Changes in some characteristics of ripening non-comminuted meats upon the application of bacterial preparations

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Abstract

Different variants of raw-dried products from non-comminuted beef were prepared, which differed in the levels of added nitrates and the temperature of ripening (12 or 20°C). In some of the variants, combined preparations of starter cultures were applied. After 24 hours at 20°C, the counts of lactobacilli and micrococci in the meat were found to be higher than at 12°C. These higher counts ensure the faster course of microbiological processes. Ripening at 20°C affects positively the stability of nitrosomyoglobine in the product, the rate of drying and decrease in pH and a_w values.
The best results concerning pigment formation, microbiological characteristics and sensory evaluation were obtained using 400 mg of nitrate per kg of product, in combination with the addition of a bacterial preparation of starter cultures.

The role of natural microflora in the formation of the colour and flavour of storable meat products, and also the possibilities to introduce additional quantities of pure cultures of useful microorganisms are problems which were the subject of a number of studies (Petaja, 1977; Reuter, 1972; Sirvio, 1977; Buyanov, 1980).
After the arising of the problem of cancerogenic nitrosamines formed in the metabolism of nitrates and nitrites, it became possible, thanks to the introduction of starter cultures, to reduce the addition of nitrates without the appearance of any quality defects (Puolanne, 1977; Scharner, 1980).
According to Skjelkvale et al., 1974, sausages with 0 ppm and 164 ppm of nitrite show no substantial differences in taste and colour upon the application of the Duploferment 66 preparation.
Pfeil and Liepe (1972) found that, on adding 50% of the nitrate quantity used normally in practice, proper pigment formation and aroma formation could be achieved if micrococci and lactibacilli be added simultaneously to the sausages, as starter cultures.
The objective of the present work was to follow the changes in some quality characteristics in the manufacture of raw-dried products from non-comminuted beef using starter cultures and nitrates reduced by 50%.

Materials and Methods

The experiments were conducted on raw-dried products from non-comminuted beef by an accelerated technology ba Chakarov et al. (1979). Experimental samples manufactured by that technology served as controls, and experimental variants differed in the amounts of added nitrate: 50% of the dose used normally in practice. Part of the experimental variants were also supplemented by preparations containing lactobacilli and micrococci with definite catalase and nitrate-reductase activities (Preparation I, P-I). In another part of the variants, preparations containing lactobacilli, micrococci and yeasts (Preparation II, P-II) were introduced. The preparations were produced in the Meat Technology Research Institute, Sofia. Three series of experiments were conducted for the manufacture of raw-dried products. Chilled meat was used (48 hours post mortem) from beef semitendinosus muscles. Ripening during the first 24 hours took place at two temperatures: 12°C and 20°C, and drying, for all variants, at 12°C. Samples were taken on definite days of the ripening and drying processes: days 2, 7, 14, 26, 30, and 38, for the following analyses:

- Micrococci counts, on MSA; lactobacilli counts, on Rogosa's medium; and yeasts counts, on malt agar;
- Nitrosomyoglobin level, % of total pigment: by the method of Mirna and Schütz (1972);
- pH, in an aqueous extract, using a Radiometer pH-meter;
- a_w - values, by a modification of Withing's method (Leistner & Wirth, 1972);
- Solids, by drying part of the product to a constant weight;
- A comparative sensory evaluation of the finished product by the 9-point Hedonic scale.

Results and Discussion

The results showing changes in lactobacilli counts during the ripening of the different variants are presented in Fig. 1. It is obvious from the figure, that the counts in control variants rise gradually and reach a maximum on day 14 (10^3-10^4 cells/g), after which they diminish. This rise in counts is higher by one cycle in the variants ripening at 20°C, than in the ones at 12°C.

In the experimental variants manufactured using preparation I containing lactobacilli and micrococci, high lactobacilli counts (10^3-10^5 cells/g) can be observed in the first days, promoting ripening during the first week. Their counts diminish gradually till day 14 (10^2 cells/g), and after that rise again.

Product ripening at different temperatures determines, further, pronounced differences in counts: by 1 to 3 cycles.

In the experimental variants with added preparation II containing lactobacilli, micrococci and yeasts, lactobacilli diminish gradually during the first week, after which a sharp increase follows, till day 14 at 12°C. This is probably due to a synergism between lactobacilli and yeasts at this temperature.

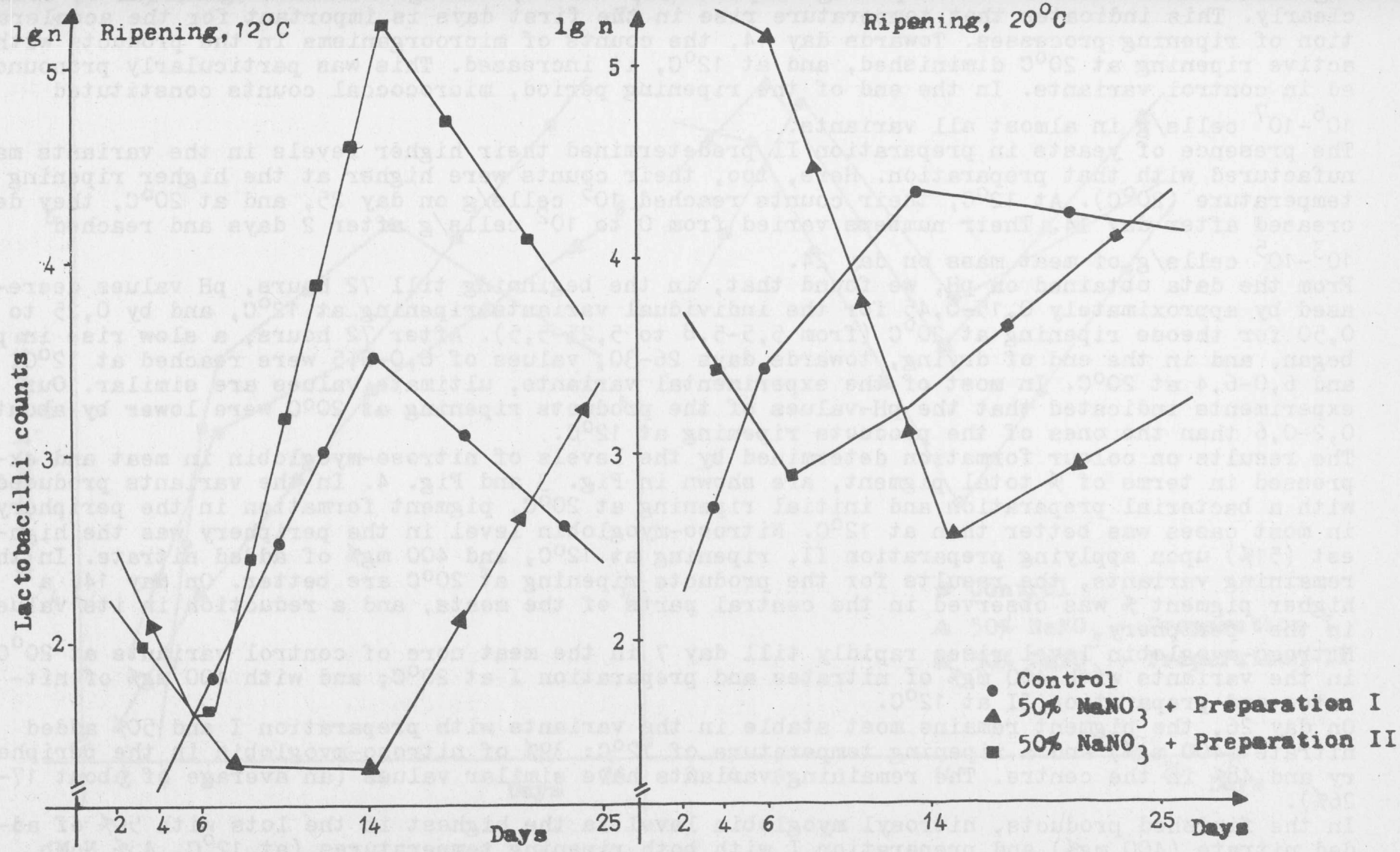


Fig. 1. Changes in lactobacilli counts during ripening and drying

Micrococcal growth in the meat products tested is shown in Fig. 2. Differences between microorganism counts with the two ripening temperatures tested, during the first week, can be seen clearly. This indicates that temperature rise in the first days is important for the acceleration of ripening processes. Towards day 14, the counts of microorganisms in the products with active ripening at 20°C diminished, and at 12°C, it increased. This was particularly pronounced in control variants. In the end of the ripening period, micrococcal counts constituted 10^6-10^7 cells/g in almost all variants.

The presence of yeasts in preparation II predetermined their higher levels in the variants manufactured with that preparation. Here, too, their counts were higher at the higher ripening temperature (20°C). At 12°C, their counts reached 10^5 cells/g on day 25, and at 20°C, they decreased after day 14. Their numbers varied from 0 to 10^2 cells/g after 2 days and reached 10^3-10^5 cells/g of meat mass on day 24.

From the data obtained on pH, we found that, in the beginning till 72 hours, pH values decreased by approximately 0,15-0,45 for the individual variants ripening at 12°C, and by 0,25 to 0,50 for theose ripening at 20°C (from 5,5-5,8 to 5,25-5,5). After 72 hours, a slow rise in pH began, and in the end of drying, towards days 26-30, values of 6,0-6,5 were reached at 12°C, and 6,0-6,4 at 20°C. In most of the experimental variants, ultimate values are similar. Our experiments indicated that the pH-values of the products ripening at 20°C were lower by about 0,2-0,6 than the ones of the products ripening at 12°C.

The results on colour formation determined by the levels of nitroso-myoglobin in meat and expressed in terms of % total pigment, are shown in Fig. 3 and Fig. 4. In the variants produced with a bacterial preparation and initial ripening at 20°C, pigment formation in the periphery in most cases was better than at 12°C. Nitroso-myoglobin level in the periphery was the highest (51%) upon applying preparation II, ripening at 12°C, and 400 mg% of added nitrate. In the remaining variants, the results for the products ripening at 20°C are better. On day 14, a higher pigment % was observed in the central parts of the meats, and a reduction in its values in the periphery.

Nitroso-myoglobin level rises rapidly till day 7 in the meat core of control variants at 20°C; in the variants with 400 mg% of nitrates and preparation I at 20°C; and with 400 mg% of nitrates and preparation II at 12°C.

On day 26, the pigment remains most stable in the variants with preparation I and 50% added nitrate (400 mg%) and a ripening temperature of 12°C: 39% of nitroso-myoglobin in the periphery and 48% in the centre. The remaining variants have similar values (an average of about 17-26%).

In the finished products, nitrosyl myoglobin level is the highest in the lots with 50% of added nitrate (400 mg%) and preparation I with both ripening temperatures (at 12°C, 45% NoMb, and at 20°C, 43% NoMb). After drying for 38 days, the results for the individual variants are similar in values.

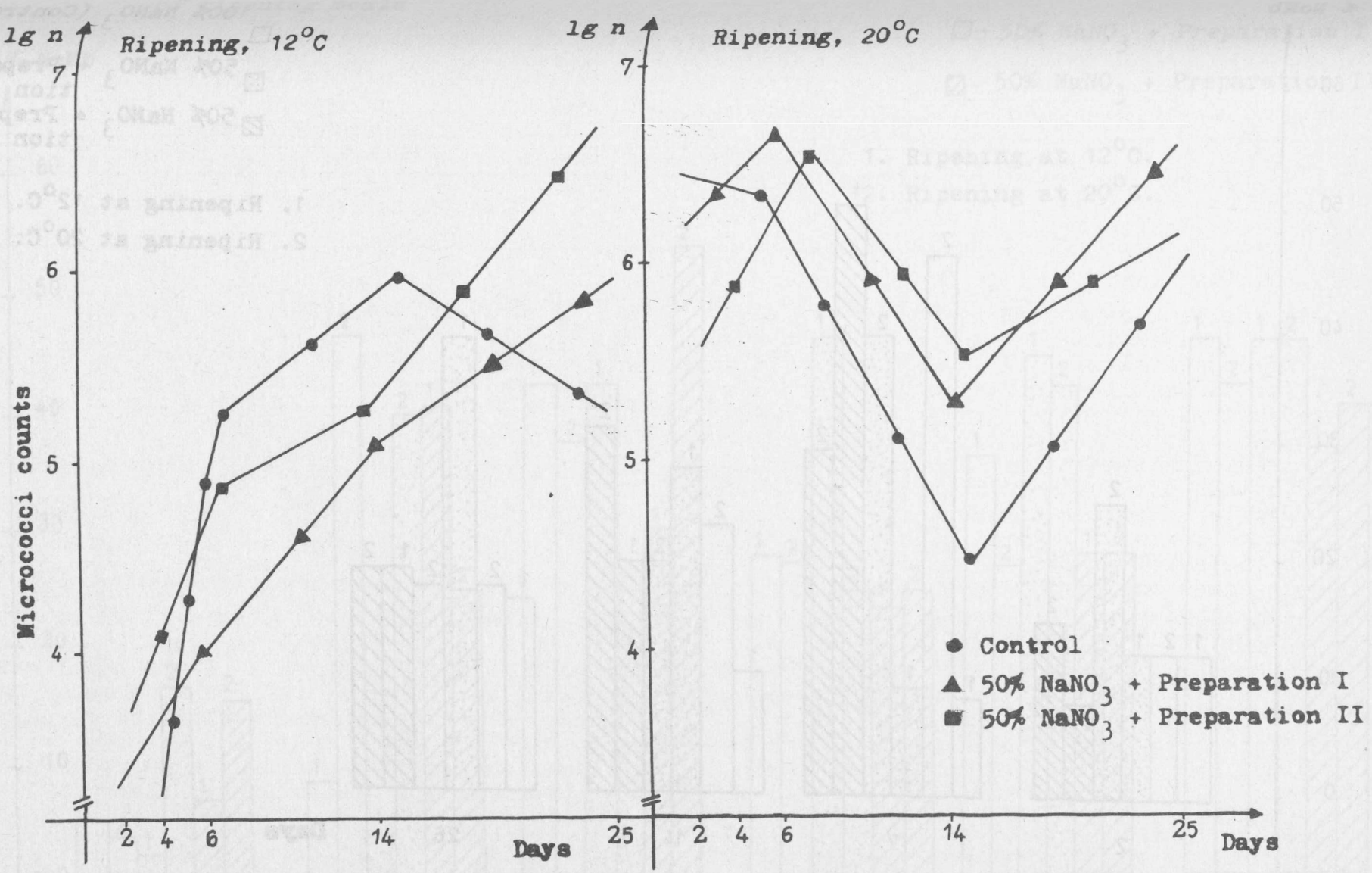


Fig. 2. Changes in micrococci counts during ripening and drying

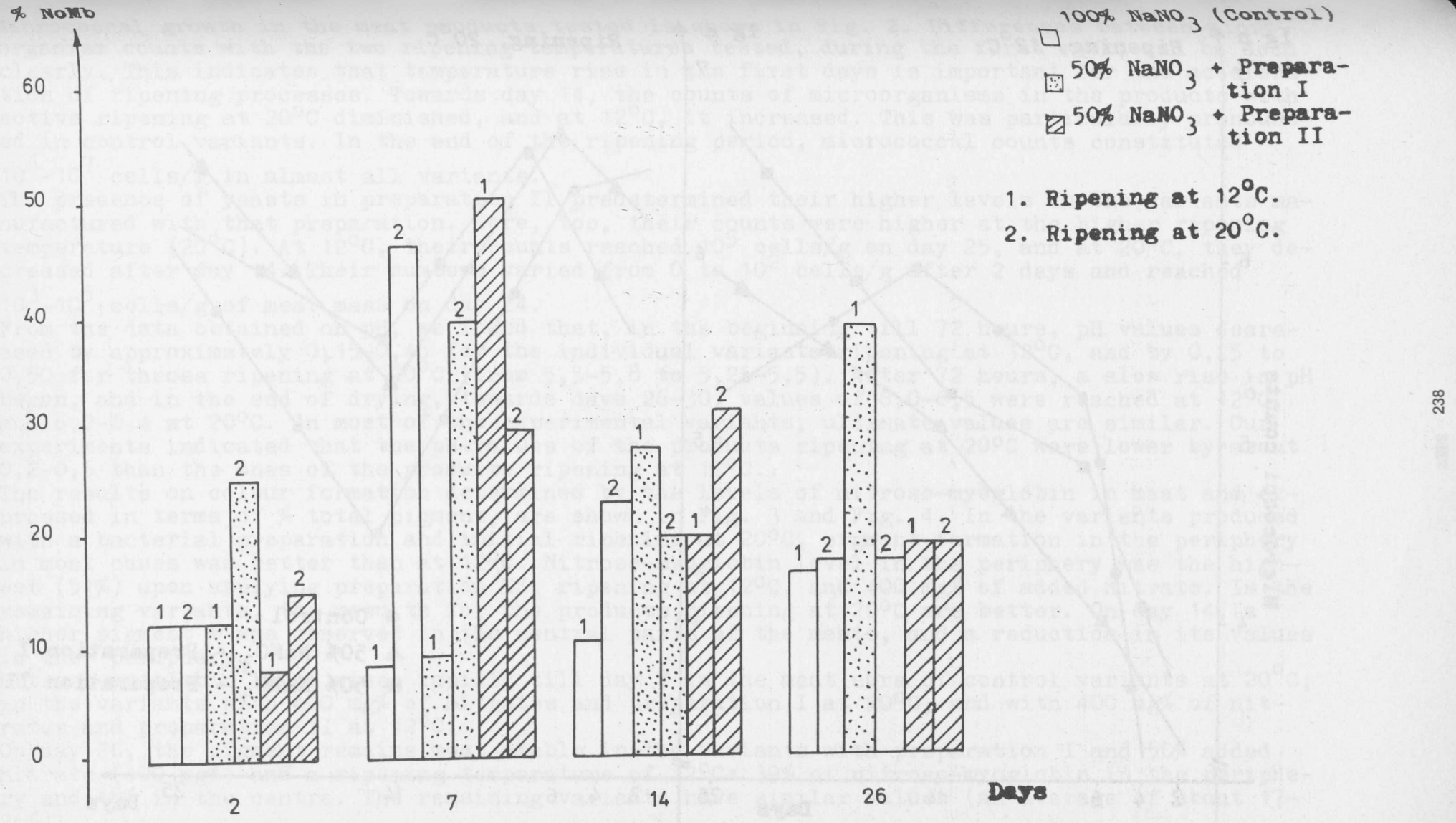
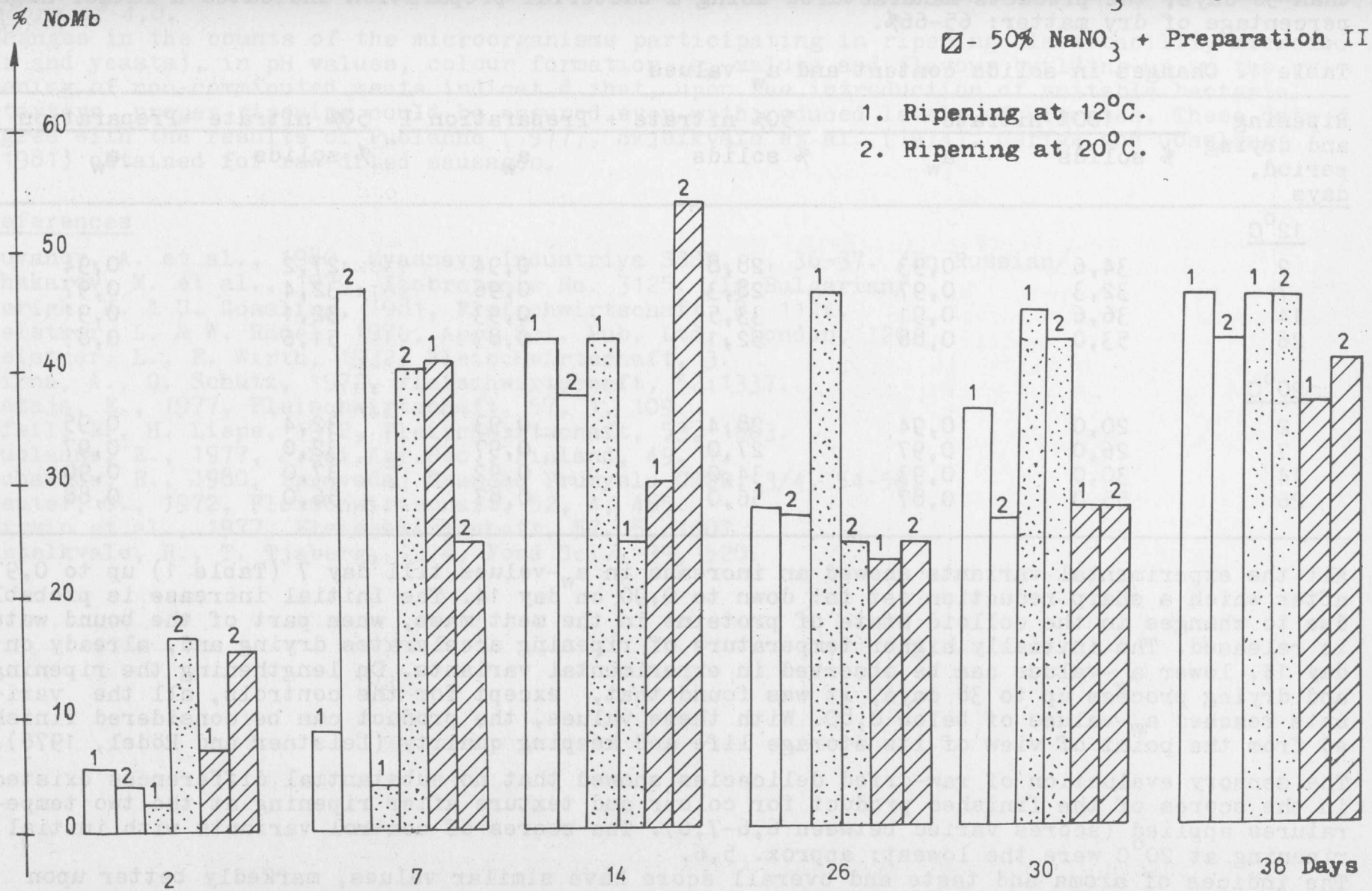


Fig. 3. Changes in nitroso-myoglobin levels in the periphery of ripening meats.

Fig. 4. Changes in nitroso-myoglobin levels in the cores of ripening meats



The data obtained for dry matter and a_w-value are shown in Table 1. A clear trend to a faster product drying after ripening at a higher temperature is observed. In a drying period longer than 38 days, the products manufactured using a bacterial preparation indicated a rather high percentage of dry matter: 65-66%.

Table 1. Changes in solids content and a_w-values

Ripening and drying period, days	100% nitrate		50% nitrate + Preparation I		50% nitrate +Preparation II	
	% solids	a_w	% solids	a_w	% solids	a_w
12°C						
2	34,6	0,93	28,8	0,94	27,2	0,94
7	32,3	0,97	28,3	0,96	32,4	0,97
14	36,6	0,91	33,5	0,93	32,1	0,91
26	53,0	0,88	52,1	0,87	51,6	0,87
20°C						
2	20,0	0,94	28,4	0,93	32,4	0,95
7	26,0	0,97	27,0	0,97	32,0	0,97
14	30,0	0,93	34,0	0,92	37,0	0,90
26	55,0	0,87	56,0	0,87	56,0	0,88

All the experimental variants showed an increase in a_w-values till day 7 (Table 1) up to 0,97, after which a sharp reduction set in: down to 0,90 on day 14. The initial increase is probably due to changes in the colloid state of proteins in the meat mass, when part of the bound water is released. The initially higher temperature of ripening accelerates drying and, already on day 14, lower a_w-values can be observed in experimental variants. On lengthening the ripening and drying process up to 38 days, it was found that, except for the controls, all the variants reached a_w-values of below 0,80. With these values, the product can be considered finished from the point of view of its storage life and keeping quality (Leistner and Rödel, 1976).

The sensory evaluation of raw-dried delicacies showed that no substantial differences existed in the scores of the finished product for colour and texture after ripening at the two temperatures applied (scores varied between 6,6-7,6). The scores of control variants with initial ripening at 20°C were the lowest: approx. 5,6.
The indices of aroma and taste and overall score have similar values, markedly better upon

ripening at 20°C (7,2), particularly in comparison with controls which received an overall score of 4,8.

Changes in the counts of the microorganisms participating in ripening (lactobacilli, micrococci and yeasts), in pH values, colour formation, a_w-values and flavour building-up in the ripening of non-comminuted meats indicat d that, upon the introduction of suitable bacterial starters, proper ripening could be ensured even with reduced levels of nitrates. These data agree with the results of Puolanne (1977), Skjelkvale et al. (1974), Gerigk and Gossling (1981) obtained for raw-dried sausages.

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