I. SOME PHYSICAL AND CHEMICAL CHANGES OF HAM MUSCLES OF PIGS DURING CHILLING AND CURING UNDER DIFFERENT CONDITIONS

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Many investigations were done in order to shorten the duration of some operation in meat production. With the same aim the possibilities for abbreviation of chilling in canned ham production have been investigated. However, it is little known what is the influence of such abbreviation of chilling, including the influence of cure ingredience on post mortem changes in muscle.

Kassai and Karpaty (16) quoted that injecting 10% of brine, chilled at -10°C, in the ham of pigs and than dipped into the brine of same temperature, the meat was chilled after 2 h on the surface at -2°C, and in the center at 10°C. They didn't mentione the changes neither in ciochemical processes nor in physical characteristics of muscles.

It is known that the quicke chilling of muscle retards the glycolysis with retardation of decrease of pH. The consequence is that the pH_u will be higher (1,27). Muscle with slow decrease of pH is of higher WHC.

Hamm (9) summarizied that muscle would shorten less when the glycolysis developed at lower temperature, but only up to 15°C. At lower temperature the shortening of muscle will increase, with max. at 1°C (3,9,13,18,19,20). This phenomenon, or cold shortening is more expressed in muscle cut or detached from carcass (2,8,9,13,20). Muscle in cold shortening is coarser. Bush et al. (3) and Jungk et al. (13) quoted that muscle in cold shortening tenderizes about 30 h p.m. Weniger et al. (26) estimated that in aged beef the negative

effect of cold shortening even disappears.

There are data that the salts increase the tenderness of meat (7,17). Deatherage (7) mentioned that all factors influencing WHC influence the tenderness, also. Some authors quoted that NaCl added to beef immediately p.m. slows down the glycolysis and decreases the pH. The WHC of such meat is higher (9,21).

Kamstra and Saffle (15) found in pork, and Carpenter et al. (4) in beef that polyphosphate injected 15 min p.m. in meat retard or even stop the fall of pH, but not because of stopping of glycolysis but owing to the buffering power of this salt. Such a meat is more tender.

According to some authors the content of free SH groups is decreasing during development of rigor mortis but during ripening it increases (5,6,21). On this basis Chajuss and Spencer (5,6) concluded that during development of rigor mortis disulfide linkeage are formed between protein molecules provoking the stiffness of meat, and during the aging the linkeages are broken and meat tenderizes. There are some recent quotations that the amount of free SH group in meat doesn't change p.m. singnificantly.

The amount of NPN and free amino acids increase in meat p.m. as a result of proteolysis (21,22). However, was estimated that meat tenderizes before intensive proteolysis, also. The results mentioned above were obtained from the investigations of the rate of proteolysis without the influence of curing salts. Pavlovskij and Golovkina (23) investigated these changes under the influence of NaCl and found that salt slows down the proteolysis.

This study was initiated to examine comparatively the influence of rate of chilling of pig hams under curing conditions on (a) pH, (b) development of rigidity of muscle, (c) changes of WHC

and of (d) amount of free amino N and (e) SH group, as well as (f) on the changes of plasticity of muscle.

Experimental

Material.

Hams of landrace pigs, weighing from 105 to 115 kg were used. All pigs were from the same farm, grown and nourished under the same conditions. Pigs were electrically stunned and dressed in orinary way, for 30 to 40 min. Hams for quick chilling were cut from halves and trimmed by taking of the skin with fat, leaving the layer of 1 to 2 cm of fat. Hams were trimmed in 2 h p.m. Hams used as controls were cut and then trimmed from halves chilled in chilling rooms at 0° to 3°/24 h.32 hams were examined in total.

Methods.

Hams were quickly chilled by two procedures:

Procedure I: Right trimmed hams were dipped 2 h p.m. in brine refrigerated at 0°C. Relation meat-brine was 1:3. Brine was permanently stirred and kept at the same temperature. When hams were refrigerated at 10°C in the depth of m. semimembranaceus (m.Sem.) were transfered into brine refrigerated at 5°C. The hams were injected 24 h p.m. by 12+2% of brine, containing 3 kg of "Tari P2", at 100 l.

Procedure II. In right hams was injected 2 h p.m. 12+2% of brine and than they were dipped in it as described in Procedure I.

In chilled left hams, used as controls, 12+3% of brine was injected 24 h p.m. Brine was refrigerated at 4°C.

Hams chilled by Procedures I and II were dipped into brine for 3 and controls for 2 days, and after that were drained for 1 day at 5°C.

Rate of chilling was measured by bimetalic thermometer in m. Sem. 1 cm beneath the surface and in depth near ossis femoris.

Rigidity was registered with rigormeter by Sybesma at three determined spots on m. Sem. and m. gluteus medius (m.G.m.). Results obtained by three measurement were expressed as average values.

pH was measured in two samples of aqueous extract of m.Sem. (1:5) with Phyllips M 9400 potentiometer.

WHC was determined in two samples of m.Sem. using Grau and Hamm method. Besides, WHC was determined in (b) 450 g of m. quadriceps femoris (m.Q.f.) cut into 3 to 4 pieces, canned and sterilized for 35' (105°C, and (c) in 200 g of ground and mixed muscles, canned and sterilized for 35'/110°C. Two days later the cans were opened and drip in relation to meat was determined.

Plasticity of muscles was determined by measuring the surface of compressed samples of muscle while WHC was determined. Surface of muscle film (and of wet filter paper) was measured by planimeter MOM, Budapest.

Free amino N was determined by Pope and Stevens method (24) as modified by Schröder et al. (25). Extract from m.biceps femoris (m.B.f.) was prepared according to the Herzheld (12) method. Results were expressed as amount of free amino N in relation to total N.

Free SH groups were determined by Hamm and Hoffman (10) method.

Samples for determination of pH, WHC (by compression), plasticity, content of free amino N, and free SH groups were taken 24 h p.m. from the center of hams chilled by Proc.I, where curing ingredients didn't diffuse.

Results and discussion

The rates of chilling of hams refrigerated by Proc.I and II were of small differences. These differences were expressed only in first two hours of chilling. Rates of chilling of these hams in relation to the controls were small at the beginning, later growing bigger. The temperature of 30°C was reached in depth of hams chilled by Proc.I and II after 20 min of chilling and for about 30 to 40 min earlier than in controls. Temperature of 20°C was reached after about 90 min of chilling in the center of the first group of hams and 90 min later in controls, and temperature of 10°C was reached in the first group after about 4 h of chilling and in controls about 6 h later.

In m.Sem. of hams chilled by Proc.I pH_u decreased not lower than 5,7, while in controls it reached 5,5. (The brine was pumped in these hams 24 h p.m.). In the same muscle from hams chilled by Proc.II, pumped with brine 2 h p.m., pH_u was 5,8 after 4 h, while in controls was pH_u 5,4 and began to increase after injection of brine, but never reached pH in hams chilled by Proc.I and II. pH of muscles chilled by Proc I was higher than in controls owing to quicker chilling of the first. In the hams chilled by Proc.II pH was higher because of the early influence of polyphosphate (4,15) and NaCl, which influence pH elevation (9).

The obtained results show that the development of rigidity was quicker in quickly chilled muscles. Due to it can be concluded that rigidity was developed as a result of rigor mortis and cold shortening. Namely, in m.G.m. of hams chilled by Proc.I (Fig. 1.) the rigidity was 2 h p.m., i.e. 1 h after cuting the muscle, 11 mm and in control was 9 mm. These results were in ac-

cordance with the findings of some authors (2,8,9,13,26). In m. Sem., muscle which wasn't cut while hams were trimmed, the rigidity didn't increase so much. In m.Sem. and m.G.m. of hams chilled by Proc.II maximal rigidity was developed about 3 h p.m. while in controls about 10 h p.m. However, after the maximum rigidity was reached there were not significant differences between those chilled by Proc. I and II and their controls. Maximal reached values remained, in general, the same during 96 h of examination. These results were different from findings that noncured beef muscle with developed cold shortening will tenderize after 30 h p.m. (3,13). But our results were obtained investigating pork muscles pumped with 14 and 15% of brine. In addition to these effects, injected brine mechanically increased the rigidity of muscles and its ingredients provoked the swelling effect.

WHC of m. Sem. of hams chilled by Proc. I was very similar to controls - it was decreasing until 24 h p.m. (from 5,5 to 10 cm^2) and then, when the brine was injected, WHC was increasing in hams chilled by Proc.I (Fig.2.). At the end of curing and of draining (96 h p.m.) WHC of muscles of hams chilled by Proc. I was 2,7 and of controls 4,6 cm^2. Changes of this characteristic in m.Sem. of hams chilled by Proc. II are shown in Fig. 2. a. From these data one can see that WHC of muscles of these hams was markedly higher than of controls, and that 4 h after pumping WHC began to increase. At the end of examination (96 h p.m.) the difference was about 4 cm^2 between these values (3,7 and 7,5 cm^2). In this case "presalting" effect was expressed (9).

By the measurement of the weight of hams during the chilling and curing it was determined that hams chilled by Proc. II contained the largest quantity of water. This content was higher in rela-

tion to controls for +1,59%.

However, muscle of all groups of hams processed at 105° and 110°C, including controls, released the same quantity of juice, in general (Table 1.).

Amount of released juice during sterilization of the cans containing 450 g and 200 g of meat

Table 1.

Samples	Amount of released juice in cans containing			
	450 g - Pieces of meat		200 g - ground meat	
	$\bar{x}$		$\bar{x}$	
Procedure I	25,7	0,84	23,9	1,09
Controls	24,3	0,78	23,1	0,71
Procedure II	25,4	1,18	21,6	1,82
Controls	24,8	1,00	21,8	1,64

Comparing these results with those obtained by measurement of WHC by Grau and Hamm method it is noticeable that the increased WHC detected by compression was completely lost under the effect of the temperature of 105° and 110°C. These results are opposite to the findings of Wismer-Pedersen and Briskey (27). However, these authors examined the quickly chilled hams pumped with 8% of brine.

By measuring the amount of free amino N in m.B.f. there was non difference in effect by Proc. I and II in the rate of proteolysis, but it was detected augmentation for 1/3 of free amino N (from 1,77-1,97 to about 3,0%) in all groups of hams during chilling and curing.

At the same time, it was detected that used procedures of chilling and curing didn't influence neither the change of amount of free SH groups nor these amounts were significantly changed during chilling and curing (P=0,05).

Measurements of the plasticity of muscle, as indication of

tenderness, showed that this characteristic was decreasing for 24 h in hams chilled by Proc. I as in the controls and later was increasing. Plasticity of muscles from hams chilled by Proc. II was constantly increasing and was constantly higher in controls (Fig. 3. and Fig. 3.a). Such difference in plasticity remained until the end of examination, and probably was the result of the effect of NaCl and polyphosphate.

The obtained results show that used procedures of chilling and curing increase the tenderness of muscle, but the changes of this characteristic were not followed by corresponding changes of rigidity. Difference between this result and the findings obtained by Bush et al. (3) and Jungk et al. (13) can be explained by the effect of salts from brine which was pumped in hams, while these authors examined noncured meat.

Our results didn't confirm the presumption that the changes of rigidity and tenderness of muscles were followed by the changes of amount of free SH groups. However, the changes in tenderness were in correlation with the changes of WHC.

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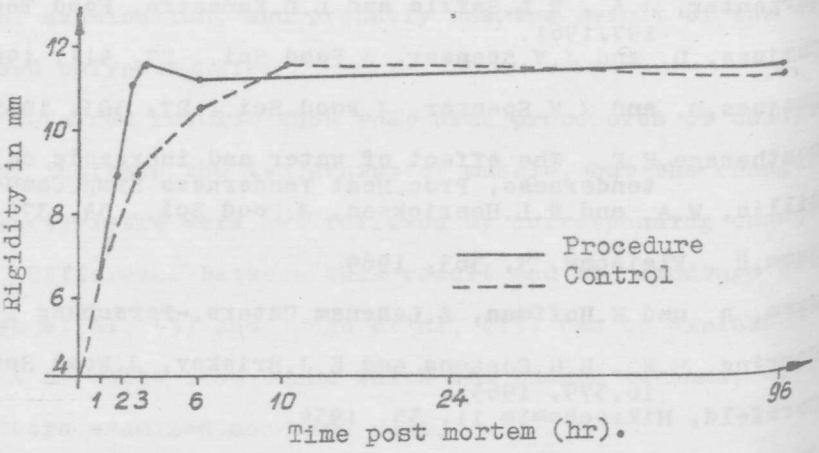

Fig. 2 WHC of m.Sem. from hams chilled by Procedure I and from controls.

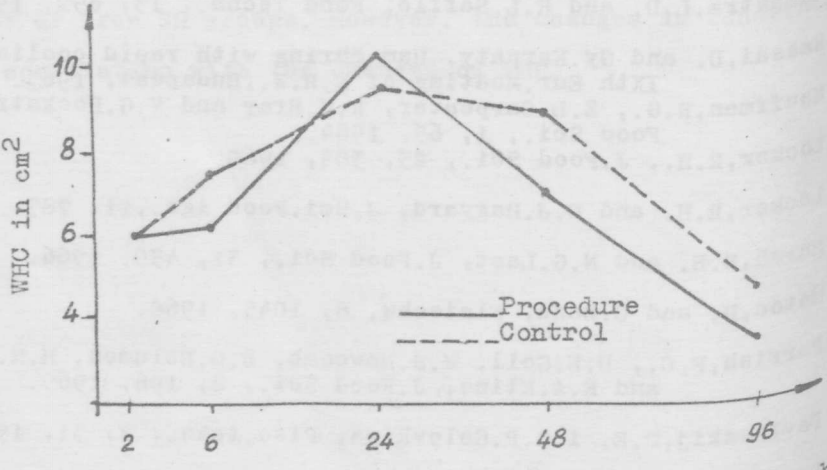

Fig. 1. Development of rigidity in m.Gl.m. from hams chilled by Procedure II and from controls

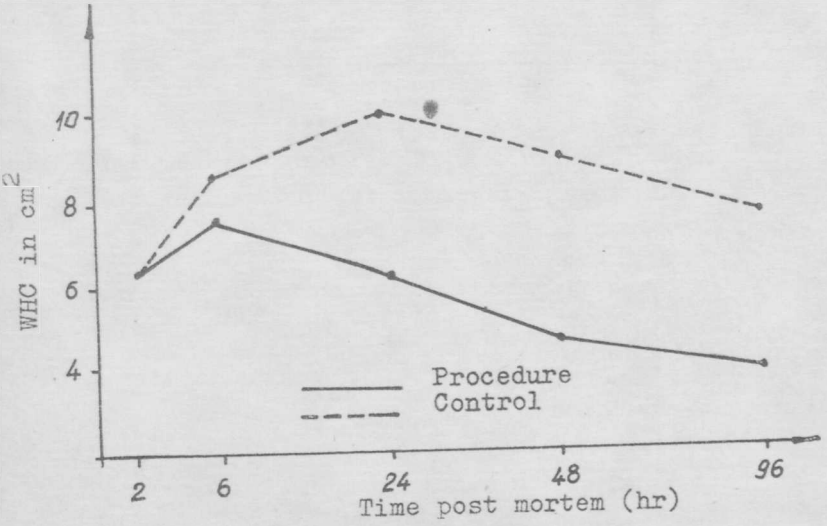

Fig. 2a. WHC of m.Sem. from hams chilled by Procedure II and from controls

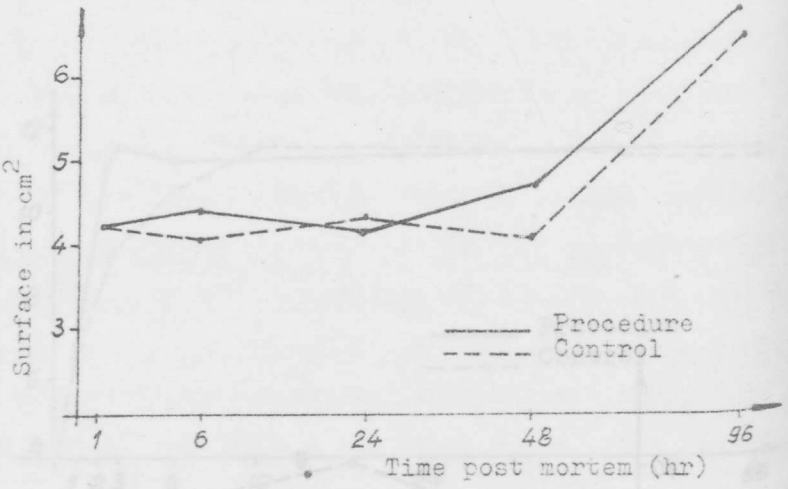

Fig. 3. Plasticity of m.Gl.m. from hams chilled by procedures I and from controls (by compression)

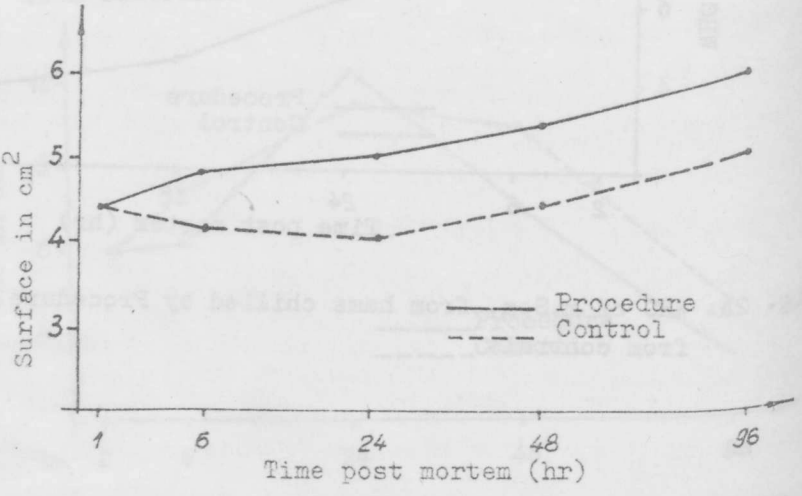

Fig. 3a. Plasticity of m.Gl.m. from hams chilled by procedures II and from controls (by compression)