A STUDY ON THE PROCESS OF DRYING AND AGEING OF RAW-DRIED SAUSAGES FROM CHOPPED MEAT USING A STARTER CULTURE

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SUMMARY: The objective of the present study was to follow the influence of the microbial starter culture Micrococcus varians on the process of drying and ageing of raw-dried sausages prepared from chopped meat. To find the optimum drying and ageing conditions, we worked out a mathematical model, and its reproduction on a computer made possible the description of the current technological processes with a certain degree of acuracy.

The study was carried out with a raw-dried sausage variety (loukanka) of which two types of samples were prepared: experimental with microbial starter, and control. The samples were tested during the drying process to determine the changes in their water contents, pH and weights.

The statistical data for the studied samples were used to draw the mathematical dependence of the changes in the typical technological parameters (water content and pH) on the drying and ageing period:

$$y = b_0 + b_1 x + b_{11} x^2$$

where y is a technological parameter, and x is the time factor

The results from the study indicated that the bacterial starter culture had led to definite intensification of the drying and ageing process without deterioration in the product's quality. The introduction of the starter culture resulted in faster pH drops in the test samples, and these values remained lower in the finished product.

The organoleptic study proved that the starter culture contributed to the improvement of the organoleptical properties of the sausage and received higher grades of evaluation.

INTRODUCTION: It is well known that the processes of drying and ageing of raw-dried meat products (sausages) are dependent on the microflora that exists in them as well as on the technological ageing conditions (Niinivaara et al., 1971). The microorganisms' structure and growth in these products are of random character, and because of that it is but impossible to manufacture raw-dried meat products with uniform quality only by controlling the drying and ageing conditions, so it is necessary to add suitable microorganism strains that are usually introduced in the meat under the shape of starters. The use of starter cultures in the manufacture of raw-dried meat products (sausages) has now become a steady practice. Thus the process of drying and ageing can be adjusted and directed in order to obtain a finished product of relatively stable quality.

MATERIALS AND METHODS: The study was carried out with a raw-dried sausage variety (loukanka) with the following composition: I grade veal - 50%; non-fat pork - 25%; lard - 25%; salt - 2.2%; saltpetre - 0.03%; sugar - 0.3%; seasonings - 0.6%. This sausage was used to prepare control samples and

test samples with added microbial starter culture of Micrococcus varians strain M_2. The meat was processed according to the established technology for this type of sausages. The strain was isolated from a raw-dried sausage (loukanka) and was introduced under the shape of a broth culture in the amount of 500 cm^3 per 100 kg of meat. The bacterial culture provided 10^6 - 10^7 viable cells in 1 g of meat. The strain was cultivated in a nutrient broth with 5.5 pH at 30°C for 24 hours.

The samples were subjected to drying and ageing in a climatic chamber at 12-15°C and relative air humidity of 70 to 85%. The air velocity was altered with the advance of the drying period.

The water content and pH values were checked once in three days, and sample weight changes were determined by daily weighing a certain number of pieces from each studied batch. The water content was determined by sample drying at 105°C to a stable weight; pH values were measured using a pH-meter. The finished product was organoleptically evaluated using a 9-grade scale.

The results obtained from the study were analysed according to the methods of mathematical statistics (Voznesenski V.A., 1969; Smirnov N.V. et al., 1965). In the respective tables, the end results are presented as $M \pm t.m$ confidence interval. M is the mean arithmetic value from n=7, m is the mean-square error of the mean result, and t is Student's criterion for the accepted 95% confidence interval.

RESULTS AND DISCUSSION: The results for the changes in the sample weights during the drying process period are given in Table 1. These results were used to plot the drying curves of the control and test batches given on Fig.1.

Table 1. Changes in sample weights.

Drying Day	Test Samples							
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	$M \pm t.m$
	1	2	3	4	5	6	7	8
1	925	900	910	920	930	810	785	785 ± 45.2
2	885	860	870	870	885	770	745	841 ± 47.3
4	785	760	770	770	785	690	665	746 ± 36.1
7	700	695	705	690	705	625	600	676 ± 44.8
11	630	625	645	635	645	580	545	615 ± 53.7
13	580	575	595	580	595	545	510	569 ± 44.3
14	565	560	580	565	580	530	500	554 ± 45.6
15	550	550	570	555	570	525	490	544 ± 33.2
17	530	525	550	530	550	505	470	523 ± 33.1
21	500	495	520	505	520	485	450	496 ± 43.7
22	495	490	515	500	515	480	445	491 ± 44.3
23	490	485	510	495	510	475	440	486 ± 45.1

	CONTROL SAMPLES							
	1	2	3	4	5	6	7	8
1	900	920	870	925	885	775	920	885 ± 37.5
2	860	880	840	895	855	740	875	849 ± 38.2
4	770	800	760	815	775	660	775	765 ± 26.3
7	700	720	695	745	700	595	705	695 ± 35.7
11	635	655	630	690	635	550	640	634 ± 45.1
13	600	615	595	650	600	510	605	596 ± 44.8
14	585	600	580	640	585	500	585	582 ± 43.9
15	575	590	570	630	575	490	580	573 ± 35.4
17	560	565	550	610	555	475	555	553 ± 35.5
21	530	535	530	590	530	445	530	527 ± 36.3
22	525	530	525	585	525	445	525	523 ± 44.8
23	520	530	520	580	520	440	520	519 ± 44.7
25	515	525	520	575	515	440	520	516 ± 45.1

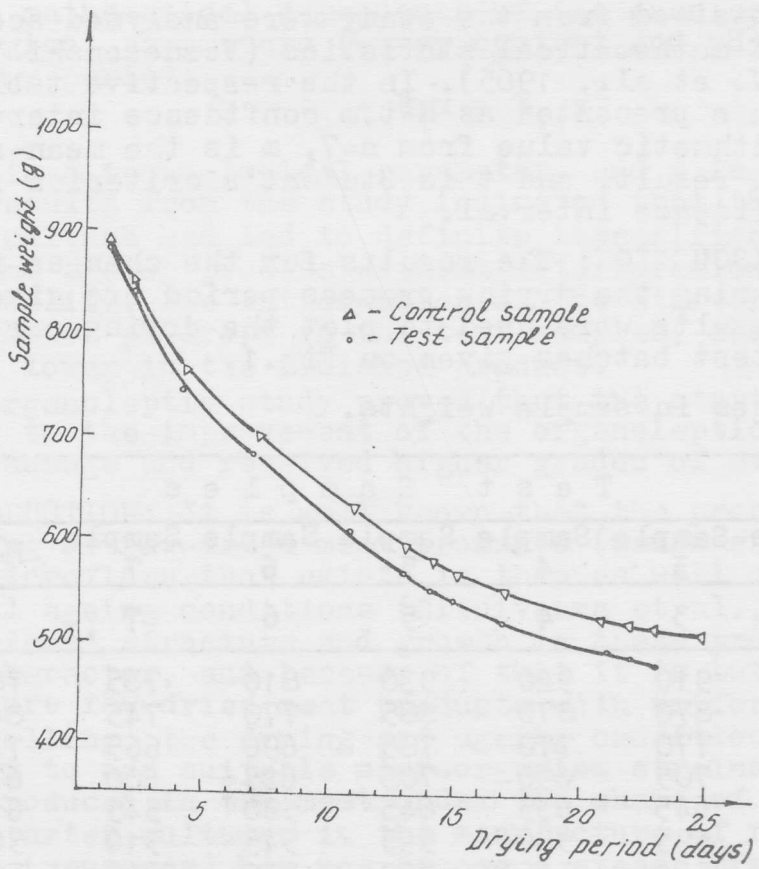

Fig. 1

The graphs on Fig.1 show that the drying process is the same both for the control and test samples. The introduction of the bacterial starter, however, contributes to the intensification of the process in the test samples. It is obvious that already on day 2 the weight of the test samples becomes consi-

derably less, and that difference becomes greater with further advance of the drying process. As a result, the drying period for the test samples is completed for 22 days while for the controls it lasts up to 25 days.

The results for the changes in the water content and pH are given on Figures 2 and 3. The changes in these characteristics also support the fact stated above that the bacterial starter intensifies the drying process. It was established that in the test samples pH values tended to drop faster and remained lower in the finished product compared to those of the controls. The water content of the finished product was achieved for 22 days in the test samples, and for 25 days in the controls.

On the basis of the statistical data obtained for the water content and pH changes in the studied samples, there were deducted the following mathematical relations describing the changes in said technological parameters which depend on the drying and ageing times. These relations are as follows:

$$y = b_o + b_1 x + b_{11} x^2 \qquad (1)$$

where y = technological parameter (water content or pH),
x = time factor (days).

The experimental results were analysed by the least-squares method (Markin U.P., 1982), and the following regression relations were synthesized:

$$\hat{y}_1 = 58.886 - 1.6099x + 0.02357x^2 \qquad (2)$$

$$\hat{y}_2 = 58.474 - 1.5074x + 0.02167x^2 \qquad (3)$$

$$\hat{z}_1 = 6.333 - 0.1617x + 0.00613x^2 \qquad (4)$$

$$\hat{z}_2 = 6.497 - 0.1763x + 0.00705x^2 \qquad (5)$$

where $\hat{y}_1$ is the water content of the test sample;

$\hat{y}_2$ is the water content of the control;

$\hat{z}_1$ is the pH of the test sample;

$\hat{z}_2$ is the pH of the control.

The multiple correlation coefficients R were used as criteria for adequateness, and the maximum absolute error $\bar{y}_1 - \hat{y}_1$ and $\bar{z}_1 - \hat{z}_1$ was used as well. $\bar{y}$ and $\bar{z}$ are the values received by experimental measurements.

For equation (2) R = 0.997, max. $(\bar{y}_1 - \hat{y}_1) = 1.741$;
for equation (3) R = 0.999, max. $(\bar{y}_2 - \hat{y}_2) = 0.578$;
for equation (4) R = 0.837, max. $(\bar{z}_1 - \hat{z}_1) = 0.235$;
for equation (5) R = 0.880, max. $(\bar{z}_2 - \hat{z}_2) = 0.173$.

The graphs on Figures 2 and 3 illustrate the good coincidence of the experimental data and the simulated ones. These are the curves for the changes in the technological parameters (water content and pH) received from the experimental studies of the test and control samples and from equations 2,3, 4 and 5 of the mathematical model. As seen from the graphs, the differences between the experiment and model are quite small.

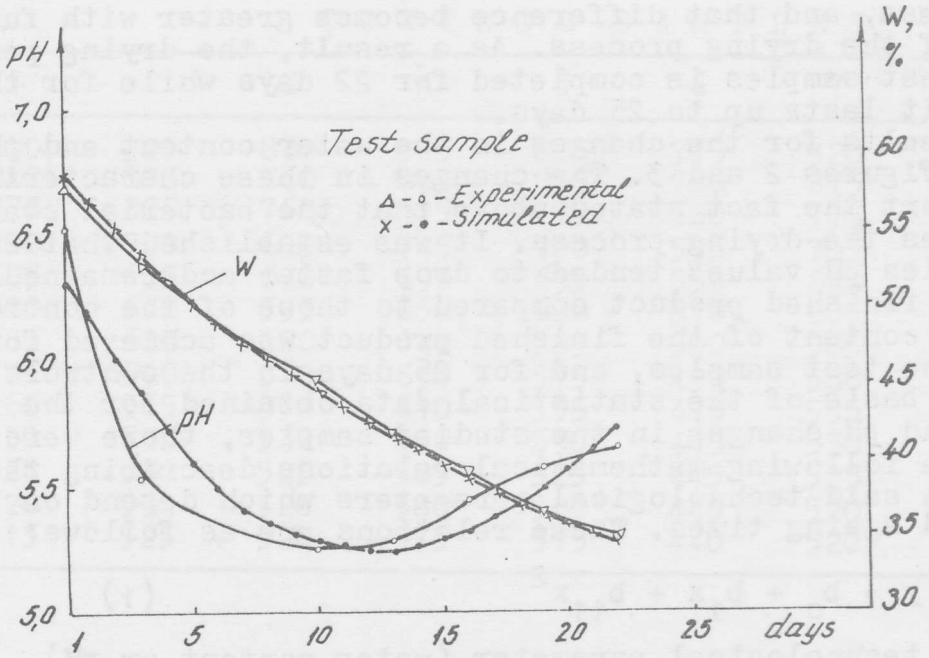

Fig.2

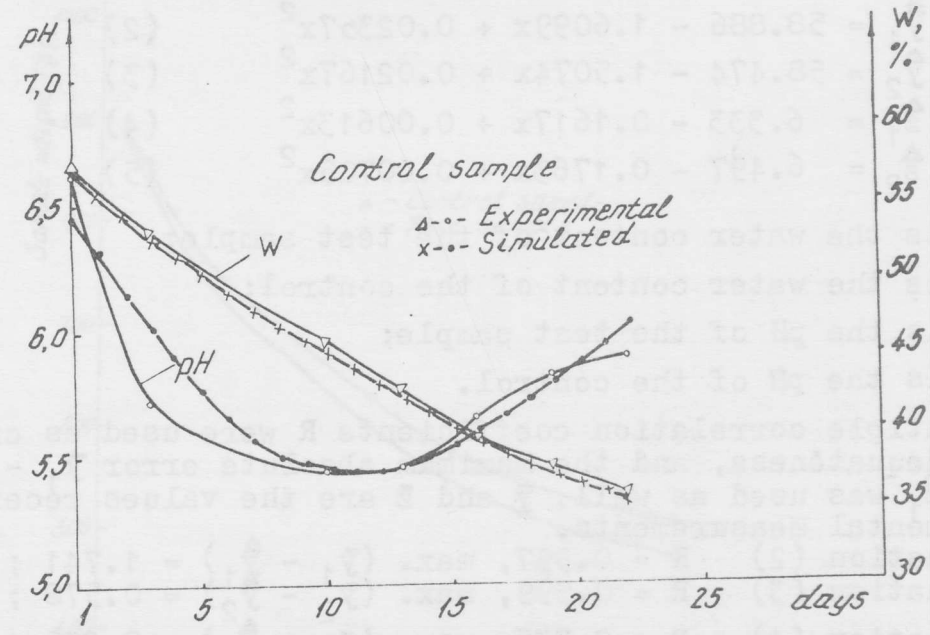

Fig.3

The results from the organoleptic evaluation of the test and control samples are given in Table 2.

Table 2. Organoleptic evaluation.

Characteristic	Test Samples	Control Samples
Outer appearance	8.71 ± 0.53	8.00 ± 0.71
Cutting surface colour	8.42 ± 0.37	7.71 ± 0.43
Flavour	8.28 ± 0.47	7.42 ± 0.46
Taste	8.14 ± 0.52	7.14 ± 0.56
Texture	7.85 ± 0.73	6.71 ± 0.45
Juiciness	7.66 ± 0.63	6.57 ± 0.53
Total evaluation	8.14 ± 0.57	7.14 ± 0.48

CONCLUSIONS: The results received from our study give reason to draw the following conclusions:

1. The microbial starter culture (Micrococcus varians) used by us intensifies the drying process of the raw-dried sausage variety (loukanka) that is expressed in the faster decrease of the pH, water content and weight values of the studied samples compared to the control samples prepared without the starter culture.
2. The samples prepared with the starter culture have better organoleptic characteristics and respectively higher organoleptic evaluation.
3. The mathematical models describe with satisfactory accuracy the real technological processes during the drying and ageing period and can be used for the practical purposes of prognostication.

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