size of resulting particles is also affected strongly by the type of the meat.

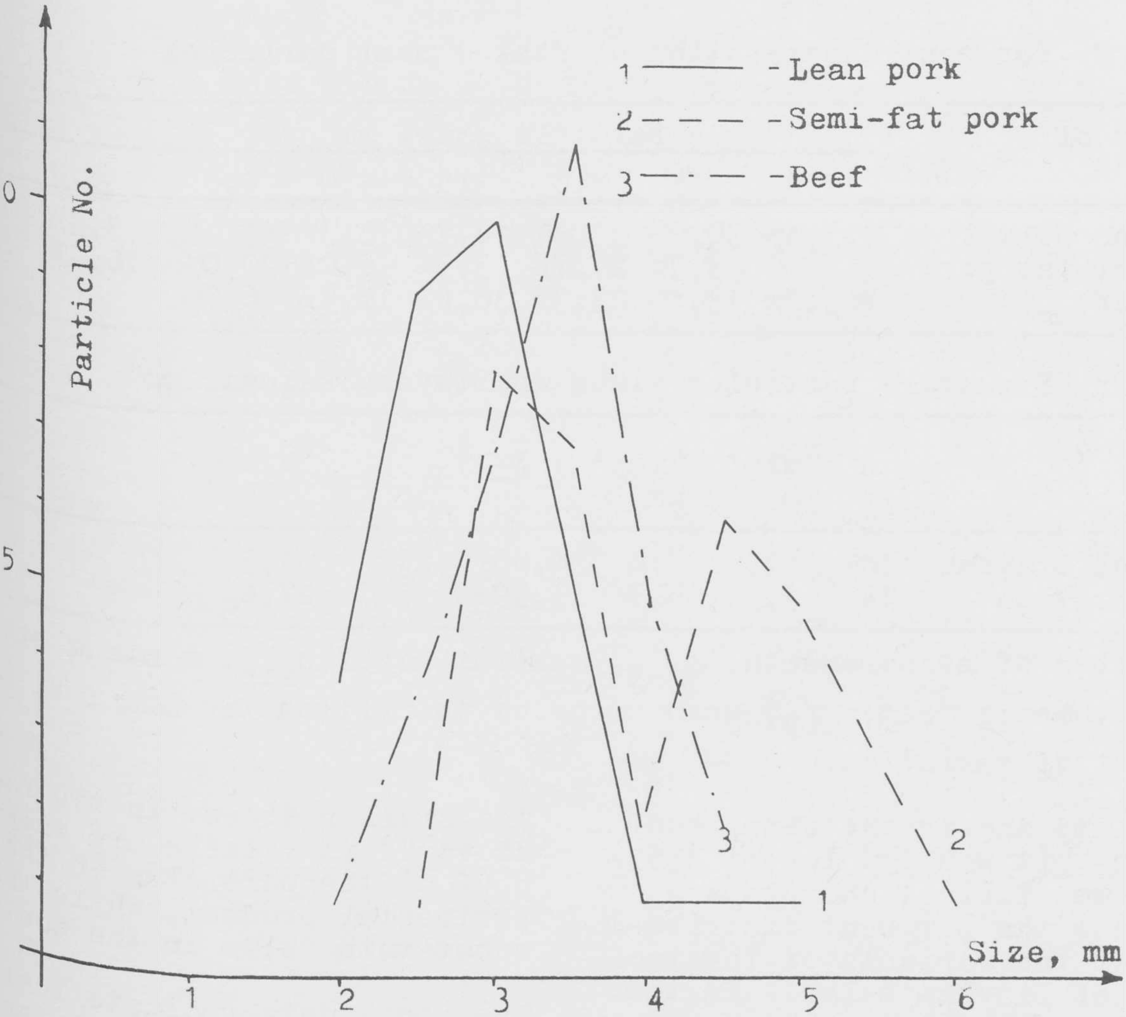
Table 2 and Graph 1 show the per cent distribution of the particles obtained by size. The graph demonstrates the following features: beef, a marked concentration of variants around the arithmetic mean (36,6%), a nearly symmetrical chart of the scattering of variants with a strongly pronounced peak at the size of 3,5 mm, and a narrow range of scattering of the variants (90% are within the range of 2,5 to 4 mm). As far as lean pork is concerned, there is also a pronounced grouping of variants around the arithmetic mean, with a narrow scattering range (96,7% of the variants are in the range of 2,0 mm to 3,5 mm). With semi-fat pork, the situation is somewhat different. The scattering of variants is greater (96,7% are in the range of 2,5 to 5 mm), and there are already two clearly marked peaks in their distribution (27,7% at 3,0 mm, and 20,0% at 4,5 mm). Obviously, the different density of the meat, as in the case of semi-fat pork, allows to obtain particles of different sizes in a vast range, which is undesirable and should be avoided.

Table 3 shows the maximum sizes of structure particles in Diavena sausage manufactured by cutter comminution (control) or by flaking (experimental sample). Mean particle size in the control salami constituted 4,66±

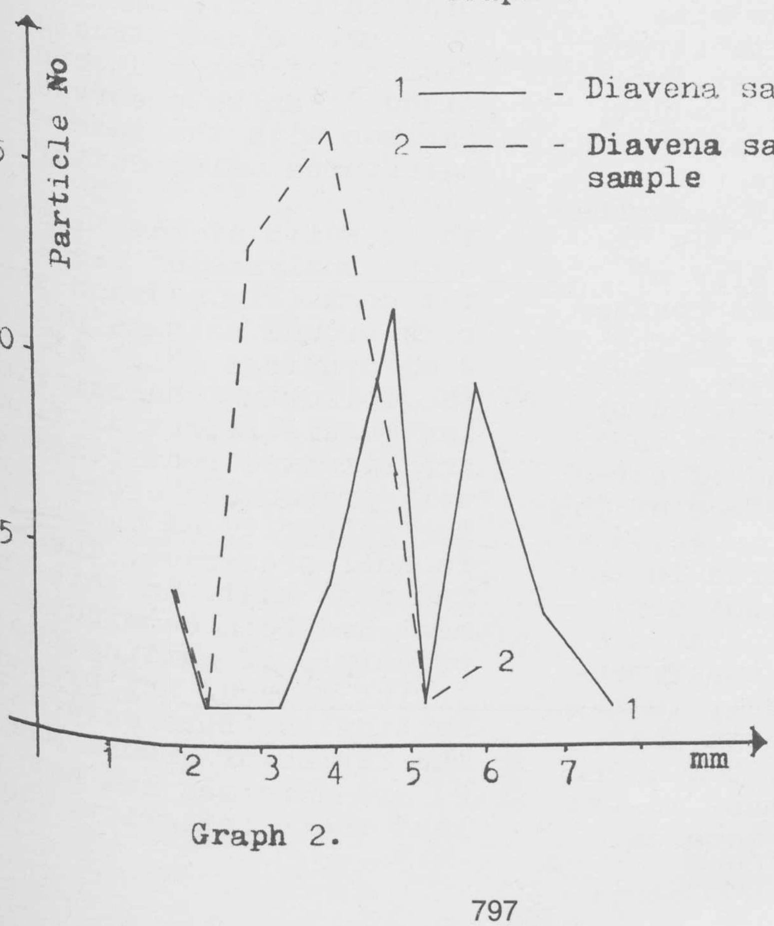
Table 1. Size (mm) of meat particles obtained using the Urschel-Comitrol flaker with cutting head No. 3K030120

Object of study	Meat temperature	n	$\bar{X} \pm \sigma_{\bar{x}}$	V %
1. Lean pork	-3^{o} - $-5^{o}C$	30	2,90±0,12	22,4
2. Semi-fat pork	-3^{o} - $-5^{o}C$	30	3,90±0,15	22,3
3. Beef	-3^{o} - $-5^{o}C$	30	3,35±0,11	17,9

n, number of measurements; $\bar{X}$, arithmetic mean; $\sigma_{\bar{x}}$, mean error of arithmetic mean; V, variation coefficient.



Graph 1.



Graph 2.

Table 2. Per cent distribution of flaked meat particles

Object of study	Particle size, mm							
	2,0	2,5	3,0	3,5	4,0	4,5	5,0	6,0
1. Lean pork	13,4%	30,0%	33,3%	16,7%	3,3%		3,3%	
2. Semi-fat pork		3,3%	27,7%	23,3%	6,0%	20,0%	16,7%	3,3%
3. Beef	3,3%	13,4%	23,3%	36,6%	16,7%	6,7%		

Table 3. Structure particles sizes in Diavena salami, mm

Object of study	n	n_{min}, mm	n_{max}, mm	$\bar{X} \pm \sigma_{\bar{x}}$	V %
Control Diavena	36	1,9	7,6	4,66±0,24	31,3
Exp. Diavena	44	1,9	5,7	3,59±0,15	27,6

n, number of measurements; n_{max}, maximum size; n_{min}, minimum size; $\bar{X}$, arithmetic mean; $\sigma_{\bar{x}}$, mean error of the arithmetic mean; V, coefficient of variation.

±0,66 mm, and in the experimental one, it was 23% lower: 3,59± ±0,40 mm. Table 4 and Graph 2 indicate the per cent distribution of the variants of the two types of Diavena salami. In the experimental salami, there is a symmetrical distribution of variants within a narrow size range (1 to 6 mm), with strong clustering around the arithmetic mean. In the control product, there is a scattering of variants in a vaster size range (1 to 8 mm), with asymmetrical distribution.

A better idea of the size of structural (adipose and connective tissue) particles in the control and experimental Diavena products can be obtained by their areas in mm^2, shown in Table 5. The mean area of particles in the cut surface of the experimental product is 44,7% lower than the mean area in the control product. Variant scattering by size (shown in Table 6 and Graph 3) for the experimental and control product, is similar in appearance with that in linear dimensions, but there is a marked displacement in the experimental product towards the smaller sizes. In the range above 11 mm^2, there are only 6,6% of the particles in the experimental product, while they constitute 29,9% in the control.

The above data indicate that, on flaking the raw material for Diavena salami, smaller and more uniformly sized structure particles (of fat and connective tissue) can be observed, in comparison with the same salami manufactured using cutter comminution.

The results of the light microscopy analyses of flaked semi-fat pork (Fig. 1) and semi-fat pork ground using a plate with 2 mm openings (Fig. 2) reveal the following characteristics: The muscle fibres of flaked meat are situated rectilineally, with well pronounced cross striation. The integrity of muscle fibres is well preserved. These data indicate that, in this case, the meat had been comminuted on the principle of cutting the raw material without any pressure resulting in fibre deformation. The fibres of ground meat (Fig. 2) are deformed and have partly lost their integrity. Curves

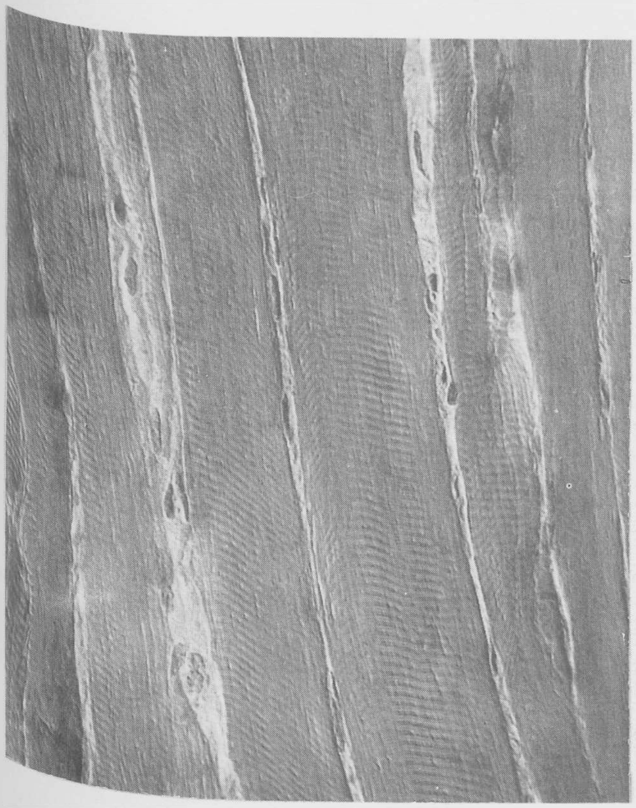


Fig. 1. Longitudinal section of flaked semi-fat pork. Well preserved integrity of muscle fibres. Magnification, 126 x.

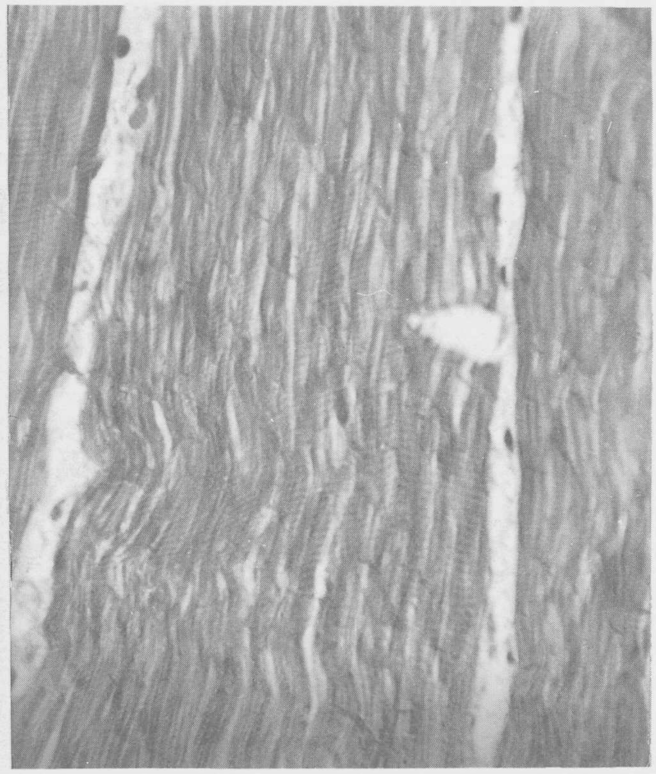
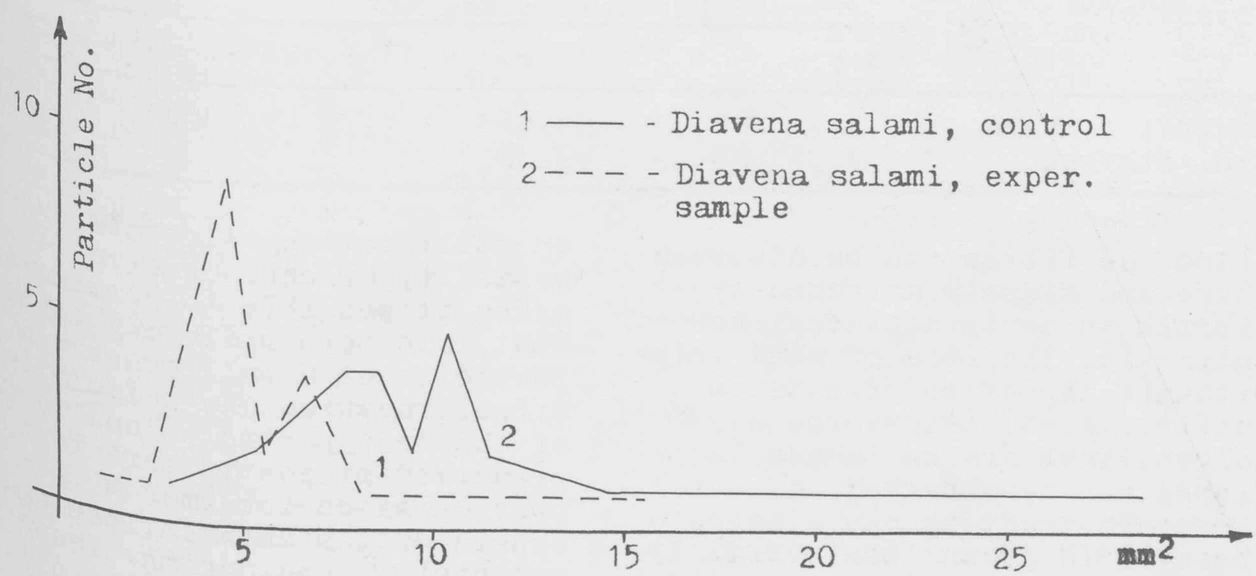


Fig. 2. Longitudinal section of semi-fat pork ground using a plate with 2 mm openings. Deformation of muscle fibres. Magnification, 126 x.



Graph 3.

Table 4. Per cent distribution of structure particles sizes in Diavena salami

Object of study	Particle sizes, mm						
	1 ÷ 2	2 ÷ 3	3 ÷ 4	4 ÷ 5	5 ÷ 6	6 ÷ 7	7 ÷ 8
Control Diavena	11,1%	5,6%	13,9%	30,5%	27,8%	8,3%	2,8%
Exp. Diavena	9,1%	31,7%	36,4%	15,9%	6,9%		

Table 5. Area of structure particles in Diavena salami, mm^2

Object of study	n	n_{min}, mm^2	n_{max}, mm^2	$\bar{X} \pm \sigma_{\bar{x}}$	V %
Control Diavena	30	3,1	28,6	10,3±0,95	50,8
Exp. Diavena	30	1,2	15,4	5,7±0,63	60,18

n, number of measurements; n_{max}, maximum area; n_{min}, minimum area; $\bar{X}$, arithmetic mean; $\sigma_{\bar{x}}$, mean error of the arithmetic mean; V, coefficient of variation.

Table 6. Per cent distribution of the area of structural particles in Diavena salami

Object of study	Particle size, mm^2						
	1 ÷ 2	2 ÷ 3	3 ÷ 4	4 ÷ 5	5 ÷ 6	6 ÷ 7	7 ÷ 8
Control Diavena			3,3%		6,7%	10,0%	13,4%
Exp. Diavena	3,3%	6,7%	16,7%	30,0%	6,7%	13,4%	6,7%

Table 6 (Continued)

Object of study	Particle size, mm^2					
	8 ÷ 9	9 ÷ 10	10 ÷ 11	11 ÷ 12	12 ÷ 13	Over 14
Control Diavena	13,4%	6,7%	16,6%	6,7%	10,0%	13,2%
Exp. Diavena	3,3%	3,3%	3,3%			6,6%

along the fibres can be observed there and closely attached myofibrils in certain places, accounting for the loss of meat drip with all the after-effects on quality. Also, transverse and longitudinal cracks in muscle fibres can be observed. A similar microstructure can also be observed in ground beef (Fig. 3). Flaked beef has a better preserved microstructure (Fig. 4).

CONCLUSION

The principle of meat cutting on still cutting elements suggested by Urschel-Comitrol makes it possible to comminute meat into more uniformly sized particles of a well preserved microstructure. The uniformity of the meat particles and their preserved microstructure form prerequisites for smooth processes of the salami ripening and ageing, and drying. The greater contact surface area between the individual particles accounts for the better binding of the sausages. This has an undoubtedly favourable effect on the quality of these meat products, imparting a better commercial appearance to them. Apart from the stated qualities of the new method of cutting, also the lower energy expenditures compared to conventional methods (30 to 60%) are noteworthy.

Fig. 3. Longitudinal section of beef ground with a plate with 2 mm openings. Deformation of muscle fibres. Magnification, 126 x.

Fig. 4. Longitudinal section of flaked beef. Well preserved muscle fibre integrity. Magnification, 126 x.