A STUDY INTO THE INFLUENCE OF SALT LEVEL AND SAUSAGE CENTRE TEMPERATURE ON QUALITY AND KEEPABILITY OF COOKED SAUSAGE

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SUMMARY: Survival of test-cultures E.coli and Str. faecalis inoculated to sausage meat was tested as related to NaCl level (2.5 and 1.8% to raw material weight) and centre temperature (68° and 72°C) during vacuum-packed cooked sausage storage for up to 30 days at 4-8°C. There was found microbiological stability of sausages at storage time up to 20 days. The used technological regimes caused bactericidal and bacteriostatic effect upon test-cultures. There was found influence on product colour and consistency depending on centre temperature, salt level and microflora.

INTRODUCTION: For cooked sausages made in this country salt content should be no more than 2.1-2.5% as related to receipe. Due to the existing tendency towards healthy nutrition it is necessary to decrease NaCl level in sausage products. This problem has two main aspects: palatability of a product and its keepability.

Therefore, salt level decrease in cooked sausages and a possible loosening of its preservative action should be substantiated by bacteriological studies into survival of test-cultures in sausage meat with low concentration of NaCl.

Colibacillus, cocci(mainly enterococci) and Clostridium perfringens have sanitary importance and predominate in sausage meat. Clostridium perfringens present, mainly in vegetative form, Initially its amount is high, and then, under the influence of competiting microflora, its level decreases rapidly up to single cells and full disappearance(Sidorov M.A. et al.,1986; Mossel D.A. et al.,1985; Kostenko Yu.G., 1980).

The aim of the study is to determine microbiological reliability of technological parameters of cooked sausage manufacture and storage at lower level of salt (1.8%) and various regimes of sausage cooking (up to centre temperature 68 and 72°C).

MATERIALS AND METHODS: As test-cultures Colibacillus and Enterococci - E.coli, mixture of 5/41 and M-17 strains and Str.faecalis, 4/63 strain, were selected. The latter being typical by their morphological and serological properties of the given type of microorganisms. They were obtained from The Tarasevich's State Research Institute of Standartization and Control of Medical Biological Preparations.

Test samples of sausage meat were inoculated with test-cultures (E.coli or Str.faecalis): 500.000cells/1g(cm^3). Besides, at stuffing a sealed ampule with a test-culture was implanted into samples to exclude the influence of fat-protein-salt medium of minced meat. Each ampule contained 1cm^3 of agar

culture washing containing suspended microorganisms (500.000 cells). For inoculation a daily agar culture washed with izotonic saline was used. Dosaging was determined by optic standard turbity for vegetative types of microorganisms using subsequent decimal dilutions up to a selected dosage. For test-cultures survival control during sausage storage ampules with abovementioned suspended cultures were stored as control and test sausage samples. Non-inoculated sausage served as a control. The level of inoculated vital cells in finished product was determined by HB-r method according to Hoskins' table.

Minced meat for model samples of control and test sausages included: I grade beef 6.0 kg, semi-lean pork 6.0 kg, water 3.66 kg, black pepper 10 g, nutmeg 3 g, sodium nitrate 0.12 g, salt 0.3 g or 0.216 g(2.5 or 1.8% to materials weight - beef and pork).

Thermal treatment of control and test samples was conducted in the same chamber. One half of control and test samples was cooked to 68-69°C, the other to 72-73°C. After chilling to 8°C they were vacuum-packed and stored at 4-8°C for 10,20,30 days. Non-packed samples were stored up to 3 days in a home refrigerator at 6-8°C.

Experiment scheme

NaCl added,%	2.5						1.8					
Inoculation	without inoculation		E.coli		Str. faecalis		without inoculation		E.coli		Str. faecalis	
Centre temperature,°C	72	68	72	68	72	68	72	68	72	68	72	68
Storage, days	0				3		10		20		30	

For finished sausage there were determined microbial load, level of vital cultures and content of moisture, fat, protein, salt on Infralyzer 400P; colour on Hunter-Lab, model D-25M-2; consistency on a universal consistometer Instron, model M-1140; organoleptical evaluation was done by a 5-point scale. Experiments were dublicated.

RESULTS AND DISCUSSION: Results of bacteriological investigations are in Tables 1 and 2.

Analysis of Table 1 and 2 data shows that sausage thermal treatment provides death of test-cultures in ampules implanted to chunks. As for control ampules cultures were vital for the whole storage period though their number slightly decreased. It testifies to the correctness of the selected strains. From the samples of raw contaminated minced meat inoculated culture the level of which per 1g corresponded to a calculated dosage(E.coli 400.000-740.000, Enterococci 300.000-700.000) was selected.

Thermal regime of sausage cooking provides test-cultures death(less than 0.3 cells/1g that testifies to this microflora absence). However at 30 day of storage culture was isolated in a small amount of 0.4-2.3 cells/g from all sausage samples inoculated with Enterococci. It testifies to surviveability of

Table 1. Survival of test-cultures inoculated to sausage meat and in ampules implanted into sausages, and in control ampules stored together with sausage samples

Strain type	Number of test-meats		Number of ampules with test-cultures			
	analysed	with vital cultures	from sausages after heat treatment storage 0-30 days		Stored control ampules storage 0-30 days	
			analysed	with vital cultures	analysed	with vital cultures
E.coli mixture of 5/41 & M-17 strains	4	4	40	0	10	10
Str.faecalis, 4/63 strain	4	4	36	0	10	10

Enterococci in fat-&-protein medium after being in a anabiotic state for a long time.

Control and test samples comparison did not show a noticeable effect of temperature(68°and 72°C) on microbial load of a product.

There was observed a slight increase of microbial load(for one order) at salt concentration decrease to 1.8%(Table 2). For the other experiment series the difference was less expressed (varied in the range of 3-signs figures of a single order). There was not found a significant increase of microbial load during long-term storage at 4°-8°C.

Results on chemical composition analysis for control and test sausages are given in Table 3, colour and consistency in Table4.

After 3 days storage there was moisture content decrease for all samples by 1.1-3.2%. It is a natural moisture loss as samples had been stored in a refrigerator as non-packed. And protein content increased by 05-1.5%. During first 10 days of packed sausages storage water content decreased, in average, by 1.3% and at further storage chemical composition practically did not changed. All samples contained 1-3mg% of nitrite.

By appearance the samples did not differ. After 10 days there appeared a greyish ring along chunck's perimeter; all samples with 1.8% salt level treated to 68°C had green ring and were brighter than at the beginning of storage. After 20 and 30 days al all samples lost their pink colour but maintained flavour and taste.

Analysis of results of instrument sausage quality evaluation (table 4) also shows that centre temperature (68 and 72°C), salt concentration and microflora influenced colour and consistency.

Table 2. Microbiological parameters during storage of cooked sausage inoculated with test-cultures depending on salt level and final centre temperature at cooking

Series	Microbiological parameters	Storage time, days	Test samples				Control samples			
			Salt added, %							
			2.5		1.8		2.5		1.8	
			Centre temperature, °C							
			68	72	68	72	68	72	68	72
I	Total microbial load, thousands/1g	0	0.8	0.75	1.09	1.05	0.88	0.81	2.89	1.17
		3-5	1.47	2.19	1.41	1.99	2.09	1.13	2.85	2.46
		10	1.17	1.26	1.21	1.56	1.37	1.13	1.71	1.17
		20	0.5	0.4	0.62	1.16	0.63	0.67	1.66	1.64
		30	1.15	0.2	1.35	1.16	1.36	1.12	1.37	1.12
	E.coli units per 1g	30	0.3	0.3	0.3	0.3	-	-	-	-
II	Total microbial load, thousands/1g	0	2.41	1.57	2.9	2.49	2.36	2.05	2.82	2.22
		3-5	3.06	1.78	2.4	2.54	3.18	2.24	2.8	2.53
		10	2.6	2.06	2.8	2.37	3.09	2.51	1.66	2.95
		20	2.07	2.1	-	2.94	2.72	1.65	1.8	2.92
		30	2.0	1.7	1.5	1.47	2.35	1.98	1.08	2.51
	Enterococci units per 1g	0-20	0.3	0.3	-	0.3	-	-	-	-
		30	0.9	0.9	0.4	2.3	-	-	-	-

At 72°C pink colour intensity was more expressed in all samples than at 68°C. Brightness and yellowness of samples at 68°c was more than at 72°C at salt concentration of 2.5 and 1.8%. Control and test samples made at 2.5% salt addition were more pink at 72°C as well as at 68°C than at 1.8% salt level.

Test samples, immediately after treatment, were more pink tan control irrespective of centre temperature and salt concentration.

Cosistency (by compression destruction force) of control samples with 2.5% salt level is more dense than at 1.8%. At storage time increase all samples, as a rule, become more dense.

CONCLUSIONS: Sausage cooking up to 68°C and salt content decrease to 1.7% guarantee sanitary wholesomeness of a product. And technological regimes exert the following effect upon inoculated test-culture (500.000/g): bactericidal - cause Colibacillus death and bacteriostatic - cause Enterococci deep anabiosis. During 20 days of storage at 4°-8°C inoculated test-cultures were not found, by th 30th day there appeared single cells of Enterococci.

Table 3. Cooked sausage chemical composition during storage(average data)

°C	Salt, %	Sample type*	Storage time, days									
			0	3	10	20	30	0	3	10	20	30
			moisture, %					fat, %				
68	2.5	C	69.0	66.9	67.9	67.8	67.5	14.1	14.5	14.0	13.8	14.3
68	2.5	T	70.8	67.6	68.9	68.3	67.9	13.2	14.4	13.0	13.7	14.4
68	1.8	C	70.3	69.2	69.2	68.0	68.0	13.2	13.6	13.3	13.5	14.2
68	1.8	T	69.8	67.6	68.7	67.8	67.2	13.1	14.3	13.3	13.4	14.3
72	2.5	C	68.3	67.0	67.3	67.0	67.0	14.0	13.8	14.3	14.9	14.9
72	2.5	T	69.9	68.5	68.4	68.2	67.8	13.2	13.5	14.0	13.8	14.4
72	1.8	C	70.5	68.9	69.1	68.7	68.4	12.9	13.3	13.4	13.7	14.1
72	1.8	T	70.0	68.4	68.7	68.2	67.3	13.0	13.4	13.3	13.8	14.2
			salt, %					protein				
68	2.5	C	2.1	2.1	2.1	2.1	2.1	12.1	13.5	13.3	12.9	12.7
68	2.5	T	2.0	2.0	2.1	2.1	2.1	12.1	13.6	13.4	12.9	12.9
68	1.8	C	1.7	1.6	1.7	1.7	1.7	12.9	13.5	13.0	13.5	13.2
68	1.8	T	1.7	1.7	1.7	1.6	1.7	13.3	13.7	13.3	13.8	13.2
72	2.5	C	2.2	2.0	2.2	2.1	2.0	12.7	13.3	13.6	13.5	13.1
72	2.5	T	2.1	2.0	2.1	2.1	2.1	12.3	12.5	13.4	13.2	13.1
72	1.8	C	1.7	1.6	1.7	1.7	1.7	13.0	13.2	13.7	13.5	13.1
72	1.8	T	1.7	1.7	1.7	1.7	1.7	12.8	13.2	13.5	13.3	13.0

* C - control

T - test(with inoculated microflora)

Table 4. Change of colour and consistency of cooked sausage during storage(average data)

°C, salt, %	Sample*	Brightness - L				Pinkness - a				Yellowness - b				Compression destruction force, kg			
		Storage time, days															
		0	10	20	30	0	10	20	30	0	10	20	30	0	10	20	30
72°C	C	51.3	52.4	53.2	54.4	11.2	9.5	10.6	10.6	8.4	8.9	8.8	8.9	7.6	8.0	9.5	8.6
2.5%	T	49.6	51.8	51.6	50.8	11.6	10.6	11.0	11.5	8.6	8.7	8.8	8.7	6.5	7.7	8.4	6.6
1.8%	C	50.6	51.8	51.9	51.1	10.7	10.1	10.5	10.3	8.7	8.8	9.0	9.2	6.3	7.0	7.8	7.4
	T	50.0	51.9	52.0	51.1	11.5	10.1	11.0	10.9	8.5	8.9	8.8	8.9	6.7	7.1	7.2	8.6
68°C	C	50.5	52.3	52.4	51.8	10.0	9.6	10.6	10.8	9.0	9.2	9.1	9.1	7.5	7.9	8.7	9.3
2.5%	T	50.5	51.3	52.0	50.3	10.4	9.8	9.7	10.4	8.9	9.2	9.1	9.2	6.6	7.9	8.8	8.0
1.8%	C	50.2	51.4	51.1	50.7	9.6	9.3	9.1	10.2	9.2	9.4	9.8	9.3	5.5	6.7	6.5	7.1
	T	50.0	51.5	51.4	50.6	11.6	9.8	10.7	11.3	8.6	7.7	8.9	8.9	7.2	7.6	7.9	8.2

* C - control

T - test

Sausage cooking to 72°C increase intensity and stability of product pink vcolour. Salt content decrease lowers sausage density irrespective of centre temperature.

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