5.29 STUDIES INTO THE POSSIBILITIES OF PREPARING FAST-RIPENING MEAT PRODUCTS USING STARTER CULTURES INSTEAD OF G.D.L.

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In 1964, Sair patented a method of applying GDL (glucono-delta-lacton) in the manufacture of meat products. This preparation mixed with moist meat produces rapidly gluconic acid. This results in the formation of a gel in the sausage meat, which in turn accelerates the production process and the sausages are ready for consumption within a few days (Frey, 1983; Modić & Turubatović, 1983). The risks of losses owing to faulty produce are minimized (Marshall, 1980).

Along with its advantages, the application of GDL has also some disadvantages. Sausages with GDL have a non-specific taste upon storage (Krylova et al., 1970; Čavlek, 1981). Gallert (1973) has also recorded the unsatisfactory taste of sausages with GDL. He felt that no spices were in a position to improve it. The author conducted parallel experiments with the application of starter cultures and found a more pleasant mildly acid taste in the finished sausages. On drying, the quality of the sausages improved, colour was preserved and storage life was lengthened. Kede & Lazić (1983) studied the effects of different sugars, GDL, starter cultures, and different temperatures on the quality of the sausages. The best results were obtained by them on the application of starter cultures and GDL.

In the GFR (1973), a preparation was patented, containing GDL, lactobacilli and micrococci, polyphosphate, ascorbic acid, and sodium ascorbate.

A number of studies on the ageing of sausages with GDL used singly or in combination with starter preparations, were made by Krylova et al. (1976a, 1976b, 1982). They found that sausages with GDL had shorter storage lives than the ones with bacterial cultures. Most of the characteristics were the best upon the application of starter

preparations, followed by those with GDL. Comparative studies with results similar to those obtained by Krylova et al., were made also by Winter (1982), Kissinger (1981) and by many other authors.
The objective of this work was, by using starter microorganisms, to substitute partially or completely GDL in the manufacture of fast-ripening meat products.

MATERIAL AND METHODS

In the experimental work, use was made of lactic acid microorganisms, micrococci and yeasts: either as 24-hour broth cultures, or freeze-dried. GDL was introduced in control variants or in experimental ones in combination with starter cultures.
The experiments were made while observing the technological requirements towards the manufacture of fast-ripening salami with the introduction of GDL or starter cultures The sausage meat was filled into casings of a diameter of 55 mm or 80-100 mm. Active ripening took place at 24-26°C for 48 hours. Then followed 24 hours of smoking at 18-20°C. The sausages of a casing diameter of 100 mm are rolled in spices after the stripping of the casing. Then drying followed at 14-16°C and a relative air humidity of 90-95% which was gradually reduced to 80%.
The growth of the major groups of microorganisms in the experimental samples was determined by standard microbiological methods. Changes in pH were monitored (potentiometrically). In some of the experiments, pigment level was determined, in terms of per cent nitroso-myoglobin, and residual nitrites (after Bulgarian State Standards /BDS/).

RESULTS AND DISCUSSION

I. Experiments with the combined application of starter cultures and GDL

Those were conducted using a technology for the manufacture of fast-ripening sausages in the following variants: (1) with 0,5% GDL; (2) with 0,5 % GDL + 10^5 cells/g of Lactobacillus plantarum, and M. varians; (3) with 0,2% GDL + 10^5 cells/g of Lactobacillus plantarum, and Micrococcus varians; and (4) 10^6 cells/g of Lactobacillus plantarum, and Micrococcus varians.
Comparative studies were made after active ripening and after two weeks: in finished product. The results of the study of the major groups of microorganisms are shown in Table 1.
It is obvious from the table that the presence of GDL results in the growth of smaller counts of lactobacilli and micrococci which is one of the reasons for the differences in the flavours of those products. Variant 1 sausages were sourer and had an insufficiently good flavour, but the best binding and colour. The best flavour qualities

Table 1. Microorganism counts in fast-ripening sausages made with GDL and starter cultures

Variant No.	Ageing time (days)	Microorganism counts (cells/g)			
		Lactobacilli	Micrococci	Coli-titre	Proteus-titre
1	2	$8,1 \times 10^5$	$5,4 \times 10^3$	10^{-1}	$>10^{-1}$
	14	$5,5 \times 10^7$	$2,4 \times 10^2$	$>10^{-1}$	$>10^{-1}$
2	2	$1,3 \times 10^7$	$2,5 \times 10^3$	10^{-1}	$>10^{-1}$
	14	$8,5 \times 10^7$	$3,1 \times 10^3$	$>10^{-1}$	$>10^{-1}$
3	2	$1,1 \times 10^7$	$4,8 \times 10^4$	10^{-1}	10^{-1}
	14	$1,5 \times 10^8$	$5,4 \times 10^3$	$>10^{-1}$	$>10^{-1}$
4	2	$4,2 \times 10^7$	$3,3 \times 10^5$	10^{-1}	10^{-1}
	14	$3,5 \times 10^8$	$7,2 \times 10^3$	$>10^{-1}$	$>10^{-1}$

were found in variant 4, but colour there was slightly paler than in variant 1.
The total scores of the finished products indicated that it was possible to reduce the GDL level used and, by combination with starter cultures, to compensate the disadvantages of both additives observed on their separate application.

II. Experiments on the substitution of GDL by starter cultures

(1) Experiments with 24-hour broth cultures: The following variants were prepared; (i) with the introduction of Streptococcus diacetilactis at he lavel of $4,0 \times 10^6$ cells/g of sausage meat; (ii) with Candida utilis, $4,0 \times 10^6$ cells/g; (iii) Lactobacillus plantarum, $1,6 \times 10^6$, and Micrococcus varians and Staphylococcus saprophyticus each $8,0 \times 10^5$ cells/g: sugar level was raised to 0,6% in this variant (0,4% being introduced in the remaining variants); (iv) the same levels of microorganisms were introduced as in variant 3, + Candida utilis, $8,0 \times 10^5$ cells/g; (v) control, 0,5% GDL related to the sausage meat without the introduction of starter cultures. Casings of a diameter of 100 mm were used.
Comparative studies were made in finished products after 14 days. The results of the microbiological analyses are shown in Table 2.

Table 2. Microorganism counts in fast-ripening sausages with starter cultures compared to controls with GDL

Variant No.	Microorganism counts (cells/g of product)				
	Lactobacilli	Micrococci	Yeasts	Coli-titre	Proteus-titre
1	$3,2 \times 10^7$	$1,3 \times 10^2$	below 10	$>10^{-1}$	$>10^{-1}$
2	$4,0 \times 10^7$	$7,8 \times 10^3$	$1,1 \times 10^3$	10^{-1}	$>10^{-1}$
3	$1,0 \times 10^8$	$7,2 \times 10^2$	$3,0 \times 10^2$	$>10^{-1}$	$>10^{-1}$
4	$8,0 \times 10^7$	$6,0 \times 10^3$	$1,0 \times 10^3$	10^{-1}	$>10^{-1}$
5	$7,0 \times 10^7$	$1,8 \times 10^2$	below 10	$>10^{-1}$	$>10^{-1}$

As obvious from the table, the highest lactobacilli counts were found in variant 3 where the level of carbohydrates was higher. The presence of micrococci was affected by the presence of lactic acid streptococci, GDL and a higher level of sugar when acid production is enhanced.
Finished product pH values and also the per cent nitroso-myoglobin and residual nitrites are shown in Table 3.

Table 3. Comparative data by some indices of finished experimental products

Variant No.	% sugar introduced	Indices		
		pH	Nitroso-myoglobin (% total pigment)	Residual nitrites (mg%)
1				
2	0,4	4,85	75,60	0,90
3	0,4	4,80	74,13	0,72
4	0,6	4,60	76,12	0,54
5	0,4	4,70	75,50	0,90
	0,4	4,50	76,90	0,90

It can be seen that the lowest pH values were obtained in the variants with GDL (4,50), followed by the one with 0,6% sugar (4,60). Nitroso-myoglobin level is similar, the highest percentages being found in variants with GDL and with 0,6% sugar. Residual nitrites are lowest in variant 3: with 0,6% sugar.
Variants 3 and 4 possessed the best expressed flavour qualities. Control samples with GDL were sourer in taste and had a slight unpleasant smell.

(2) Experiments with freeze-dried starter cultures: The experiments were conducted in three major variants: (1) sausage meat was filled into casings of a diameter of 55 mm; (2) 100 mm dia casings were filled; (3) as in variant 2, only with the addition of 0,6% sugar instead of the 0,4% introduced in the first two variants. The samples were put under the same technological conditions, of the manufacture of the Zakuska salami. Freeze-dried microorganisms were introduced at such levels as to provide $2,5 \times 10^5$ cells of Micrococcus varians/g of product, $2,8 \times 10^4$ cells/g of Candida utilis, and $2,2 \times 10^5$ cells/g of Lactobacillus plantarum.
Figure 1 shows graphically the changes of lactobacilli and micrococci counts and pH values in the three experimental variants. It is obvious that the lactobacilli counts in sausages of a larger diameter are higher than those in the variants of a diameter of 55 mm. This results in reduced micrococci levels. The lowest pH values were obtained upon the additional introduction of sugar.
At sensory evaluations, a good cut surface was found, and also a fine and stable colour, a pleasant sourish taste of the finished products. No flavour differences were found on the application of different levels of sugar. Further, no differences were found attributable to the form of the cultures introduced: a 24-hour broth culture, or a freeze-dried preparation. On the longer refrigerated storage of samples, variants with starter cultures were found to keep, and even to improve in flavour owing to continuing enzymatic processes. At the same time, the storage life of the samples with GDL was more limited.

CONCLUSIONS

(1) Good quality fast-ripening sausages can be manufactures with a reduced GDL level combined with the introduction of starter cultures.
(2) Meat products such as the Zakuska salami can be manufactures using starter cultures in the stead of GDL.
(3) Combinations of lactobacilli and micrococci, or of lactobacilli, micrococci and yeasts, can be applied as broth cultures or as freeze-dried preparations. It is necessary that the inoculation of microorganisms provides counts in the range of $10^6 - 10^7$ cells/g of sausage meat.
(4) The advantages of the application of starter cultures over the usage of GDL are:

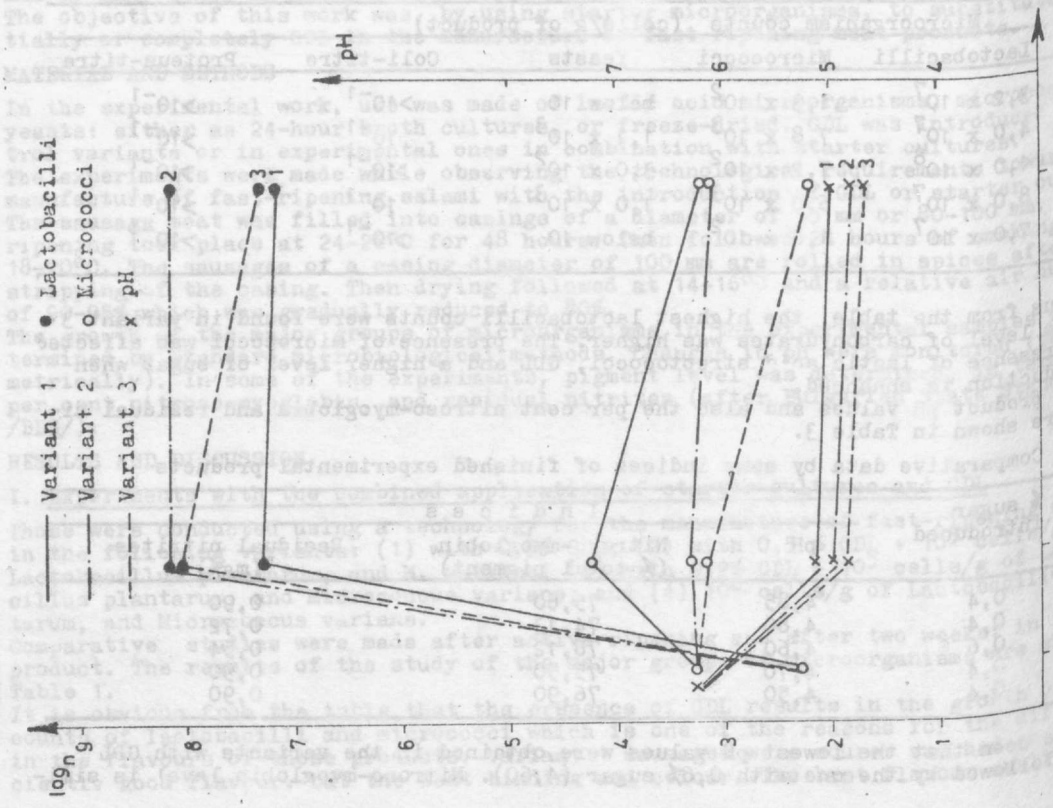

Fig. 1. Changes in lactobacilli and micrococci counts and in pH in ripening sausages

better flavour of the products; a longer storage life; it is not imperative to fill the sausages within a short time of making the sausage meat, as in GDL usage, since meat particle binding is delayed till after 24 hours.

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