SALTING OF CASINGS UNDER SEMIINDUSTRIAL CONDITIONS FOR REDUCTION OF WASTE WATER CONTAMINATION

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INTRODUCTION

On the basis of the laboratory investigations two procedures for wet salting of natural casings were developed. The investigations were carried out to test the mentioned procedures in semiindustrial conditions (pilot plant), because only such results could indicate the possibilities for industrial application. Besides, we wanted to examine the possibilities for use of waste salt solution,obtained by regeneration of ion exchanger, in wet salting.

MATERIALS AND METHODS

For the experiments the pigs small intestines, cleaned and treated by usual technology of machine treatment were used. The treated casings were bounded in bundles à 200 m.

In procedure I the casings were kept 1 hour in saturated salt solution containing lactic acid (pH = 2,0) and thereafter 5 days in saturated salt solution under the static conditions at the temperature from 5°C to 8°C (in cold storage for casings salting).

In procedure II the casings were kept during all 5 days in saturated salt solution,containing lactic acid and hydrochloric acid, at the temperature between 5°C and 8°C. In contrast to the first procedure the casings were twice dayly stirred.

The III procedure was the same as the second one. The use of waste water salt solution obtained from regeneration of ion exchanger and saturated with necessery quantity of salt was the only difference between II and III procedure.

In all three procedures for wet salting the ratio casings/salt solution amounted to 1:2. At the tank bottom there was always an excess of indissolved salt to ensure the saturation of solution during the whole experiment.

In salted casings the bacteriological contamination,chemical composition(H_2O and NaCl), mechanical and technological properties were analyzed. The examination of technological properties of salted casings was carried out under the industrial conditions, so that the casings were filled with the same stuffing for one sausage type. The suitability of casings for filling and weight losses after heat treatment of produced sausages were analyzed. The dry salted casings were used as a control. For chemical and bac- teriological determinations the usual procedures were applied, whereas the mechanical properties (tensile strenght and stretching) were measured using INSTRON 4301 (extension speed 200 mm/min). Five measurements (n=5) of casings (width 15 mm) were carried out.

In salted solution the changes of pH value, the bacteriological contamination and the quantity of nitrogen substances dissolved from casings (by Kjehldahl) were examined and determinated.

RESULTS

The experiments with the first solution didn't give the expected results, because of slow and bad diffusion of salt in saturated salt solution (2. solution). Only the casings from tank bottom were satisfactory salted, whereas the casings from the middle and top layers showed the bacteriological growth and the degradation of casings tissue, because of unsatisfactory dehydratation and low salt concentrations, which is presented by the results from table 1.

Table 1.

Location of sample	$\%H_2O$	%NaCl	Total bact. count/g
top layer	87,0	5,1	82000
middle "	79,5	7,9	49000
bottom "	69,6	19,3	13000

It is obvious that only the casings from bottom layers are satisfactory salted, where the salt solutions were saturated.

In second series of experiments the casings were salted by second procedure, i.e. by keeping them in saturated acid (pH = 2,0 to 2,5) salt solution with stirring from time to time. In the same solution three batches of casings were successively salted with addition of necessery quantities of salt and acid (to maintain the pH value between 2,0 and 2,5). After each batch, pH value and the total bacterial count in 1 ml of solution were measured, and the obtained results can be seen in table 2.

Table 2.

Sample of solution after	pH	Total bact. count /g
first use	3,54	1.000
second use	3,86	8.000
third use	4,20	20.000

In accordance with expectations, after each salting the bacterial count showed increase because of higher concentration of dissolved proteins and also because of higher pH value of salt solution. Therefore, after third usage the suspended proteins and other organic matters should be separated by adequate floculation procedure, so that the same solution could probably be used again.

In experimental and control (dry salted) casings $\%H_2O$ and total bacterial count in 1 g were determined and the obtained results are presented in table 3.

Table 3.

Casings samples from	$\%H_2O$ exper.	$\%H_2O$ dry s.	Total bact. count/g exper.	Total bact. count/g dry s.
1.batch	68,2	54,5	4.000	30.000
2. batch	70,4	52,3	7.000	25.000
3. batch	71,5	54,1	14.000	30.000

Although the wet salted casings were significantly less dehydrated comparing to the dry salted samples, the bacterial contamination was much lower, even in the third group, where the casings showed the highest contamination comparing to the other experimental sample groups. The quality of wet salted casings was technologically examined by their application in commercial conditions for sausage production. The experimental samples proved to be as good as the control samples.

In the third series of experiments, the possibility for use of waste salt solution, obtained after regeneration of ion exchanger, containing 10% salt, in wet salting procedure was examined. By chemical analysis the presence of 5% Na^+, 0,42 % Mg^{++} and 0,039 % Ca^{++} was determinated. The bacteriological analysis showed the practical sterility. Because of high content of Ca^{++} and Mg^{++}, this salt solution isn't suitable for meat salting and curing. The aim of this

experiment was to determine how the increased contents of Ca^{++} and Mg^{++} in salt solution could affect the technological and mechanical properties in wet salting. Comparatively the dry salted and wet salted (2. procedure) were used as a control. For the salt solution preparing ordinary table salt was taken. Because of higher bacteriological contamination of casings from previous experiment, the pH value of salt solution was reduced to app. 1,5.

In solutions, the pH changes, the bacteriological contamination and the quantity of extracted substances containing nitrogen were determined. The results are given in table 4.

Table 4.

Kind of salt sol.	pH after days 0	1	5	Nitrogen %	Total bact. count/g
Control with NaCl	1,50	2,30	2,38	0,029	-
Exper. with Ca^{++} and Mg^{++}	1,25	2,0	2,34	0,022	-

It is obvious that the pH value increased significantly only the first day, so this value remained low after 5 days, which was enough to prevent the bacterial growth. The extraction of proteins and other organic matters from casings was a little lower, if in salt solution the concentrations of Ca^{++} and Mg^{++} are increased, which is desirable because such solution can be used for a longer period without coagulation and flocculation.

In experimental salt solution (with higher content of Ca^{++} and Mg^{++} contents) the concentrations of Na^{+}, Ca^{++} and Mg^{++} were determined before and after salting of casings.

This results are presented in table 5.

Table 5.

	Concentrations %			Ratio of conc.	
	Na^{+}	Ca^{++}	Mg^{++}	Na^{+}/Ca^{++}	Na^{+}/Mg^{++}
Before treatm.	12,0	0,53	0,36	22:1	33:1
After treatm.	11,2	0,36	0,20	31:1	60:1

From the presented results it is obvious that casings have bounded more Mg^{++} and Ca^{++} than Na^{+}.

In salted casings the water and salt contained, the bacterial contamination and the mechanical and technological properties were analyzed.The results of chemical and bacteriological analysis are given in table 6., and the results of measurements of mechanical and technological properties in table 7.

Table 6.

Casings samples salted in	% H_2O	% NaCl	Total bact. count/g
NaCl-solution	69,5	18,3	-
Waste salt solution	66,8	20,5	-

The results from table 6. showed that the casings in both two cases are sterile, and that the dehydratation was better and the salt concentration in casings higher by the sample group which was salted in solution with higher Ca^{++} and Ng^{++} contents.It means that the

experimental salt solution, prepared on the basis of waste salt solution seems to be even better for salting of casings in comparison to the salt solution prepared using ordinary table salt.

Table 7.

Casings salted by	Tensile strenght N/15 mm		Stretching %	
	trans.	vert.	trans.	vert.
Dry proc.	4,88	16,04	54,8	41,1
Wet proc. 2	4,36	14,70	74,1	33,7
Wet proc. 3	5,66	16,28	71,0	47,6

	Weight loss after heat treatment
Dry proc.	12,2
Wet proc. 2	10,0
Wet proc. 3	10,9

It is obvious from table 7. that there is no significant differences in tensile strenght (transversal and vertical) between dry and wet salted casings, moreover it could be said that the casings salted by wet procedure 3. (with higher concentrations of Ca^{++} and Mg^{++}) showed some higher tensile strenght.Regarding the vertical stretching there was no significant difference,whereas the wet salted casings have a little higher transversal stretching in comparison to the dry salted casings. A small differences regarding the vapour permeability between dry and wet salted casings were determinated. The dry salted casings showed a little higher vapour permeability (weight loss).

CONCLUSIONS

On the basis of experiments carried out under the semiindustrial conditions (in a pilot plant), the following conclusions can be made:

1. By salting,using acid-salt solutions, the salted casings can be produced,which are not worse in comparison to the dry salted casings regarding the mechanical and technological properties. Moreover, they are sterile, which is an advantage over the dry salted casings.

2. The waste salt solution obtained by regeneration of ion exchanger for water softening can be used for weet salting of casings. The increased concentrations of Ca^{++} and Mg^{++} in salt solution has no negative influence influence on mechanical and technological properties and bacteriological contamination of salted casings.

3. The application of wet procedure for natural casings salting can reduce the salt contamination of meat industry waste waters. Nevertheless, the procedure for regeneration of salt solution should be developed.