Studies on Meachanical Treatment Possibilities of the Meat Batter to Reduce Salt Content in Non-Structured Sausages

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SUMMARY: The salt content in the meat items is still high in the modern production and do not respond to the nutrition hygiene norms. In the present study the possibilities for compensating to some extent the structure-forming functions of sodium chloride in stable meat emulsion preparation for non-structured sausages by increasing the extent of batter mechanic treatment are investigated.

Experiments are carried out under industrial conditions for development of stable meat emulsion in non-structured perishable sausages with different salt content. The micro and ultrastructure of "Teleshki" sausage and wieners "Sofia" are examined as the quantity of added salt content is reduced by 0,4% from the standard and the extent of mechanical treatm by cutting varies. In the experiments with the wieners "Sofia" is used frozen pork. Physico-chemical and organoleptic investi-gations of the produced sausage are carried out.

It is established that there is a possibility for decreasing the salt content by 0,4% as the rev number of the knives increase by 58% for "Teleshki" sausage and by 42% for the wieners. These cutting conditions do not modify the structure of the tested sausages and do not influence in negative way the organoleptic parameters of the meat products.

INTRODUCTION: It is widely recognized that the sodium has a significant influence on the occurence of hypertonia deseases (Winter, 1986; Wirth, 1988), which cause other deseases as infarct and brain insult. The main source of sodium in food is salt, which is widely used in the meat industry. The necessary average daily norm - 2 to 5 g - in Germany is 8-15 g, in Poland - 16-19,5 g, in Japan - 15-20 g (Wirth, 1988). Recently there is a tendency for a continious decrease of salt content in the sausages due to the consumer's demand and hygienic requirements. But this decrease should be done in definite limits, defined by the physico-chemical processes in development of stable structure of the perishable sausages. The question for the necessary quantity salt content is arguable. Sofos (1983) states that the salt content below 2,0% decreases the yield and batter emulsion stability. Other authors give as limited salt content 1,5% (Oelker et Dehmlow, 1988).

In the present study we are oriented to the investigation of the possibilities for compensating to some extent the structure-forming functions of sodium chloride in the production of stable meat emulsion for non-structured sausages as the extent of batter mechanical treatment increases.

MATERIALS AND METHODS: We used 150 l cutter "Wemag" with 3 knives and speed of revolving 1460 rev/min and 2830 rev/min, and for the cutter bowl - 15 rev/min. There were produced 4 batches of "Teleshki" sausage as follows: 1) with standard quantity salt content - 2,2% and 16384 knife rev in the process of cutting (Control I); 2) with 2,2% salt and 18150 knife rev (Control II); 3) with 1,8% salt and 21360 knife rev (Test I); 4) with 1,8% salt and 28718 knife rev (Test II). The raw materials were cooled at 4°C - veal and semi-lean pork. The end temperature of the finished meat batter did not exceed 14°C.

In the technological workshop at the Institute of Meat Industry we produced 3 batches wieners "Sofia" from frozen semi-lean pork and cooled one sort beef. The raw materials were treated in 60 l cutter "Alpina - Hoegger" TYP PB - 60 - 990 with 4 knives and speed of knife revolving - 2490 rev/min, and for the cutter bowl - 18 rev/min. The three batches differ one onother in the quantity of added salt content and the rev number of the knives, as follows: 1) with standard quantity salt content 2,2% and 16185 knife rev in the process of cutting (Control); 2) with 1,8% salt and 19920 knife rev (Test I); 3) with 1,6% salt and 23032 knife rev (Test II). The end temperature of the finished meat batter did not exceed 12°C.

The produced "Teleshki" sausage and wieners "Sofia" according to the above mentioned technological experiments, were investigated as follows:

1. Histochemical investigations
2. Ultrastructural investigations
3. Measurements of the quantity salt content by the method of Moor
4. Water content measurements by "Infra-Lyzer", precalibrated for perishable sausages
5. Organoleptic investigations according to the nine-score hedonic scale for color, structure, consistency, smell, flavour and juiceness
6. Yield measurements

The meat batter for the wieners and "Teleshki" sausage was examined for histochemical results at different extents of mechanical treatment.

The materials for histochemical investigations in the form of blocks with sizes - 0,5 x 1 x 0,5 cm were frozen in isopentan, precooled in liquid nitrogen to -196°C. Sections with thickness 10 m, produced on cryostat "Minotome" - USA, stick on the covering glasses, after fixation in 10% formaldehyde and washed in water, were stained with oil red "O", hematoxilin eosin and Ponceau S. The stained sections were observed under the microscope "Docuval" - Zeis.

The materials for ultrastructural investigations were fixed by glutaraldehyde, postfixed osmium acid and embedded in Dorkupan - Fluka. Ultrathin sections, produced on ultramicrotome LKB - III, were contrasted with uranyl acetate and lead nitrate. Then they are observed under the transmission electron microscope TESLA BS 613 - 80 kv.

RESULTS AND DISCUSSION: According Wirth (1985) the meat batter for the cooked-smoked sausages is structurally polyphase system, consisting of:

- molecular dispersed protein and salt solution
- net-like structured protein gel from fibre-like protein formations
- dispersion of the fat particles and fat cells in the protein gel, particularly covered with protein film
- suspension of more coarse muscle fibres and tissue composed parts.

The formation of these structures is based on two main technological factors: salt content and mechanical treatment through cutting. The first factor lead to swelling and opening of the miofibrilar proteins and participate by its sodium ions in the intimate electrostatic processes in the formation of fat globules membranes. The mechanical treatment is unique regarding the distruction and fine fragmentation of the fat, miofibrilar and connective-tissue structures and their transformation into elementar filament proteins and fat globules. These two technological factors are closely related. This enables the possibility for a compensating the structure-forming role of the salt when its content decreases in the meat batter by the increase of the mechanical treatment.

In the production of the control batches "Teleshki" sausage we follow the regulations of Bulgarian State Standard (BSS) and use 2,2% salt. During the mechanical treatment of the meat batter - 18150 rev - we observed homogeneous fine meat emulsion in the meat batter (fig. 1). On the base of ultrastructural investigations we establish well formed fat globules and homogeneous protein matrix with traces of miofibrilar fragments (fig. 2).

We observed large sections of unshaped fats in the sample batches "Teleshki" sausage with reduced salt content - 1,8% and 18150 knife rev (fig. 3). When the mechanical treatment increase to 28718 knife rev and by 1,8% salt, we obtained homogeneous meat emulsion in the meat batter (fig. 4) with uniform fat distribution. The ultrastructure of this sausage batch show well shaped small globules with dense, homogeneous covers, which show the formation of stable meat emulsion.

The micro and ultrastructural characteristics of the produced "Teleshki" sausages were integrated with the organoleptic investigations of the same meat products.

We produced 3 batches wieners "Sofia" to study the microstructure of the meat emulsion with reduced salt content and frozen meat. In the control batch according to BSS 127-83 we used 2,2% salt and obtained homogeneous and stable meat batter at 16185 knife rev. Regarding the ultrastructure we observed predominantly small and average fat globules with well shaped dense protein membranes (fig. 6)and fragments from collagen fibres. In the test batch with 1,8% salt we produced a homogeneous meat batter with uniform distributed fats after 19920 knife rev (fig. 7)and clearly expressed dense membranes of the fat globules (fig. 8). After producing a good and stable meat emulsion in the meat batter with 1,8% salt, we began to perform experiments with the wiener batch containing 1,6% salt. We produced a good structure of the wieners when the mechanical treatment was 23032 knife rev. We observed well shaped homogeneous protein matrix without preserved muscle and connective tissue structures (fig. 9).

It is clear from the table 1 that the increase of the mechanical treatment to 21360 rev is still unable to compensate the reduce in the salt content regarding the parameters - consistency and juiceness. But when the mechanical treatment increase to 28718 rev and the salt content decreases, the organoleptic characteristics of the control batches with the standard salt content could be obtained.

The data from the physicochemical investigations on table 3 show equal water content and equal yield when the batches are with different quantity salt content. This is an evidence for a stable meat emulsion formation in the three wiener batches, nevertheless of the salt content reduce. These results are in correlation with the data from the microstructural investigations of the different wiener batches.

CONCLUSIONS: In the production of "Teleshki" sausage the quantity of the used salt content can be reduced by 0,4% without any negative effect on the sausage structure and organoleptic parameters. The reduced salt content is compensating during the technological process by increase the extents of mechanical treatment in the cutter by 58%. The salt content decrease in the production of wieners could be achieved by the use of frozen meat and increase of mechanical treatment in the cutter. We succeed during our investigations to reduce the added salt content to 1,6% and to increase the mechanical treatment by 42% and we establish structural and physicochemical parameters and yield equal to the parameters in the samples with 2,2% salt content.

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Table 1. Organoleptic parameters of "Teleshki" sausage, produced with different salt content and different extent of mechanical treatment

Parameters / Batch	Colour	Structure	Consistency	Flavour	Juiceness	Total score
Veal sausage-2,2% salt, 16385 rev	8	8	7,7	8	7,7	7,7
Veal sausage-2,2% salt, 18150 rev	7	7	6,8	7	6,8	6,8
Veal sausage-1,8% salt, 21360 rev	8	7	5,5	5,7	5,5	5,5
Veal sausage-1,8% salt, 28718 rev	7	7	8	7	8	8

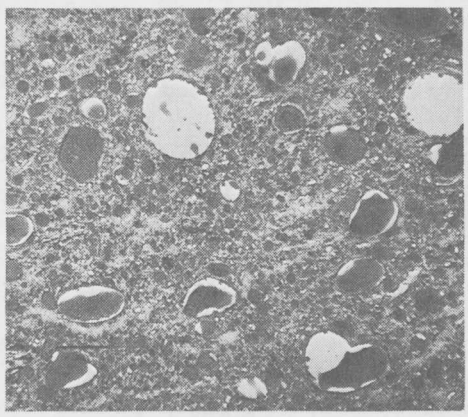

Fig. 1

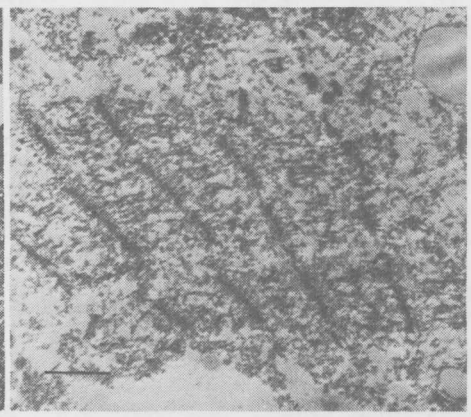

Fig. 2

Fig. 1 - Microstructure of meat batter for "Teleshki" sausage with 2,2% salt content and 18150 knife rev. Bar = 0,1 mm

Fig. 2 - Ultrastructure of "Teleshki" sausage with 2, salt content and 18150 kni rev. Bar = 100 nm

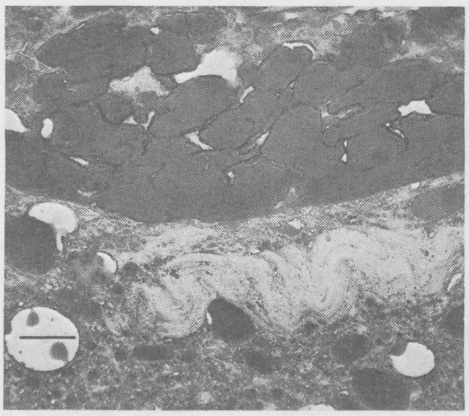

Fig. 3

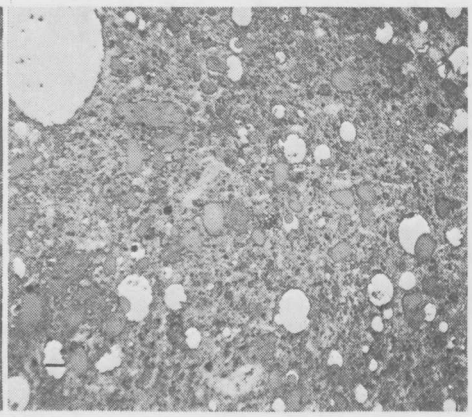

Fig. 4

Fig. 3 - Microstructure of meat batter for "Teleshki" sausage with 1,8% salt content and 18150 knife rev. Bar = 0,1 mm

Fig. 4 - Microstructure of meat batter for "Teleshki" sausage with 1,8% salt content and 28718 knife rev. Bar = 0,1 mm.

Fig. 5

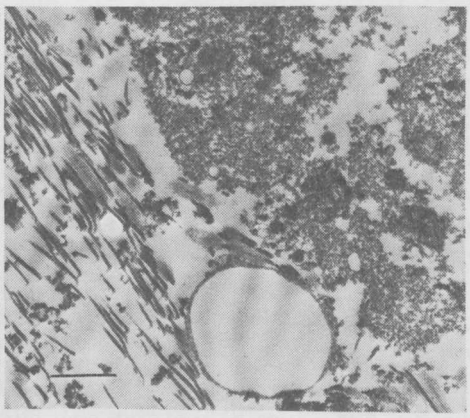

Fig. 6

Fig. 5 - Ultrastructure of "Teleshki" sausage with 1, salt content and 28718 kni rev. Bar = 100 nm

Fig. 6 - Ultrastructure of wieners "Sofia" with 2,2% salt content and 16185 kni rev. Bar = 100 nm

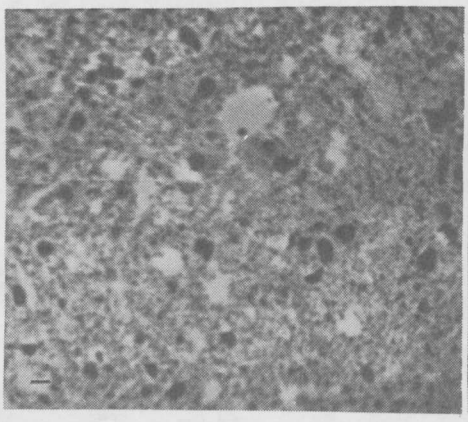

Fig. 7

Fig. 8

Fig. 7 - Microstructure of meat batter for wieners "Sofia" with 1,8% salt content and 19920 knife rev. Bar = 0,1 mm

Fig. 8 - Ultrastructure of wieners "Sofia" with 1,8% salt content and 19920 kni rev. Bar = 100 nm

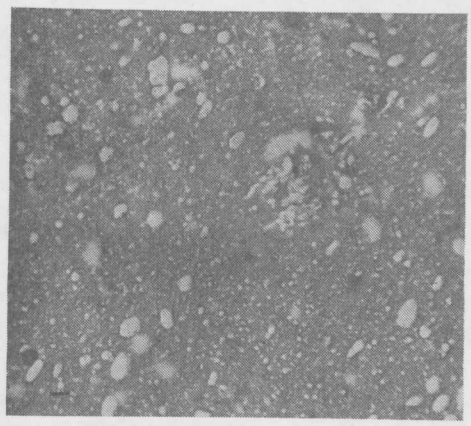

Fig. 9

Fig. 9 - Microstructure of meat batter for wieners "Sofia" with 1,6% salt content and 23032 knife rev. Bar = 0,1 nm

Table 2. Physicochemical parameters of wieners "Sofia" with different salt content and different extent of mechanical treatment

Parameters	Water content %	Salt content%	Yield	
			x±Sx	V%
Wieners - 2,2% salt, 16185 rev	58,5	2,13	121,5±0,11	0,22
Wieners - 1,8% salt, 19920 rev	59,2	1,74	121,9±0,05	0,10
Wieners - 1,6% salt, 23032 rev	58,2	1,60	121,5±0,13	0,26
			n=6	