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ЕВРОПЕЙСКИЙ КОНГРЕСС РАБОТНИКОВ
Н И И МЯСНОЙ ПРОМЫШЛЕННОСТИ

th EUROPEAN CONGRESS
OF MEAT RESEARCH INSTITUTES

ter EUROPÄISCHER KONGREß
DER FLEISCHFORSCHUNGSINSTITUTE

ème CONGRES EUROPEEN
DES INSTITUTS DE RECHERCHES
SUR LES VIANDES

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THE INFLUENCE OF PRE-FREEZING OF MEAT ON THE QUALITY OF FERMENTED SAUSAGES

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МОСКВА 1962г.

THE INFLUENCE OF PRE-FREEZING OF MEAT ON THE QUALITY OF FERMENTED SAUSAGES

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The main characteristic of the modern meat industry is the tendency to fasten every processing stage. However, we imply that the achieved economical effect will be followed by better or, at least the same as before, quality of meat products. The realization of these demands is easier because of the technical progress and on the other hand because of the better knowledge of the biochemistry of processed raw mate-reals.

A good example that illustrates the general development tendencies of the meat industry is the production of fermented sausages-for instance cervelates. The production of these sausages from meat subjected to preliminary dripping with simultaneous pickling or without this treatment goes down in history. The present development of refrigeration and conditioning technics facilitated the removal of many generally known technological and economical shortcomings connected with this type of production and facilitated also passing to the production of these sausages even from frozen materials. There is no exaggeration in the statement that nowadays only unsatisfactorily modernized processing plants produce the above mentioned sausages from pickled or only preliminary dripped meat.

Previous achievements in biochemistry connected with those in freezing of raw material, especially of meat, allow to make the assumption that the use of frozen meat to the production of sausages may fasten the processing and thereby to fulfill the progressive demands. It is evident that in defrosted meat both the autolitic and the bacteriological proteolysis are generally more intensive. The so called cryolysis is followed by greater intensity of biochemical and biophysical changes in defrosted meat. Cryolysis breaks the osmotic balance, causes changes in colloidal structure of meat tissue and

microstructure of its cells, increases the total surface of colloidal particles, intensifies the precipitation of proteins from solution etc, Cryolysis causes the increasing of the surface area for enzymatic action hence also the potential conditions for greater enzymatic activity and increases the rate of enzymatic processes and thereby the process of pickling as a whole.

The intensity of processes caused by cryolysis is different. Undoubtedly it depends both on the biochemical and biophysical structure of raw materials at the time of slaughter of the animals, the advancement of their post-slaughter changes and technological conditions of the very freezing process i.e. practically the level of attained temperature of frozen raw materials and the period of its action.

On the basis of the outlined situation the purpose of our work was to give the answer on two questions namely the question of the technological usefulness of pre-freezing of raw material intended for production of fermented sausages and on the other hand what temperature conditions applied for pre-freezing are most suitable.

According to this the experimental sausages-cervelates were produced by the normal method i.e. without pickling of meat. The raw material for these sausages contained 40% of beef meat, 40% of pork and the remainder was lard. The only experimental modification of the production was the division of the raw material into three parts before further processing. All parts were disintegrated into fist-size pieces. One of them was stored in a cooling room /temp.0 to 4° C/in a 5 cm. layer. The other was frozen at temp. -2,5 to -3.0° C and the third one was frozen in a freezer /temp. -24 to -25°C/. After a 24 hours storage period the sausages were produced from each batch separately. Then the sausages were stored in an unconditioned magazine /temperature -10 to 14°C, humidity=75 to 85%/ for 40 days.

Analysis of the effects of different refrigeration treatments included the determination of changes in the raw material and the determination of deviations in the course of biophysico-chemical processes in the obtained fermented sausages.

The changes occuring in meat after 24 hour storage at different temperatures were observed by means of examining the water binding capacity of meat by Grau's modified method /7/ the relative concentration of myoglobin derivatives by the method of Braumand et al./I/ and buffer capacity referred to dry basis /I03.

The changes occuring in experimental fermented sausages during production and storage were evaluated by means of determining the level of reducing sugars according to Somoga's method modified by Kurowska /3/, free nitrites according to Matrozowas metod modified by Pezacki /9/ chlorides by adjusted method of Molher /6/. The results were referred to dry basis. The comparison of the changes in these criteria was possible in each period of production and storage of sausages. For the same purpose potentiometric concentration of hydrogen ions and weight losses during production and storage were estimated. The sausages were also subjected to organoleptic evaluation by a panel consisting of three to five members /I5/. The orientation in biochemical processes based on the criteria above mentioned enabled the examination of stuffing sausages immediately after aging, after smoking, and then after I0,20 and 40 days of storage. In every case outer and center layers of sausages were analysed, there was no examination made of inner layer.

The results show that most evident are the differences in colour of sausages, produced from raw material prepared in different ways. Pre-freezing does not change the general pickling tendency towards myoglobin oxygenation to nitroso-oxy-myoglobin, but it changes the dynamics of this process and its localization. According to the data from fig. I we may state that:

I. The greater part of nitroso-oxy-myoglobin develops during aging and smoking of sausages, produced from meat frozen at a temperature of $-3^{0}C$ the smallest in those produced from meat frozen at a temperature $-24^{o}C$; because of the low temperature the colour of the last sausages is of the smallest intensity.
2. Nitrosooxymyoglobin in sausages of meat frozen at a tempe-

rature of -24°C is of the worst stability and in the time of storage is most easily subjected to undesirable destruction processes. The best stability shows the above mentioned heme pigment in sausages produced from meat held at temperatures not lower than 0°C; the differences in this cas are most pronounced when the time of storage of sausages is prolonged.

3. Oxygenation of myoglobin to nitrosooxymyglobin during production and storage is greater in the inner layers of sausages produced from meat cooled and frozen at a temperature of -3°C than that in outer layers; in sausages of meat frozen at -24°C the situation is just the opposite-the desired colour of the outer layers is more intensive and stable.

The observation of colour and pigment changes in fresh sausages indicates that especially in the case of a short storage of the final product the pre-freezing at a temperature of -3°C is advisable. If the sausages are stored for a longer time, such technological treatment is less advisable. In the applied method of production the freezing of meat prepared for production of fresh sausages is not advisable. One gets the impression that the rate of raw material freezing before production is unimportant. The intensity of undesirable pigment transmutations refers to colour intensity and its saturation in sausages. One states that not only sausages produced from quickly frozen meat/at temperatures of -24 to -25°C/ but also produced from meat more slowly frozen /at a temperature of -8°C/ show the decreased concentration and stability of technologically desired pigments/ IO/.

In search of the reasons explaining the observed colour differences, pigment concentration and stability of fresh sausages of differently prepared raw material, one has to observe the fact that the pre-freezing of raw material considerably changes the relative concentrations of different myoglobin derivatives /tab.I/. Practically there is no oxydation and oxygenation processes of myoglobin in meat kept for 24 hours at a temperature of -24°C. However, in cooled meat the relative content of oxy-and metmyoglobin increases. It is generally known that both pigments are undesired for

colour transmutations during pickling of meat. In order to change them into the desired nitrosooxymyoglobin the first pigment must be oxygenfree /I3/ and the other reduced /4/. Metmyoglobin reduction demands a strictly defined medium /I6/. If such reduction. which is usually of small intensity, takes place, it increases the storing stability of colour. Experiments show the greatest stability of heme pigments in fermented sausages produced from meat held at temperatures above $0^{o}C$, which can be explained by the increased content of metmyoglobin in the raw material.

The other factor which affects the colour of fresh sausages is undoubtedly the denitrification of nitrates, added during the production. Its intensity does not show considerable differences but nevertheless one can observe the tendency to increase the contents of free nitrates in the central layer of fermented sausages produced of frozen raw material /fig.2/. However the quantity of free nitrites is the least in the central layer /fig.3/. The same dependence is stated in the case of other experimental sausages. The drop in free nitrite content corresponds to the decrease of free nitrates level.

The comparison of the dynamics of myoglobin oxygenation to nitrosooxymyolobin with that of denitrification shows that in the case of using meat frozen at $-24^{o}C$ less nitrosooxymyoglobin develops. This is probably caused by the lower denitrification rate of nitrates added. The performed experiment did not allow, however, to give an answer in what a degree the stated deviation in the denitrification the process is connected with the cenoanabiotic exchange of microorganisms. The recognition of deviations in the microbiological picture of fermented sausages produced from differently prepared raw material would enable to join the chain of causes and effects.

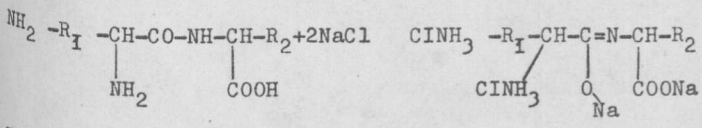
So or otherwise meat frozen even for a short period at- to a temperature about $-24^{o}C$ is not suitable for production of fermented sausages because such a treatment influences undesirably hydrokynases first of all intensifying the activity of exidases. It is interesting that freezing influences

also the activity of such enzymes as phosphatases or carboxylases. This is testified by the different intensity of inversion and consumption of added sacharose /fig.4/. The greatest differences in activity of these enzymes appears in the period of production especially during smoking. These differences are diminished in the course of storage of the final product. In freshly smoked sausages and at the start of their storage the amount of monosaccharides in the central layer of sausages produced of meat frozen at a temperature $-3^{o}C$ is the least. In these sausages also the greatest content of nitrosooxymyogblobin was found. The influence of pre-freezing of meat on enzymes, taking part in the chemical changes of carbohydrates are not, however, so plain and pronounced as in the case of hydrokinases. Nevertheless we may state that the increased activity of dehydrogenases, phosphorylsses, amylase and other enzymes taking part in transmutations of carbohydrate compunds are generally accompanied by considerable increase in concentration of hydrogen ions /fig.5/.

The technological preparation of raw material for sausage production exerts at least an influence on the group lf enzymes catalyzing transmutations in proteins of sausages. The effect of the change in activity of proteases that is both proteinases and peptidases is the increased buffer capacity of water extracts and greater moisture loss of sausages produced from meat frozen at a temperature of $-24^{o}C$. It is interesting that as a result of different meat refrigeration above all the dissociation of carboxyl groups increases; the more the lower is the temperature of treatment /fig.6/. In similar way forms the dissociation level of these groups in the period of production and storage of fresh sausages. In central layers of experimental sausages the changes in buffer capacity were always greater, than superficial ones. However, we must pay attention to the fact that the applied procedure of buffer capacity measurement enabled the determination of the quantity of carboxyl groups of water soluble proteins, amino-acids and organic acids, which follow the fermentation of sugars. Now, the question arises what is the share of the last mentioned acids in the

buffer capacity of fermented sausages during the production and storage.

We may find and indirect answer to the question in an analysis of ion change in proteins, and at least in the observation of changes in the amount of chlorides. According to some opinions /I4/ the following reaction occurs during the pickling process;



The data from fig.7 show that the production and storage changes in the amount of chlorides depend also on raw material preparation prior to production and besides on the dislocation of points in the sausage, where from samples were taken for analysis.

The amount of chlorides:

I. is in the central layers in every case greater than in the superficial ones
2. is higher in the period of production especially during smoking
3. in the internal layer increases or is the same during the storage period of final product as compared with that at the end of smoking but decreases permanently in the superficial layers
4. in both layers of sausages produced from chilled meat is always greater than in comparable sausage layers from meat frozen at a temperature of $-3^{o}C$ and especially in sausages from meat frozen at a temperature of $-24^{o}C$.

The changes in the amount of chlorides are similar to buffer capacity changes but they simultaneously show distinct differences. Since the buffer capacity of water extracts from sausages produced from meat frozen at a temperature of $-24^{o}C$ is the greatest and the chlorides level is the lowest. On the basis of these facts we may conclude that the increase in buffer capacity of the above mentioned water extracts is connected not only with the dissociation of protein particles but also with carbohydrate fermentation. This conclusion

may be confirmed by the fact that the decrease of buffer capacity in water extracts from cooled meat is mostly accompanied by the decrease in summary content of lactic and pyruvic acid /I2,II/.

Nevertheless the increase in buffer capacity of water extracts from sausages of meat frozen at a temperature of $-24^{o}C$ gives evidence of decrease in buffer capacity of the very meat and thereby of compounds which did not diffuse to the extract. This fact we may explain by an increased tendency to alkalization of these sausages during storage /fig.5/. In spite of only insignificantly lower concentration of hydrogen ions in meat frozen at a temperature of $-24^{o}C$ /tab.2/.

The above outlined changes of proteins are reflected in changes of the water holding capacity of meat. The most important technological effect in the described case are deviations in drying ability observed in fermented sausages during production and storage stages. The carried out experiments lead to the statement that a short lasting freezing of meat to the temperature of $-24^{o}C$ does not change its water binding capacity. On the contrary, the cooled meat, previously stored during 6 days in a cooling room shows a further tendency to increase the water binding capacity. Consequently we may suppose that in this period follows the liberation of hydrophylic protein groups, in consequence even as a result of actomyosin dissociation /8/. These insignificant differences in water binding capacity of meat are distinctly manifested in range of moisture losses in weight of the sausages. The losses are the greatest in sausages from frozen meat. In comparison with sausages produced from cooled meat the losses are greater, even to about 5% /fig.8/. In this scope the above-mentioned results agree with previously publicated data by one of us /I0/. Even if omit other discussed in this publication technological consequences of reduced water binding capacity, nevertheless we must state that pre-productive freezing of meat in every case decreases the effectiveness of the production of fermented sausages.

No wonder that the above outlined different effects of refrigeration of raw material on the activity of their enzy-

matic system and the direct effect of these catalysts reflects also in subjectively evaluated quality of fresh sausages. Sausages produced from meat cooled and frozen to a temperature of -3°C did not differ considerably. They were characterized by a typical sourish taste, aromatic odour, satisfactory red colour and cleancut several raw material components. On the contrary sausages from meat frozen at a temperature of -24°C were characterized by a more queasy taste, less intense odour, colour rather orange and their components were more crushed. After 20 days storage the first two sorts of experimental fermented sausages lost in some degree their own typical taste and odour. The taste of sausages from frozen meat was at that time sour and their odour was similar to that of acetic acid.

It is clear that the above described experiments on sausage production do not solve the problem. The do not fully answer many other questions. There remains e.g. the question of such further modification of the sausage processing, which would enable to retain the undoubted profits of pre-refrigeration of raw material and simultaneously to avoid the undesirable effects of this treatment. Still, our interest is connected with the level of temperature and duration of freezing, quality of raw material, the technics of its homogenization, raw material components and also the suitable oxygen-free conditions in the ageing period of fermented sausages even if by immersion into brine. However, the performed experiments give an answer, which confirms the lack of technological justification of pre-freezing of raw material in the case of its processing to fermented sausages according to the method applied more and more often, especially in Middle and West Europe. The most technologically suitable to such processing is meat shortly treated by a temperature of -3°C.

Conclusions:

I. The method of pre-freezing of meat for production of fermented sausages influences to a great extent the course of biochemical processes occuring during production and storage stages of sausages and thereby their quality.

2. There is no technological justification with regard to quick short lasting freezing at the temperature of -24°C for raw material designed for fresh sausages. The taste and odour of these sausages is unsatisfactory as well as their internal structure, the colour is unstable and undesired, productivity smaller. Increasing of oxydation processes causes the detaining or desired colour changes of sausages. One can also observe less intensive denitrification and a greater tendency of myoglobin to oxidation. Because of a stronger tendency to alkalization spoilage of sausage is quicker.
3. No serious quality differences are observed between sausages produced from meat cooled only and from meat frozen at a temperature of -3°C. Sausages produced from raw material, which was not stored at a temperature below 0°C are more suitable for longer storage in an uncoditioned magazine.
4. The above mentioned results are in good agreement with results obtained in our previous experiments, that is none of them confirm the technological usefulness of preprocessing freezing of meat even at -8°C for fresh production of fermented sausages.

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Summary

The influence of pre-freezing of meat on the quality of fermented sausages

There were two purposes of the performed experiments. The first was the evaluation of the technological usefulness of three different pre-processing operations of preparation of rerrigerated meat fro the production of fermented sausages /cervelat type/. The second was the technological explanation of their biophysical and biochemical changes. The experiments proved that the pre-processing freezing to -3°C of the raw material is fully advised. The production of fermented sausages to be stored for a longer time of meat kept at temperatures not lower than 0°C shows also the satisfactory effects.

In contradiction, meat frozen to -24°C is not suitable for production of fermented sausages. Oxidation processes were intensified in sausages produced from such a meat. As the result, smaller amount of nitrosooxymyoglobin is formed,which in addition is more easily subjected to oxidation, during storage of the sausage in such products carbohydrate fermentation is of smaller intensity the acidity is lower, the potential susceptibility to decomposition is higher and the productivity is by some per cents lower than in sausages of meat cooled only. The organoleptic quality of sausages from frozen meat is also lower than that of the controls.

The above effects are identical with our previously published results. They showed that the pre-processing freezing of meat even to -8°C is not necessary.

However this problem is not solved yet. There exists a theoretical probability of modification of the production of fermented sausages, which permits to take advantage for the deep freezing of meat and simultaneously to avoid its undesired effects on the quality of the final product.

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