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THE EFFECT OF SALT AND HEATING ON SOME PROPERTIES OF MEAT

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Biochemical and structural changes of meat under heat treatment are not known enough or are unknown at all. The reason for this is the fact that the chemical composition of meat is not only very complexive but also considerably varying-depending on feeding, way of the processing of meat product in question, way and duration of storage etc.

Among the changes taking place in meat during heat treatment, pH has undoubtedly very important role. Intensity anc character of all more important changes of meat during boiling and smoking is greatly influenced by pH.

The other changes of meat under the heat treatment are also of first-rate interest for meat technology. As the heat treated meat is always previously salted or cured, there is a need for detailed studies on meat, as well.

In view of lack of data about the influence of heat on meat and its components, the Institute of Meat Technology FPRY designed extended research on this matter. One part of this investigations includes the reexaminations of data available in the literature, while the other involves problems not ćet cleared up. The purpose of this paper is to give concentrated survey of results gained up to date.

The effects of salt upon meat.- Addition of salt to the meat emulsion* causes the decrease of pH value. Table 1 shows the intensity of this decrease in meat emulsion. As evident the decrease of pH value depends on the concentration of added salt.

*Under this term it is to comprehend:
ground beef + 2,5% salt + 75% water

1. The Effects of Various Quantities of NaCl upon pH of Meat Emulsion Containing 75% of Added Water*

/I.Savić-S.Karan Djurdjić,1955/

% NaCl	pH
0,0	6,11
0,75	5,99
1,50	5,96
2,25	5,92
3,00	5,90
3,75	5,82
4,50	5,81
5,25	5,80
6,00	5,73
7,50	5,75
8,25	5,75
9,00	5,75

/* Reading of pH values performed several hours after addition of salt/

Examinations showed that the pH value was not influenced only ba the salt concentration, but also by initial pH value of meat emulsion. For instance, if the pH value of meat emulsion /containing 5% of salt/ is being adjusted at a larger range of values from 4.4o to 7.18 /by the adding of normal solutions of NaOH and HCl/, new interesting data can be noticed /Figure 1/. It is evident instantly that by initial pH 4.38 to 4.69 there are no changes of pH values or very slight ones. Below 4.38 pH value inclines towards alcaline and above 4.69 towards the acid reaction.

It should be noted that the curve has a different course with other concentrations of salt /$\leqslant$ 5%/. To a smaller extent it applies to the quantity of water added to meat emulsion /$\leqslant$ 75%/.

With regard to the foregoing the conclusion can be made that only relatively large concentrations of salt can cause changes of pH value which are of practical interest. Quantities of salt of approx. 2% or less cause slight decrease of pH value which is not of any practical significance.

Beyond doubt is the practical significance of the fact

that salt can prevent further changes of pH value of meat /Figure 2/. Namely, if salt is added to meat immediately after slaughter / i.e. to the meat in which glycolitic phase of aging has not been over/ then glycolisis is stopped irrespective of the fact that glycogen reserve was not exhausted /Karan-Djurdjić, Hamm/. Wothout touching the very complicated theoretical explanations of this phenomenon we point out the work of Hamm/ 6/.

While the work of salt on ground meat is apparent more or less in a definite way, it is not the case with the meat in joins, that is, the meat with the natural anatomic-hystological structure. For example, the shifts of pH value of cured meat /injected with 1o% of brine and immerssd 5 days / do not correspond to the changes of pH value of ground meat or meat emulsion.

It can be stated that the decrease of pH value of cured meat depends besides the initial pH value also on the extent of salt penetration into muscle fibres. The latter is influenced by the strength and quantity of curing brine, by the location of blood vessels from the respective part of meat, by the relation of fatty, connective and muscle tissues and by some other factors.

Some results concerning the changes of pH value in brine-meat system are given /Tables 2 and 3/.

The effects of salt upon water binding-capacity of meat.- Figure 3 presents the effects of salting up on water binding-capacity of body warm meat. This meat retains permanently very high binding capacity /it has been said already that it maintains a high pH value, Fig.2/. Figure 3 also shows that the effect of presalting depends greatly on the extent of grinding, and that by the same grinding grade a better binding effect is achieved by simultaneous addition of water and salt than in case of adding of water to the previously salted meat.

2.Ph of cured meat and brines containing various concentrations of salt*

/Stolić/

% salt in brines	pH at the end of 7th day of curing	
	meat	brine
3	5,59	5,58
6	5,58	5,56
9	5,59	5,54
12	5,51	5,53
15	5,53	5,53
18	5,53	5,53
21	5,51	5,53

* Initial pH of brine 8,26.
Ph of meat before curing 6,11 to 6.12

3.Ph of hours before and during curing

/Plant "Izvor"/

Serie of pro duction	One hour before curing	1st day	7th day
I	6,38	6,32	5,86
II	6,33	6,26	5,72
III	6,12	6,1o	5,84
IV	6,27	6,18	5,72
V	6,34	6,28	5,63
VI	6,12	6,o8	5,81
VII	6,18	6,14	5,76
VIII	6,13	6,1o	5,74
IX	6,13	6,1o	5,74
X	6,22	6,14	5,82

The effects of heating upon meat.- If pH value of meat emulsion is adjusted /in the way shown in Fig.1/ to a larger range of values from 4.2o to 7.18 and afterwards the emulsion is heated up to 65°C, the curve presented in Fig.4 is gained. It is apparent from it that if the initial pH value of meat emulsion is of approx. 6.45 no change whatsoever does occur by heating. If initial pH is greater than 6.45 the final pH decreases, while with the initial pH lower than 6.45, it increases. The latter fact is of great importance for meat technology. Generally these findings correspond to the results achieved by

Bate-Smith /1945/ and Bendall /1947/, who, examining the changes of proteins under the heat, established that the variations of pH values depend on the initial pH and are positive if pH is below 6.5 and negative if it is above 7.0.

In meat processing practice only salted or cured meats are heat treated. For this reason it is interesting to know in which way does the heat effect the meat containing certain quantities of salt.

Figure 5 shows the increase of pH value of meat emulsion containing different salt quantities after heating at 55°, 65° and 75°C. Also in this case the increase of pH is mostly noticable at the temperature of 65°C or above, but it can be observed to a lower extent already at 55°C.

In view of the abovem salt and heat are the factors acting differently to a certain extent so that their effects are partly or completely compensated. Especially it is the case when initial pH of meat is about 6,0.

It should be noticed that the effects of salt upon pH of meat can be observed also in meat previously denaturated by heat.

Similarly to the effects of salt the effects of heat upon meat in joins are also more complicated than upon meat whose structure is destroyed by grinding in cutter and by adding of large quantities of water. However, by recording the variations of pH values of meat juice /obtained by pressing/ the afore-cited details can be confirmed. From Table 4 it is evident that considerable differences exist not only in pH values of meat and pH values of meat juice itself, but also that the variations of pH of meat juice correspond more to those of meat emulsions.

The final pH value remains unchanged after curing //devrease of pH/ and heating /increase of pH/ when the fresh meat juice is of an initial pH from 5.8 to 6.2. /Note: The differences between pH values of meat and meat juice do not result only from the greater possibility of failures when the direct estimation of pH of meat is performed - heterogene

structure of meat - but the main reasons are positively of a quite different nature/.

4. The effects of heating upon quantity and composition of meat juice

Meat	% Juice	Moisture %		NaCl %		pH		% N in juice
		Meat	Juice	Meat	Juice	Meat	Juice	
Fresh/72h/5°C/	21,09	74,32	-	-	-	-	-	0,225
Cured /I/*	18,60	71,07	86,23	6,49	9,58	6,04	5,67	0,292
60°C/10'	19,00	69,03	91,28	4,23	5,84	6,48	6,14	0,040
97°C/10'	10,52	63,06	91,62	4,22	5,84	6,48	6,25	0,207
Fresh/72h/5°C/	26,56	71,07	-	-	-	-	-	0,225
Cured /II/**	24,28	67,03	83,42	9,56	15,42	5,86	5,52	0,343
60°C/10'	28,63	58,35	87,56	6,28	9,58	6,42	5,97	0,042
97°C/10'	8,33	51,33	87,80	4,48	8,87	6,51	6,08	0,533

* 16 Bé/10% + 12 Bé/5 days

** 23 Bé/10% + 12 Bé/5 days

Among the other particularities which are also apparent from Figure 4, the differences of quantities of salt in meat and meat juice are of special interest. Special attention is to be payed to the fact that in the juice obtained from pork and slightly heated at 60°C/10', there is always only a small quantity of nitrogen, irrespective of the curing being performed in stronger or weaker brines. According to the recent results it appears that the quantity of juice which remains in meat after heat denaturation depends to the smaller extent on water content, pH or curing method, and to the greater extent on the structure, shape and size of treated meat join.

Tables 5 and 6 present the composition and pH values of meat juice of fresh, cured /by weaker or stronger brine / and pasteurised pork. These data confirm once more the before mentioned statements. The data shown in Table 7 have the same meaning.

5. Composition and pH value of juice of fresh, cured* and pasteurised pork

Ristin /unpublished data/

Meat/ham/	pH	Moisture %	NaCl %	N %
Fresh	6,27	98,76	0,46	0,225
Cured	5,99	85,45	8,87	0,164
Pasteurised** 60°C/10'	6,28	88,98	6,54	0,020
Pasteurised** 85°C/10'	6,16	87,40	7,47	0,102

* Brine I

** Temperature in centre of join

6. Composition and pH value of juice of fresh, cured* and pasteurised pork

Ristin / unpublished data/

Meat/ham/	pH	Moisture %	NaCl %	N %
Fresh	6,27	98,76	0,46	0,225
Cured	5,96	82,71	14,25	0,205
Pasteurised** 60°C/10'	5,94	85,55	9,46	0,020
Pasteurised** 85°C/10'	6,06	84,29	12,85	0,389

* Brine II

** Temperature in centre of join

7. The water and NaCl content and pH value in meat and meat juice after pasteurisation

/Ristin/

N° of examined ham	NaCl %		Moisture %		pH	
	Meat	Juice	Meat	Juice	Meat	Juice
1.	4,19	5,69	67,71	85,39	6,29	6,62
2.	4,02	4,58	70,64	84,99	6,29	6,38
3.	3,17	3,92	-	-	-	-
4.	3,02	4,77	-	-	-	-
5.	4,41	6,01	-	-	-	-
6.	3,43	4,34	-	-	-	-
7.	-	-	-	-	6,3	6,45
8.	-	-	-	-	6,1	6,10
9.	-	-	-	-	6,1	6,15
10.	-	-	-	-	6,3	6,45

The influence of heating on the quantity of nitrite in meat is of practical interest, too. Figure 6 shows that the biggest loss of nitrites is in brines containing meat juice /obtained by pressing/ considerably smaller in brines with meat and completely slight in brines with added meat juice. By all means reduction of nitrites is more complete in brine /i.e. in the presence of salt /than in water. No difference occur in the grade of reduction on temperatures of 60°C/10' and 97°C/10'.

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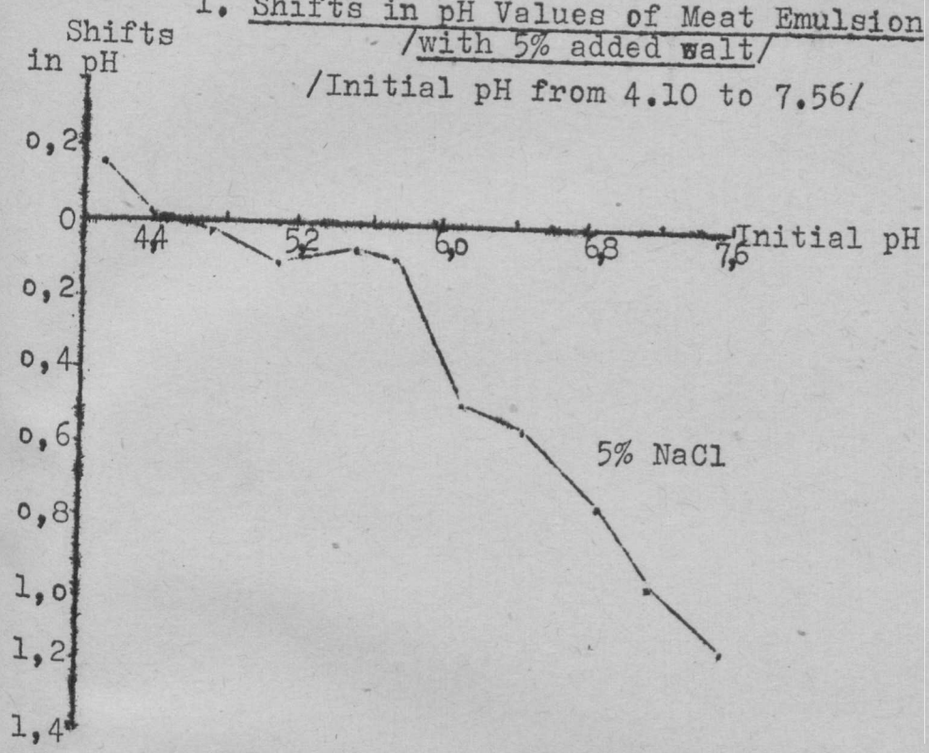
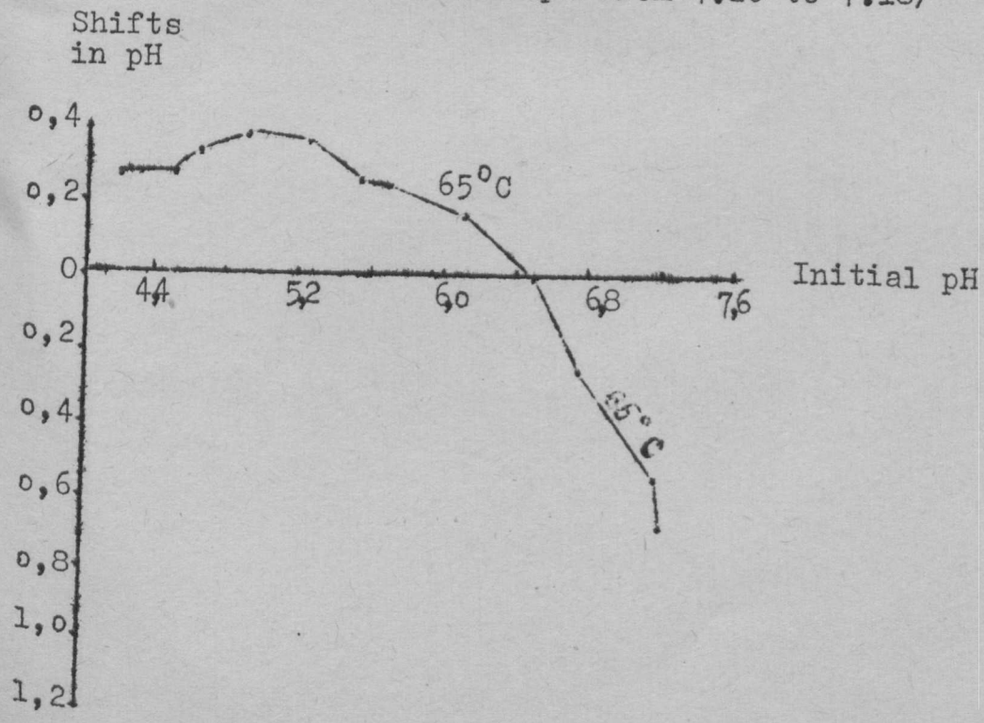
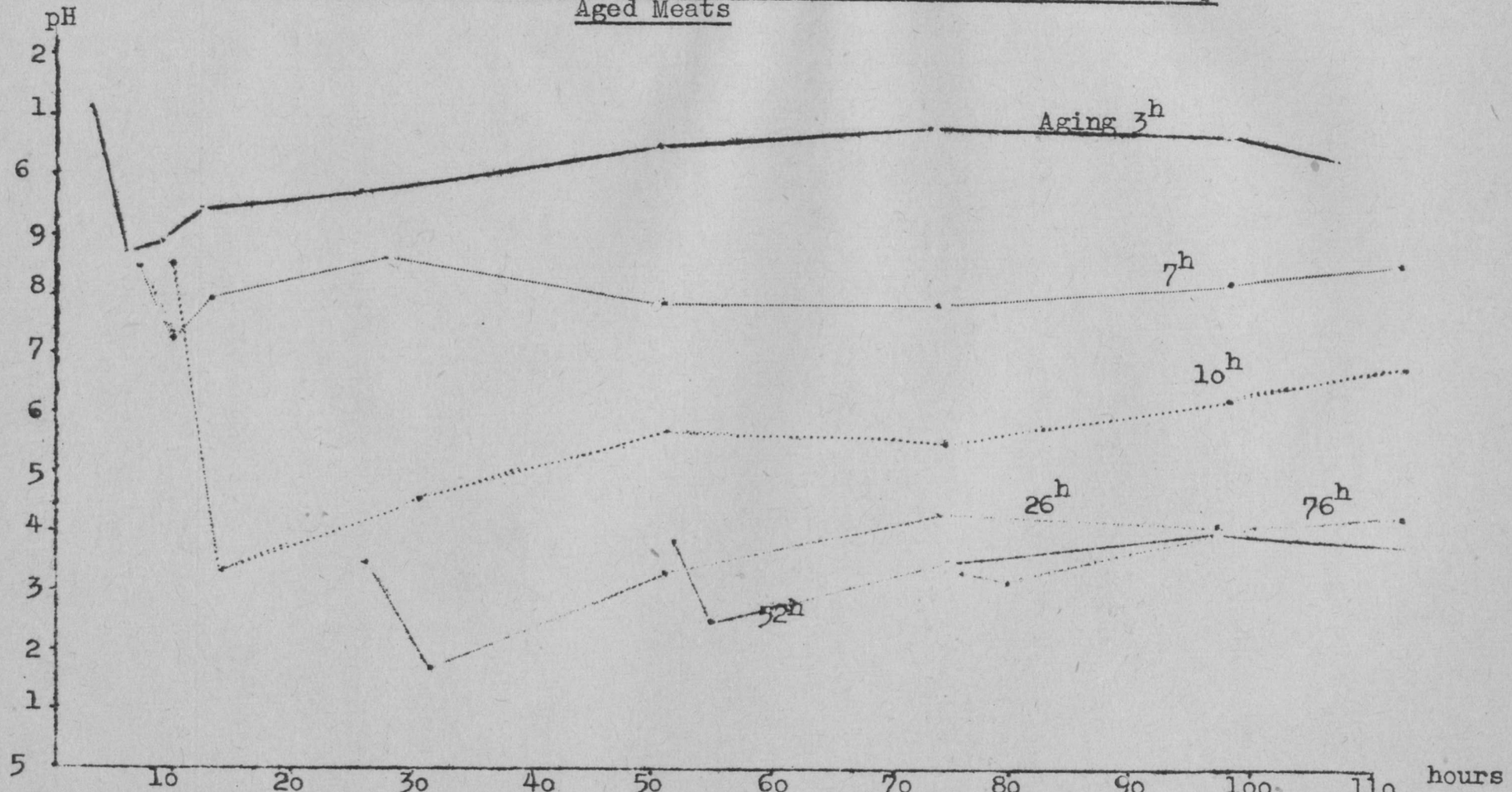
1. Shifts in pH Values of Meat Emulsion /with 5% added salt/
/Initial pH from 4.10 to 7.56/



4. Shifts in pH Values of Heat Treated /65°C/ Meat Emulsion
/Initial pH from 4.20 to 7.18/



2. Shifts in pH Value of Meat Emulsions Prepared from Differently Aged Meats



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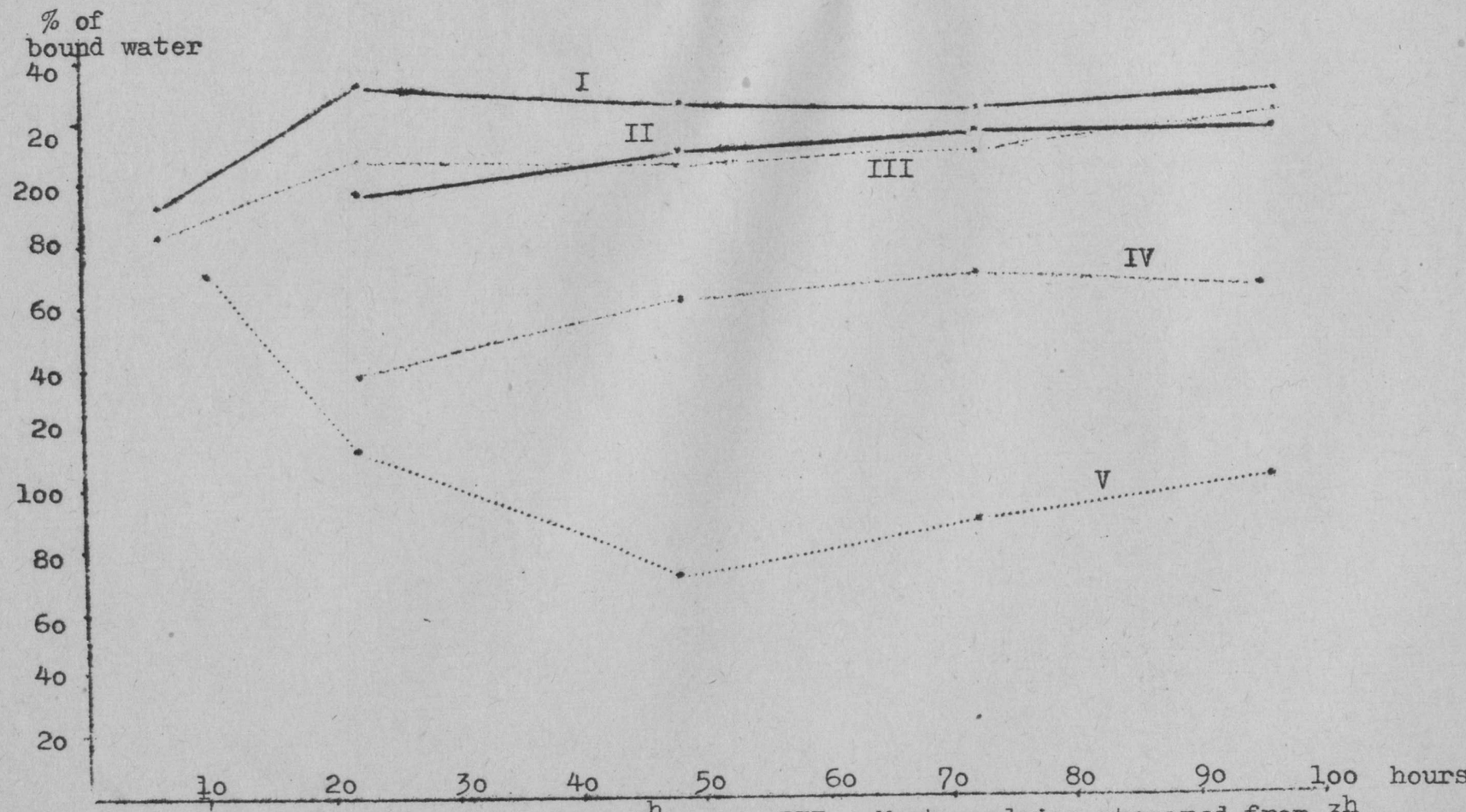
3. The Effect of Presalting on Water Binding Capacity of Meat



I = Meat emulsion prepared from 3h aged meat /ground in cutter/

II = Meat emulsion prepared from pre-salted meat /ground in cutter/

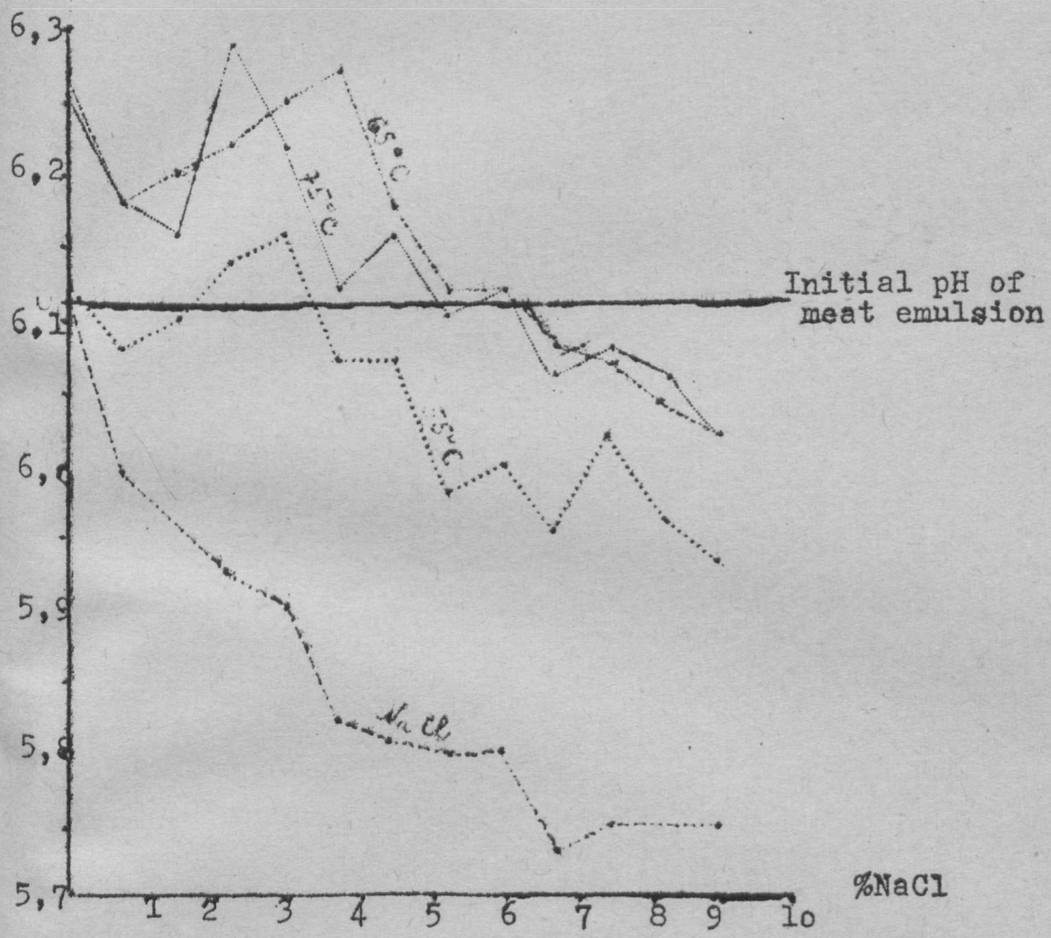
III = Meat emulsion prepared from 3h aged meat /ground in mincer/

IV = Meat emulsion prepared from pre-salted meat / ground in mincer/

V = Meat in join

5. The Effect of NaCl and Heating on pH of Meat Emulsion

/Initial pH 6,11/



.6. The Effect of Heating on Loss of Nitrite