THE TECHNOLOGICAL AND MICROBIOLOGICAL ASPECTS OF $CACL_2$ USE AT COMMINUTED MEAT PRODUCTS MANUFACTURE

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INTRODUCTION

In soviet and foreign sources of technico-scientific information the effect of Ca^{++} ions on the technological properties of meat raw material is described in a contradictory manner. The shortage of concrete data necessary for establishment of the interrelation between the quantity of exogenous Ca^{++} and its influence on such important characteristics as cooking loss, broth, protein and fat loss at different ratios of the main components of comminuted meat products in the process of their heat-treatment, did not clear out wether it is worth using ionized Ca^{++}, namely $CaCl_2$, during manufacture of such products.

MATERIALS AND METHODS

To solve this problem research was conducted on the so-called "model" comminuted meat systems which after raw material grinding and mixing with 10% brine were introduced into cans No.3, closed with lids and heat-treated to 71 + 1°C centre temperature.

RESULTS

Experimental data, characterizing the common chemical composition of the initial ground meat systems including comminuted beef muscle tissue, and also influence on their technological properties of $CaCl_2$, added in the process of mixing meat with brine, are presented in Table 1.

From the data of Table 1 it follows that adding of 0.1% and 0.2% of $CaCl_2$ into model systems causes lowering of broth and increase of the "solid part" mass share as compared with the heat-treated model system, salted without $CaCl_2$. Increase of $CaCl_2$ concentration to 0.3% influences negatively the technological properties of comminuted meat during its heat-treatment.

Taking into account that the total cooking loss of the model ground meat comprises, besides broth, moisture, evaporated in the process of heat treatment, $CaCl_2$ concentration equal to 0.1% should be considered the most effective for the minimal fat and protein separation into broth and for the maximal preservations of the ground meat mass.

Results of the analogical research into model systems comprising comminuted muscle and fat pork tissues, are presented in Table 2.

Analysis of the data listed in this table shows that concentration equal to 0.1% on the protein equivalent (i.e.0.074%) by weight of the model systems, consisting of ground beef ensures minimal quantity of separable broth as well as minimal losses of its nutritive components - protein and fat.

The interest to the study of possible $CaCl_2$ bacteriostatic effect arose during the comparison of microbiological analysis of different types of cooked sausages, manufactured with blood plasma, when it became clear that sausages, con-

Table 1.

Concentration of $CaCl_2$	Degree of comminution	Mass shares,%			Yield, %		Cooking loss of the initial raw material			WHC,% to dry matter
		moisture	protein	fat	solid part	broth	fat	protein	moisture	
0.0					80.5	19.5	1.5	2.3	19.56	191.4
0.1	2.5	72.37 ± 0.95	21.08 ± 0.69	4.45 ± 0.47	83.0	17.0	0.6	1.7	18.52	195.2
0.2					81.2	18.8	0.9	1.7	20.13	189.4
0.3					79.5	20.5	1.12	1.9	21.51	184.38
0.0					80.1	19.9	1.9	2.1	19.77	189.6
0.1	5.0	72.30 ± 0.89	21.48 ± 0.73	4.12 ± 0.44	82.4	17.6	0.9	1.5	19.06	192.2
0.2					80.2	19.8	1.2	1.6	20.99	185.2
0.3					89.0	21.0	1.4	1.7	21.96	181.7

Table 2.

Concentration of $CaCl_2$	Degree of comminution	Mass shares, %			Yeild, %		Cooking loss of the initial raw material, %			WHC, % to the dry matter	FHC*, % to the fatless dry residue
		moisture	protein	fat	solid part	broth	fat	protein	moisture		
0.0					76.3	23.7	7.1	1.9	23.8	56.8	123.1
0.1	3	51.4 ± 0.54	15.71 ± 0.54	30 ± 1	78.7	21.3	6.2	1.4	22.4	59.7	127.9
0.2					77.1	22.9	6.5	1.6	23.3	57.8	126.3
0.3					76.8	23.2	6.9	1.8	23.6	57.2	124.2
0.0					75.7	24.3	8.2	1.7	24.3	54.9	115.5
0.1	6	51.13 ± 0.99	15.8 ± 0.61	30 ± 1	78.2	21.8	7.4	1.2	22.9	57.8	119.8
0.2					76.7	23.3	7.7	1.4	23.3	56.9	118.2
0.3					76.1	23.9	7.9	1.6	23.9	55.7	117.1

* FHC - fat-holding capacity

taining calcium chloride as a coagulant, were characterized by the lower microbial load as compared to sausages, manufactured without $CaCl_2$. With this aim 5 types of model protein-containing mixtures were examined, salted with 2.4% NaCl: 1 - blood plasma mixed with beef trim; 2 - blood plasma mixed with beef trim and the isolate of cottonseed protein; 3 - blood plasma mixed with beef trim and sodium caseinate; 4 - blood plasma mixed with beef trim and diafiltrational protein concentrate of skimmed milk; 5 - blood plasma mixed with beef trim and micellium mushroom mass.

Each type of the model mixture was prepared in two variants. The control variant was prepared without calcium chloride. The test variant - with the addition of 0.1% $CaCl_2$ in the process of components mixing. After pre-treatment the model mixtures were placed into cans No.3, closed with lids and heat-treated in a cannery retort of the "Rotor Zwerg" company until 71 ± 1°C centre temperature. Then the samples were thermostated at this temperature during 5 minutes and cooled to 18 ± 1°c centre temperature. After 72h storage at room temperature the samples were taken for the microbiological analysis. Results of these analysis, presented in Table 3, show that for all system types under investigation, variants, prepared with 0.1% $CaCl_2$ are characterized, on the average, by the 1.69 times less bacterial load as compared with the control ones.

Another stage of $CaCl_2$ influence on the microbiological characteristics of food systems was devoted to the evaluation of its effect on the microorganisms of one of typical species of bacteria of the group E.coli.

In Table 4 experimental results of the $CaCl_2$ influence on the E.coli growth rate in the meat-peptone agar (MPA) are presented. During these experiments 2 types of E.coli suspensions were prepared with the equal concentrations of cells - 12 x 10^6/ml: 1 - in meat water, without calcium chloride addition/control;
2 - in meat water, with addition of 0.1% $CaCl_2$.

Both variants of suspensions before inoculation into MPA were stored during 24h at room temperature and at 6°C. After that, inoculation into MPA was made without $CaCl_2$ (control) and into MPA, containing 0.1% $CaCl_2$. Cultivation of microorganisms was conducted at 30°C during 72 hours. Results of these studies are given in Table 4.

Analysis of the data presented in the Table indicates that in case of holding E.coli bacteria suspensions containing and not containing 0.1% $CaCl_2$ at 19-20°C and at cultivation of these suspensions inoculations in MPA without $CaCl_2$, the amount of colonies, grown in the suspension inoculation, prepared with 0.1%$CaCl_2$ almost twice exceeds the amount of colonies, grown in the suspensions prepared with 0.1% $CaCl_2$ addition. During cultivation of the inoculated suspensions of the above-mentioned type in the MPA, containing 0.1% $CaCl_2$, the growth rate of the microorganisms in the process of their 72h cultivation at 30°C slows down by 2-3 times. At the inoculation into MPA without $CaCl_2$ of suspensions, containing of not containing 0.1% $CaCl_2$ and held at 6°C during 24hrs, the amount of colonies growth in both inoculations appeared to be prac-

Table 3.

Samples	Microbial count	Microorganisms' type	E.coli	Pr.vulgar	Salmonel.
1	$2.01 \cdot 10^3$	Bac. mesentericus; mycoides	-	-	-
1 + $CaCl_2$	$1.15 \cdot 10^3$	Bac. mesentericus; mycoides	-	-	-
2	$3.25 \cdot 10^3$	Bac. mesentericus; mycoides; Staph. Saprophitum	-	-	-
2 + $CaCl_2$	$1.65 \cdot 10^3$	Bac. mesentericus; mycoides; Staph. Saprophitum	-	-	-
3	$1.42 \cdot 10^3$	Bac. mesentericus; mycoides; subtilis	-	-	-
3 + $CaCl_2$	$1.16 \cdot 10^3$	Bac. mesentericus; mycoides; subtilis	-	-	-
4	$1.85 \cdot 10^3$	Bac. mesentericus; mycoides; subtilis; Staph.Saprophitum	-	-	-
4 + $CaCl_2$	$1.17 \cdot 10^3$	Bac. mesentericus; mycoides; subtilis; Staph. Saprophitum	-	-	-
5	$2.91 \cdot 10^3$	Bac. mesentericus; mycoides; subtilis	-	-	-
5 + $CaCl_2$	$1.52 \cdot 10^3$	Bac. mesentericus; mycoides; subtilis	-	-	-

tically equal. During cultivation of the analogous suspensions inoculated with E.coli in MPA, prepared with 0.1% $CaCl_2$, the amount of grown colonies decreased only by 30-40% as compared to those inoculated in MPA without $CaCl_2$.

With both variants of holding the initial E.coli suspensions in meat water before their inoculation into MPA, adding of 0.1% $CaCl_2$ into meat-peptone agar significantly decreases sizes and the amount of such colonies.

In general, the received data analysis convincingly evidences that $CaCl_2$ possesses pronounced bacteriostatic effect on bacteria of the E.coli type. Special series of tests was conducted to control effect of the above-said amount of $CaCl_2$ on thermoresistance lowering of the E.coli bacteria at moderate heat-treatment regimes. For this purpose suspensions of these bacteria (37×10^3 cells/ml) were inoculated into 50ml of meat-peptone agar, poured into spheric glass flasks. MPA was prepared with-

Table 4.

	Microbial count after 72 hrs cultivation at 30°C	
	in MPA without $CaCl_2$ (control)	in MPA, containing 0.1% $CaCl_2$
I. Preliminary holding at room temperature during 24 hrs		
a. without $CaCl_2$	94.4×10^7/ml Large, typical of the E.coli bacteria type surface and inner colonies	29.2×10^7/ml Typical of the E.coli bacteria type surface and inner colonies. Size of the colonies is significantly lower as compared to the variant of cultivation in MPA without $CaCl_2$ addition
b. with 0.1% $CaCl_2$ addition	54.8×10^7/ml	26.8×10^7/ml
II. Preliminary holding at 6°C during 24 hrs		
a. without $CaCl_2$	176×10^5/ml Typical of the E.coli bacteria type surface and inner colonies mostly of middle size	134×10^5/ml Typical of the E.Coli bacteria type surface and inner colonies of small and extremely small sizes
b. with 0.1% $CaCl_2$ addition	174×10^5/ml	102×10^5/ml

out $CaCl_2$ addition(control) and with 0.1% of $CaCl_2$. After inoculation the flasks were closed with sterile corks and placed into "swinging" water bath to ensure uniformity of their contents heating. Temperature control with the accuracy of ± 0.5°C was done with the help of a high-sensitive temperature recording kit connected to the thermocouple, which was fixed by a special adapter in the center of the flasks containing suspensions, inoculated intp MPA, and not involved in further microbiological test.

As temperature reached 60°C, 62°C and 64°C flasks with suspensions inoculated in MPA, containing and not containing 0.1% $CaCl_2$, were taken out of water bath. Selected flasks were placed in a thermostat and held there at 30°C during 72hrs. After every 24 hours visual analysis was made to test the surface and inner growth of E.coli colonies.

Experimental results indicate that at 60°C complete elimination of E.coli already takes place in MPA, containing 0.1%

$CaCl_2$. After 24, 48 and 72 hours of thermostating at 30°C this variant of the meat-peptone agar remained sterile. The same sterilizing effect with E.coli inoculations into MPA, not containing $CaCl_2$, was reached only at the heating temperature of 64°C.

CONCLUSIONS

Addition of calcium chloride into ground meat at the level of 0.1% by weight of the raw material for systems composed of high-protein components (beef muscle tissue) as well as for systems where mass share of fat exceeds mass share of protein, ensures significant positive effect on fat- and water-holding capacity of the ground meat.

This makes possible to recommend addition of such amount of $CaCl_2$ during comminuted meat products manufacture (cooked sausages, cans, semi-prepared foods) in order to increase yield and to minimize losses of the main macronutritive substances, containing in the initial meat components of their formulations.

Calcium chloride at the level of 0.1% by weight of the food products, possesses bacteriostatic effect on such types of microorganisms as Bac. mesentericus; Bac. mycoides; Bac. subtilis; Staph. Saprophitum; E. coli and lowers thermoresistance of E. coli bacteria during heat treatment.