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CURING OF MECHANICALLY DEBONED PORK MEAT

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The bones of the body of slaughtered animals extracted during the process of cutting up the carcase are a basic raw material for obtaining mechanically deboned meat. The term mechanically deboned meat /MDM/ is intended to include meat tissue from which the bone portion has been removed by mechanical, as opposed to manual, techniques. Pork carcases would each contribute from 3 - 4 pounds of MDM per carcas /Goldstand 1975/, if all bones were processed. Under present industry practices /Goldstrand 1975/ picnic, ham and blade bones are the bones available in large volume for deboning. These bones represent 60 - 65% of the bones of a pork carcas and will produce 2,0 - 2,8 pounds of deboned meat.

Although mechanically deboned beef, pork, lamb, turkey, chicken and fish are the terms most often found in the literature, mechanically deboned meat is called by many different names. The term "mechanically separated meat" was adopted at the 10th Session of the Codex Committee on Processed Meat and Poultry Products in Copenhagen, November 20-24, 1978, and is being used in some countries. "Mechanically processed /species/ product" - for example, mechanically processed beef product - is the name used by the Food Safety and Quality Service of the United States Department of Agriculture /USDA/ for red meat. Nevertheless, the Food Safety and Quality Service continues to call chicken and turkey "mechanically deboned poultry" /U.S. Department of Agriculture, 1979/. "Mechanically recovered meat" is a still different name used in some European countries. Perhaps the most controversial name is "tissue from ground bones", which was proposed by the Food Safety and Quality Service of the USDA /U.S. Department of Agriculture, 1977/. The name was widely circulated by the popular press and by consumer activist groups that opposed acceptance of the process, but it will never accepted by government or industry in any country.

In recent years the meat industry has equipped itself with machinery for obtaining mechaninically deboned meat. Meat obtained in this way is used as a component of sausage mixtures, poultry meat products and canned products. In practice the use of the meat has hitherto been based on traditional processing methods, but there have been no investigations in this field and thus no results of such investigations. Results of this kind would be of interest because of the different chemical composition and thus different properties of mechanically separated meat as compared with muscle tissue.

The specific chemical composition of mechanically separated meat is due to the relatively high percentage of bone marrow in the meat mass. The proportion of this substance in mechanically deboned meat causes a rise in the content of iron, ascorbic acid and fat and the higher content of unsaturated fatty acids /Field 1976/. The increased content of haemines from the marrow determines the 25 to 35% more intense colour of mechanically deboned meat as compared with meat with a similar protein and fat content /Goldstrand 1975/.

The higher proportion of haem compounds has a catalytic effect on lipid oxidation, which is regarded as the most important factor in the deterioration in quality of mechanically separated meat during storage. At the same time oxidation and destruction of the haem are brought about by fat oxidation and this causes the colour of this meat to deteriorate.

The reduced keeping quality of mechanically deboned meat is also the result of serious infection, particularly by psychrophilic microorganisms which are proteolytically very active. This situation is brought about by mixing and the temperature rise in the mass during mechanical pressing /Wittmann 1977/.

As mechanically deboned meat does not keep as well, suitable measures must be taken against spoilage or a drop in quality. One of the oldest methods of preserving meat is curing, which is also a means of retaining colour. The curing process depends on a number of factors such as temperature, pH of the meat, pigment content and content of reducing compounds in the meat, degree of comminution of raw material and, particularly, the type and quantity of curing substances used.

The aim of this work was to determine optimum curing conditions for mechanically deboned pork meat. Particularly minimal doses of curing substances in consideration of the degree of reddening sufficient for obtaining a stable, red colour of MDM, were derived.

Material and methods

Pork from mechanically separated backbones was used as experimental material. It has been obtained by means of industrial plant made by Seffelaar and Looyen /type MRS/. Preliminary to the main experiments several curing tests with traditional nitrite-nitrate mixtures were done. Because this method did not give the desired results it was decided that nitrite curing mixtures to which ascorbic acid will be added should be used to cure mechanically deboned pork.

The separated meat was dry cured and then, after a defined curing time /0,5 to 24 hours/ was thermally treated /until reaching a core temperature of 70°C/ in order to interrupt the reaction and to convert nitric oxide myoglobin into the more stable nitric oxide myochromogen.

The following experiments were done: a/ initial experiments conducted in order to determine aproximate doses of $NaNO_2$ and of ascorbic acid, sufficient for obtaining the degree of reddening of 60%, and the lowest residual nitrite content. Curing of MDM with a constant content of ascorbic acid /0,3%/ and various doses of $NaNO_2$ /0,000 - 0,015%/ was done, and next - curing with a constant dose of nitrite /0,006%/ and various doses of ascorbic acid /0,00 - 0,30%/ as related to the weight of meat/. The content of 2% sodium chloride did not changed. The time dependence of the curing process was determined by the evaluation of the degree of reddening at 1, 2 ,4, 6 and 24 hours from the time of adding the curing mixture.

b/ main experiments conducted in order to determine necessary, minimal doses of nitrite and of ascorbic acid to cure MDM. Nine mixtures with three nitrite contents /0,004;0,006;0,008% related to the weight of meat/ and three ascorbic acid contents /0,00;0,04;0,08% related to the weight of meat/ were examined during curing of mechanically deboned pork. Curing time was 0,5; 1; 2; 6 and 24 hours from the moment in which the curing mixture was added.

In the cured product, after thermal treatment the content of nitric oxide myochromogen and of free nitrite was determined. Colour of cured MDM was also estimated using reflection and organoleptic methods. Total plate counts of bacteria were determined in cured and non-cured product during refrigeration at 2 - 4°C for 2, 4 and 6 days. The sample material was examined for total content of haemine in the fresh MDM. The total quantity of myoglobin and reddened haemine was determined by Hornsey's method /1956/ modified by Bunnig and Hamm /1970/, and adapted to suit our laboratory conditions. The degree of reddening was calculated from the ratio of nitric oxide myochromogen content to the total quantity of haemine. The nitrite content was determined in accordance with the Polish standard method /PN-66/A-82114/. The colour of MDM was measured with a tristimulus photocolorimeter "Momcolor D" made in Hungary. The obtained trichromatic components were applied to calculate chromaticity coordinates /x, y ,z/. The dominant wave length / d/ and colorimetric purity /p/ was determined by the graphical method from CIE, colour triangle. Chromatic component Y, read from the colorimeter was the measure of brightness. Sensoric evaluation of MDM colour was done by Baryłko-Pikielna's method, by a group of five persons /Baryłko-Pikielna 1975/

The average experimental results were statistically analyzed by the means of the t-student test and the determination of the linear correlation coefficient. Method of statistical optimization was used to appoint efficient, minimal doses of curing substances. /Zieliński 1974/

Results

The traditional curing methods first used /nitrite-nitrate/ did not give the desired results. With a very long time /2 - 4 days/ a maximum degree of reddening of 20% was achieved. In the next stage we used a nitrite mixture to which ascorbic acid was added as a reducing agent.

It was found that satisfactory degree of reddening of 60% may be obtained when curing with the application of 0,004 - 0,008% nitrite /Kołożyn-Krajewska et.al.1983/ and of 0,04 - 0,08% of ascorbic acid, together with 2% of $NaNO_2$ /as related to the weight of meat//Fig.1/. Several series of curing with nine chosen mixtures followed by the statistical optimization were done /Fig.2/. The method of regression function analysis was utilized. We wanted to find the equation of the regression function /expressed by the degree of reddening/, which locally describes the dependence of two variables: u_1 - dose of $NaNO_2$, u_2 - dose of ascorbic acid.

The following equation was derived:

$$F/u_1,u_2/ = 7,5+4950u_1+687,5u_2-150000u_1^2+31250u_1u_2+3750u_2^2$$

The theoretical value of the degree of reddening which can be obtained using different curing mixtures, may be calculated from the above equation. Minimal theoretical dose of nitrite is 0,0027%, together with 0,08% of ascorbic acid, and minimal content of ascorbic acid is 0,057%, together with 0,008% of $NaNO_2$/as related to the weight of meat/.

The degree of reddening can not be regarded as the only criteria indicating the optimal composition of the curing mixture. Colour of meat, stability of colour, rate of achieving the maximum degree of reddening, residual nitrite content, microbiological stability, possibility to prevent fat oxidation are also significant. Some of

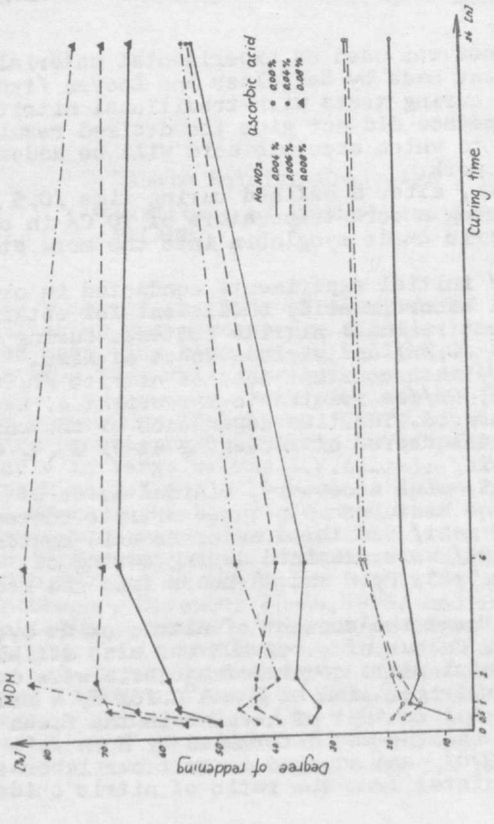

Fig 1 Degree of reddening in dependence on the dose of nitrite (0,004, 0,006, 0,008%) and of ascorbic acid (0,00, 0,04, 0,08%) during curing of MDH

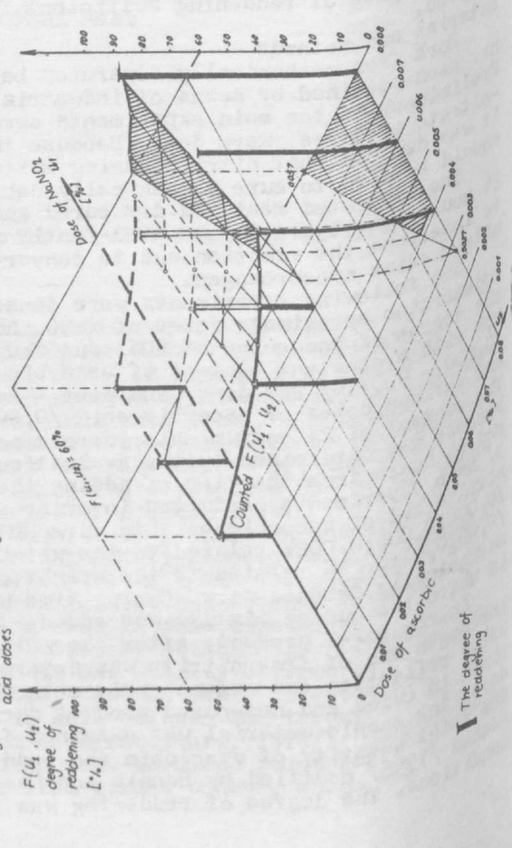

Fig 2 Dependence of the degree of reddening upon the nitrite and ascorbic acid doses

The degree of reddening

these factors were evaluated in further experiments.

A statistically significant correlation was found between the degree of reddening and the dominant wave length, and between the degree of reddening and the organoleptic evaluation of cured MDM colour. For this reason one of the mentioned methods can be used for colour evaluation of cured mechanically deboned meat./Fig.3/.

The residual nitrite content found in our experiments was at a very low level /up to 38ppm after 0,5h of curing/. The level of free nitrite mostly depended on the presence and amount of ascorbic acid, which influenced the decrease of the residual nitrite content/Fig.4/.

Microbiological evaluation demonstrated that a statistically significant decrease of the total number of bacteria was observed only when 0,01% of $NaNO_2$ was added. Due to this a higher level of $NaNO_2$ would be recomended if mechanically deboned meat was stored in refrigeration.

Conclusions

1. The carried out experiments and statistical calculations led to a proposition of a minimal /in relation to the degree of reddening/ doses of nitrite and ascorbic acid /0,003% of $NaNO_2$ together with 0,08% of ascorbic acid, and 0,06% of ascorbic acid together with 0,008% of $NaNO_2$/.
2. Due to another evaluated properties of MDM /e.g. microbial contamination/ it is recomended that the levels of 0,006 - 0,01% of $NaNO_2$ together with 0,06 - 0,08% of ascorbic acid should be used for curing of mechanically deboned pork.
3. The sufficient degree of reddening, red colour of MDM, acceleration of the curing process and the decrease of the residual nitrite content is possible due to the application of ascorbic acid.

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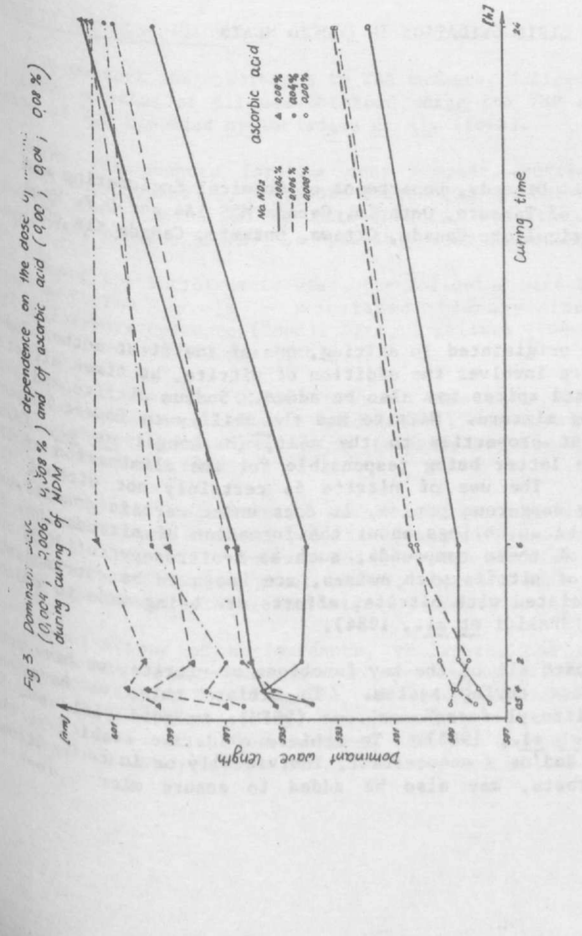

Fig 3. Dominant wave length in dependence on the dose of $NaNO_2$ (0,004, 0,006, 0,008 %) and of ascorbic acid (0,00, 0,04, 0,08 %) during curing of MDM

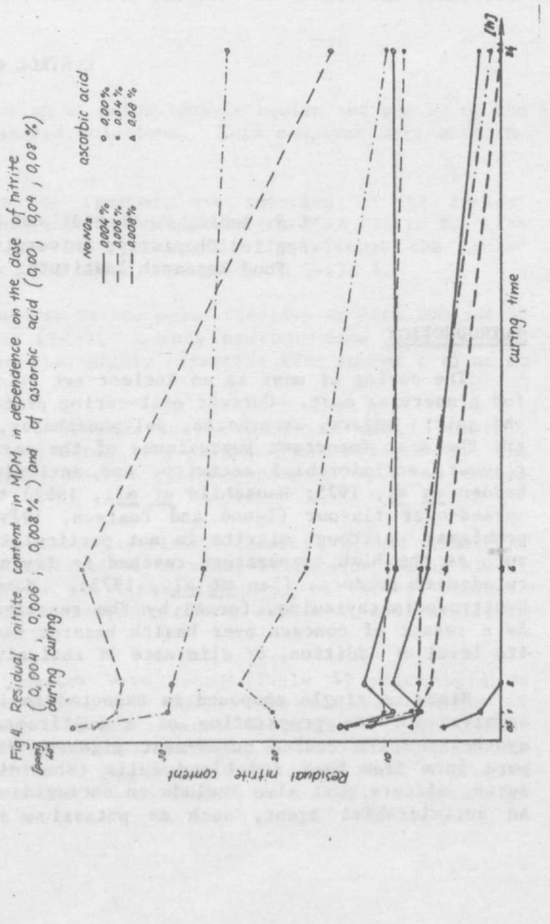

Fig 4. Residual nitrite content in MDM in dependence on the dose of nitrite (0,004, 0,006, 0,008 %) and of ascorbic acid (0,00, 0,04, 0,08 %) during curing