# MEAT CONSISTENCY CHANGES CAUSED BY DEHYDRATATION AND SALTING IN THE PRODUCTION OF RAW RIPENING HAM

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## Background

Consistency is an important quality criterion in all meat products. It may be easily formed in products made from minced meat but it is more difficult to achieve when tissues maintain their natural structure. In the production of raw fermented ham the consistency is being formed, above all, by dehydration, salting and acidification of muscle tissue. During long-term ripening further consistency changes may occur and are caused by the activity of muscle tissue own enzymatic system as well as of that produced by purposely introduced microorganisms. Examination of meat consistency changes during the manufacture of raw fermented ham is faced by restraints of methodological nature. There has been no method that is based on repeatable sampling and differentiate well the natural properties of raw meat having loose structure as well as of the finished product demonstrating specific structure similar to that shown by meat under *rigor mortis*.

## Methods and material

General principles of consistency examination.

The CASRA method (Tyszkiewicz, Olkiewicz and Daun, 1997) was found useful in the examination of both natural raw muscles and raw fermented ham. That method examines deformation changes caused by a rectangular punch that squeezes into the sample and exerts compression action in front of the punch and cutting action at the sharp edges of the punch. The adequately programmed stress distribution in the course of measurements makes an observation of meat feasible both during the successively growing stress as well as during relaxation.

The application of a special rack, that fastens the meat sample was a novelty. The rack in question is in the form of a flat plate furnished with sharp needles situated in the corners of hexagons and placed densely on the surface area. In that way the cell contour lines are arranged in the honeycomb form (Figure 1A). The meat sample as a thick slice (Figure 1B) was placed into the rack and pressed. Afterwards the upper layer of the sample was cut off using a special guide bar (Figure 1C) to achieve exactly the required slice thickness. The samples were examined by successive penetration carried out with the punch in surface points being the centre of hexagons determined by the needles.

Detailed principles of consistency examination method.

UTM Zwick model 1445 was used. The rack was furnished with needles of 2mm diameter, 20mm long and the distance between them was 15mm. The CASRA method was used under the following parameters: crosshead velocity: between the bites - 120mm/min and within the bite 2mm/min, unit force $F_1$=1N, force increment - 1N, duration of stress and relaxation period - $t_0$=15s each, rectangular punch (2 x 6mm) - S=1,2 x $10^{-5}$ $m^2$, modular stress $\sigma_1$=8,33N/$m^2$.

Experimental material - 6 pieces of porcine *m. Quadriceps femoris* (Large White breed). The muscles were cut into transverse slices about 35mm thick. One slice was examined by that method immediately after being cut off. The other slices were dredged with coarse-grain salt and stored under refrigeration for 1, 3, 7, 14, 18, 28 and 36 days. After those periods, salt was removed and the slices dripped off, packed into plastic bags and kept for 7 days to equalize water and salt content in the samples. The slices prepared in that way were examined in UTM Zwick using the method presented earlier. After examination of muscle slices, both fresh and salted, they were minced and subjected to chemical composition analysis. Among others, total protein (B) by Kjeldahl method and water content (W) by drying method at 105°C were determined and expressed in %.

## Results

The results of meat consistency examination were obtained as CASRA specific rheograms. Figure 2A presents the typical rheogram of fresh meat, whereas Figure 2B the typical rheogram of salted and dehydrated meat. In CASRA rheograms three basic rheologic parameters are given: plasticity (P), elasticity (E) and fluidity (F). Besides, two additional parameters pertaining to deformation were obtained, i.e. $D_{min}$ [%] - degree of deformation under the lowest stress $\sigma_1$=8,33N/$m^2$ and $D_{plast.}$ [%] - degree of deformation under the stress resulting in structure damage, i.e. yield point $\sigma_0$. The data on consistency examination are presented taking into consideration the degree of muscle tissue hydration; i.e. water content to protein content (W/B) ratio.

Figure 3 presents the P, E and F parameters, while Figure 4 the $D_{min}$ and $D_{plast.}$ parameters as W/B functions. As it can be seen, all examined consistency parameters were dependent on the degree of muscle tissue hydration. With the increasing dehydration of the muscle tissue expressed by the diminished W/B value, the plasticity (P) increased whereas the elasticity (E) and fluidity (F) values decreased. Such relationships were observed earlier by Tyszkiewicz (1989) who examined those parameters in thermally denatured sausages. Certain difference was noted in the relationship between elasticity parameter (E) and total protein content, when the characteristic maximum was found at 16-20% total protein content. However, it should be remembered that such protein content is typical for sausages showing 100% yield and a part of the graph prior to maximum pertained to sausages of higher hydration than natural.

Very interesting conclusions may be drawn from the analysis of variance of $D_{min}$ and $D_{plast}$ parameters as affected by W/B ratio. The $D_{min}$ parameter characterises „loose" structure of natural meat and may be used as *rigor* indicator in the muscle tissue. The examined samples of meat in the natural state demonstrated very „loose" structure and after salting and water loss it soon disappeared and under W/B ratio around 2 they were found to be in *rigor* state.

$D_{plast}$ parameter in meat samples of natural, „loose" structure was close to the maximum (100%) value, thus it means that structure damage by cutting muscle fibres was achieved under total or nearly total sample penetration. It demonstrates that muscle fibres in the natural state are able to be markedly stretched and are being cut under total tissue crushing under the mandrel. In the *rigor* state, cutting of muscle fibres can already be done under substantially smaller deformation.

## Conclusions

1. The method of meat consistency examination was developed that may be used to examine, in comparable conditions, samples of natural muscle tissue of „loose" structure and in the *rigor* state associated with dehydration and salting in the process of modelling raw ripening ham production.
2. It was demonstrated that with meat dehydration and salting the plasticity (P) value is monotonously increasing while the elasticity (E) and fluidity (F) values are monotonously decreasing.
3. It was demonstrated that the parameters which characterise meat sample deformation during $D_{min}$ and $D_{plast}$ examination manifest the *rigor* state that contracts muscle tissue and makes its structure similar to the plastic structure being found so far in meat products subjected to thermal denaturation.

## Literature:


1. Tyszkiewicz S. (1989) – Effect of amount and origin of protein on the rheologic characteristics of cooked sausages. Acta Alimentaria Polonica, Vol. XV (XXXIX) No 4, 277-289.
2. Tyszkiewicz S., Olkiewicz M., Daun H. (1997) – Multiparametric method for the rheological evaluation of meat and other solid food. J. Texture Studies, **28** (1997), 337-348).


Fig. 1

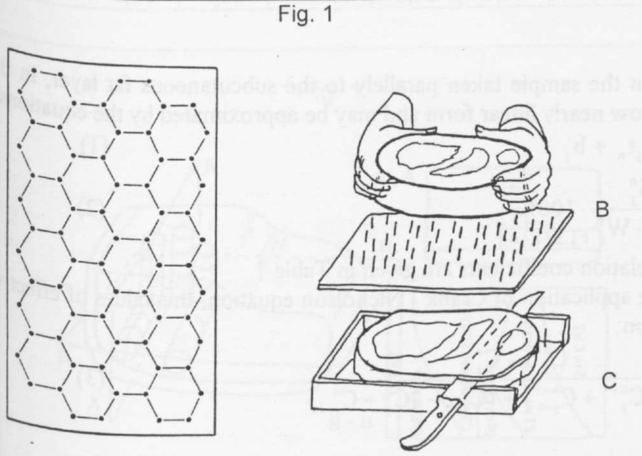


Fig. 2

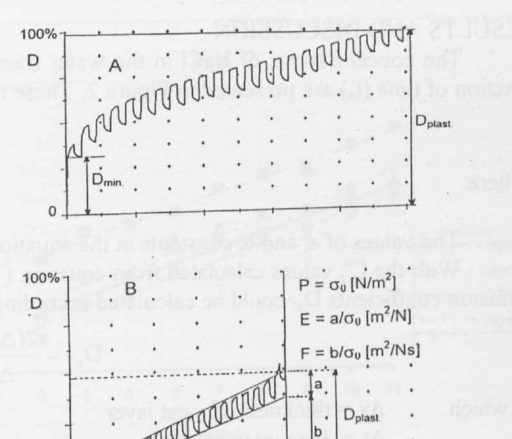


Fig. 3 Influence of W/B on P, E and F

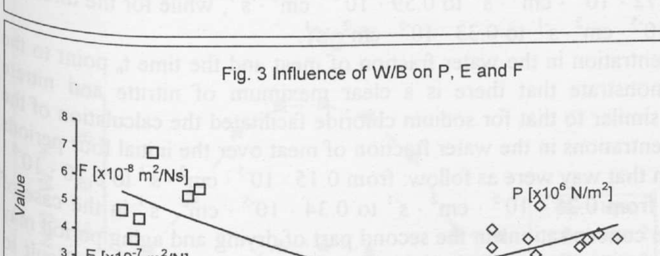


Fig. 4 Influence of W/B on $D_{min.}$ and $D_{plast.}$