Varsova 1961 / 1

12 191

SEVENTH MEETING OF EUROPEAN MEAT RESEARCH WORKERS

WARSZAWA, SEPTEMBER 18th to 22nd, 1961

THE EFFECT OF COOKING ON THE COLOUR OF CURED MEAT.

by

Irena CHMARA and St.TYSZKIEWICZ

Polish Meat Research Institute, Warszawa
Livestock Division, Poznań.

Introduction.

The colour of meat is one of the most important measures for determining its quality. There exist many publications which discuss the problem of total pigments in meat and the factors that may influence them. Nevertheless among all of these publications only few deal with the colour of meat as a physical phenomenon and as examined by means of physical methods.

It is clear that the impression one gets of the colour of meat is the result of different factors. The most important of them but not the only ones are the total pigments. This becomes evident especially in the technological processes, which cause profound alterations both in the total pigments of meat and in its medium. One of these technological processes is heat treatment. The influence of this treatment on the colour of meat examined by means of physical methods is the main subject of the experiments referred to.

Methods and Experiments.

1. Material and heat treatment.

The experiment has been carried out in two cysles. In both of them muscles of pork ham, trimmed from fat have been cured for five and a half days at 4°C in a a mixture composed of:

salt..... 2%

nitrate..... 0,05%

nitrite.....0,003%

sugar.....0,05%

Next the cured meat has been thoroughly ground , mixed and put into cylindric cans of 99x119 mm.size. These cans after having been evacuated were submitted to heat treatment following one of the described thereafter:

Cycle I.

Four variations of heat treatment have been adopted:

A.....heating water at 65° C

B..... " " " 75° C

C..... " " " 85° C

D..... " " " 95° C

During the experiment B,C and D when the temperature in the can centre reached 63°C /1/ the temperature of the heating water was reduced to 65°C and maintained at this level for 30 minutes.Afterwards all the cans were cooled in current water of about 15° C.until the centres of the cans reached a temperature of 30°C.The diagram of these temperature changes is shown in fig.1 The line represents the temperature of 63°C.

Cycle II.

Four variations of heat treatment have been adopted. This time the heating water was at 75°C in all the experiments.When the inner temperature of the cans reached

63°C that of the heating water was reduced to 65°C and maintained at this level for:

variation A.....15 minutes

" B.....30 "

" C.....45 "

" D.....60 "

Variation B was identical in both cycles. Afterwards the cans were cooled in current water in the same way as described in Cycle I.

The diagram of the temperature changes is shown in fig.2.

2. Examination of the product.

The pasteurized cans were opened not later than 6 days after the experiment has been performed.x/ They were stored at 4°C/. Samples for the measurements were taken from the central part of the meat bloc. The following analyses have been performed:

1. the measurement of meat colour immediately after the cans have been opened
2. the measurement of meat colour after 18 hours exposure to diffused light, of an intensity of 50 1x
3. determination of the amount of nitroso-haem pigments and total pigments

---

x/ They could not be opened at the same time because of technical difficulties

4. the determination of the quantity of soluble proteins
5. the determination of the reductivity and pH of the sample.

3. Analytical methods.

Colour. The measurement of the reflectance spectrum of meat has been made with the Unicam SP-500 Spectrophotometer fitted with a reflectance attachment. Using the method of selecting coördinates, the dominant wavelength, brightness and saturation have been determined/2,3,4,5/.

Nitric oxide-haem pigments and total pigments. Here the method of Hornsey has been adopted./6/

Soluble proteins. were extracted with water and after centrifugation determined according to the Kjeldahl technique.

Reductivity. The water extract of meat was acidified with oxalic acid and titrated with a solution of 0,001 N 2,6-dichlorophenolindophenol.

pH has been measured using the Radiometer R-22.

R e s u l t s.

The results of cycle I are shown on table 1. The results of cycle II on table 2.

In order to determine the exact conditions of heat treatment, the quantities of heat absorbed by the can centre in each of the variants has been denoted.

The respective computations were based on the formula:

$$Q = \sum_{i=1}^{m} T_i \Delta t$$

T_1-initila temperature of meat , T_m-maximal temperature of the ham centre , t- time.

Discussion and conclusions:

The process of cooking causes important changes in the colour of meat.It can be realised while studying table 1 and 2,that the dominant wavelength of cooked meat is getting shorter in comparison with the one in raw meat.On the other hand brightness is decidedly increasing.These changes are of course only a small part of the general changes which occur in meat while being cooked/7/.It is probable that it is due to the denaturation of chromoproteins and other proteins.The denaturation of chromoproteins causes a transformation of their spectrum /8/.Changes in prosthetic groups are also most probable/9/.The denaturation of the other muscle proteins,which is due probably to the changes in their special configuration must influence the brightness of meat/10,11,12/.Furthermore the loss of transparency of meat caused by diminished solubility of the denaturated protein /11,12/ makes impossible the absorption of light in the inner parts of meat. It is difficult to enumerate all the other factors which may influence upon the matter.

The changes of colour in cooked stored meat are also of great interest.The shift of the dominant wavelength in the direction of shorter waves has been observed /significant, $P < 0,0001$/ as being equal in both cycles.The same phenomenon has been found in raw smoked sausage while being stored/15/.It is probable that these changes are due to the process of progressive oxidation of the pigment.In both the cycles the saturation of the colour after exposure to light did not show any serious changes.

The brightness,however,grew up in both cycles.In the first cycle the growth of brightness was different in all the variants and in the second one equal in all of them.This shows a doubtless influence of heat treatment on the colour of meat and its durability after the exposure to light.This proves that the brightness of the colour of cooked meat is the gage of the stability of this colour.On the other hand the dominant wavelength and the saturation seem not to have a preponderant influence.This observation is in conformity with previous experiments/5,14/.

The heat treatment may be approximatively characterised by three factors:

a/ velocity of the rise of the meat temperature

b/ the maximal temperature of meat

c/time of exposure to heat.

In the first cycle all these factors are variable. In the second one,however,only the time of warming is changeable.This proves clearly that the brightness of meat depends chiefly on the rapid rise of temperature and on its maximal height.

Fig.3 shows the dependence of the maximal temperature of meat and the speed at which this temperature is rising in cycle I.The interval up from the moment of boiling until the temperature of the centre part of the can had reached 63°C,was used as a measure of speed of the rise of the temperature.The brightness of meat colour after exposure has been shown on the same diagram,which evidences also that the smallest change of meat brightness after exposure,what means the most constant colour of meat is obtained when the rise of temperature in the centre of the can is quick and the maximal temperature of it not very high.Furthermore the results of cycle II indicate that the prolongation of warming time does not influence the brightness of meat in a negative sense.It seems also that the time of warming has not much to do with the other qualities of meat,in any case much less than the remaining two factors of heat treatment.For instance one can observe in cycle I rather important differences in the contents of soluble proteins in hams processed under different variances,which is in conformity with the obser-

vation made by Hamm and Deatherage on beef /7/.Here also the prolongation of warming time /cycle II/ did not show not show a serious reduction of soluble proteins.The same dependence has been found while examining reductivity.The contents of nitrisexide -haem pigments are the most favourable in that variant,which shows the most constant colour.

The above presented conclusions are are only of preliminary character.More comprehensive ones will be given after the whole cycle of the planned experimental works will be performed.

Acknowledgments.

The authors wish to express their appreciation bo the Professors W.Pezacki and M.A,Janicki for advices in the work reported here.

R e f e r e n c e s:

1. Coretti- "Fleischwirtschaft" 1957,3,115
2. Mirna-"Fleischwirtschaft" 1955,10,589
3. Zausznica A.-Nauka o barwie,PWN 1959
4. Boume P.J.-Farbe und Farbwahrnehmung,Eindhoven 1951
5. Chmara I.,Tyszkiewicz St.-Prace Inst.Lab.Bad.Przem. Spoż./in press/.
6. Hornsey H.C.-J.Sci.Food Sgric.1956,7,532
   J.Sci.Food Agric.1957,8,547
7. Hamm R.,Deatherage E.F.-Food Res.1960,5,587
8. Lemberg R.,Legge J.W.-Hematin compounds and bile pigments.Intersci.Publ.1949
9. Pezacki W.-Personal communication.
10. Connell J.J.-Soc.Chem.Ind.London 1958
11. Anson M.L.-The chemistry of the amino acids and proteins.Thomas Books 1945
12. Anson M.L.-Adv.Protein Chem.1945,2,361
13. Pezacki W.- Fleischw. 1961,5,390
14. Pezacki W.-Przem.Spoż./in press/.
15. Watts B.M.-Adv.Food Res.1954,5,1
16. Rice R.E.-Beuk J.F.-Adv.Food Res.1953,4,262
17. Ziemba Z.-Przem.Spoż.1961,15,2
18. Jones O.-Canning practice and control.Chapmann & Hall Ltd.1949
19. Stumbo C.R.-Adv.Food Res.1949,2,89
20. Desrosier N.W.-The technology of food preservation. The Avi Publ.Comp.Inc.1959

Table 1. Computation table of the average results in cycle I.

parameter/variant:	raw meat		after curing		A		B		C		D	
	x		x		x		x		x		x	
Before exposure												
Dominant wavelength in m_M	purple	-	601,0	1,2	600,6	5,5	600,6	5,7	600,6	5,5		
brightness	20,79	1,51	32,26	0,35	32,36	1,22	32,54	1,99	32,05	0,52		
saturation	-	-	0,39	0,049	0,39	0,007	0,38	0,049	0,39	0,049		
After exposure:												
Dominat wavelength in m_M	-	-	593,8	0,50	594,4	0,99	592,3	1,60	593,5	0,78		
brightness	-	-	34,13	0,80	32,57	1,71	36,20	0,54	37,71	0,84		
saturation	-	-/	0,38	0,050	0,38	0,064	0,38	0,011	0,37	0,049		
pH	5,860	-	6,130	-	6,125	-	6,125	-	6,150	-		
% of soluble proteins	-	-	1,41	0,16	1,07	0,20	0,63	0,08	0,42	0,12		
reductivity	-	-	0,74	0,11	0,71	0,10	0,70	0,07	0,65	0,13		
% of nitric oxide haem pigments	-	-	73,7	4,14	75,3	3,01	64,0	6,60	69,1	3,90		
quantity of heat x cal.	-	-	7503,7	-	5302,5	-	4185,0	-	4020,0	-		

27

Table 2. Computation table of the average results in cycle II.

parameter/ variant:	raw meat after curing		A		B		C		D	
	x		x		x		x		x	
Before exposure:										
Dominant wavelength in m_M	purple	-	603,4	2,3	602,5	5,4	601,5	6,8	602,5	5,2
brightness	18,63	1,04	31,95	0,69	30,92	1,41	31,45	1,14	30,43	1,72
saturation	-	-	0,37	0,067	0,38	0,032	0,38	0,027	0,38	0,016
After exposure:										
Dominant wavelength in m_M	-	-	593,8	1,16	593,6	1,01	592,0	0,97	594,3	0,48
brightness	-	-	33,81	0,73	32,95	0,68	33,48	0,98	33,13	1,14
saturation	-	-	0,37	0,009	0,38	0,017	0,37	0,048	0,37	0,023
pH	5,915	-	6,255	-	6,250	-	6,250	-	6,248	-
% of soluble proteins	-	-	0,92	0,14	0,91	0,27	0,84	0,31	0,66	0,09
reductivity	-	-	0,64	0,21	0,70	0,10	0,72	0,08	0,68	0,33
% of nitric oxide haem pigments	-	-	69,9	6,42	74,5	2,12	75,9	3,27	72,8	4,46
quantity of heat x cal	-	-	4452,5	-	4912,5	-	5591,1	-	5932,5	-

202

Fig 1

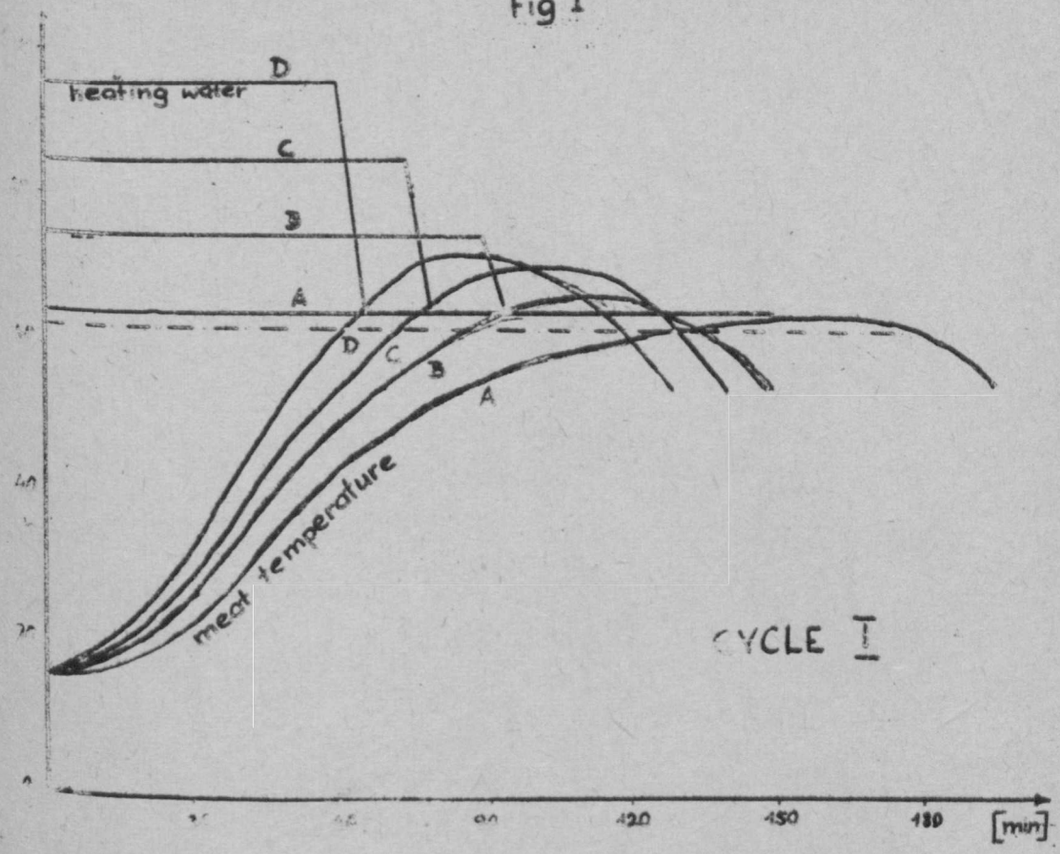

D
heating water
C
B
A
D
C
B
A
meat temperature
CYCLE I
120
150
180
[min]

Fig.2

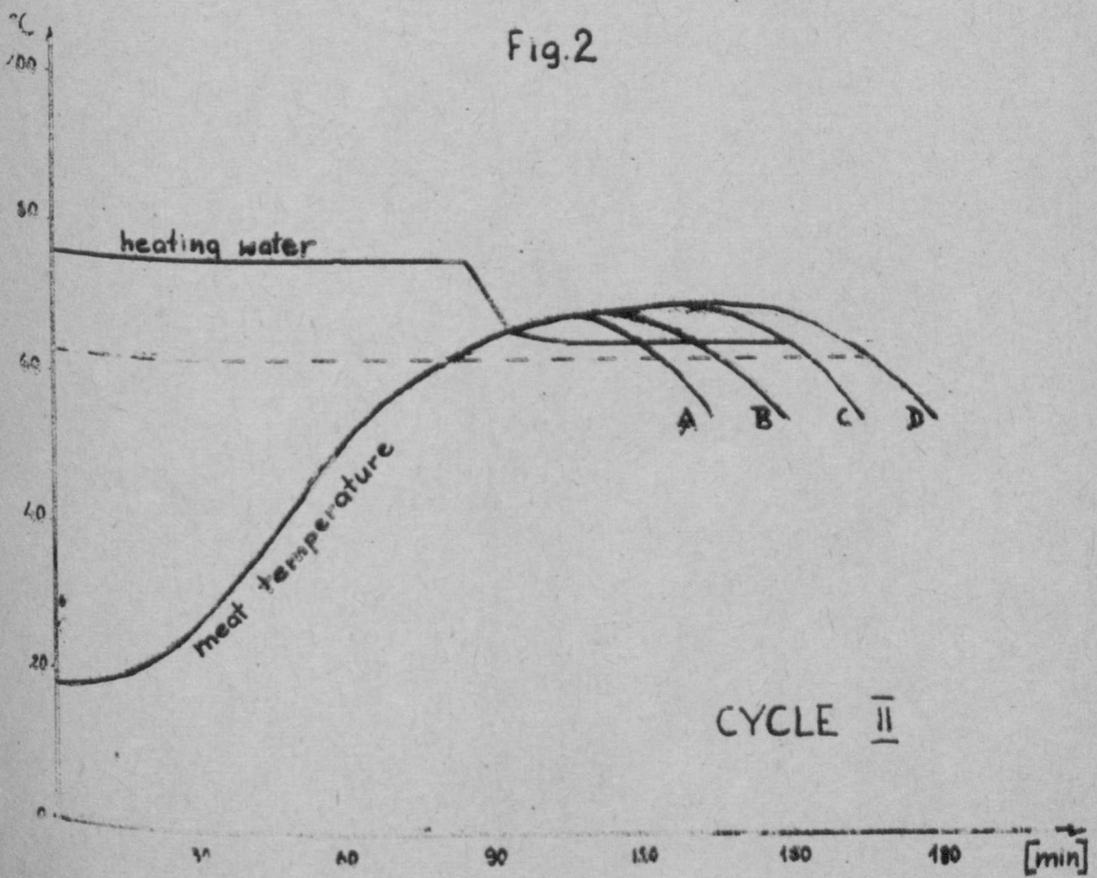
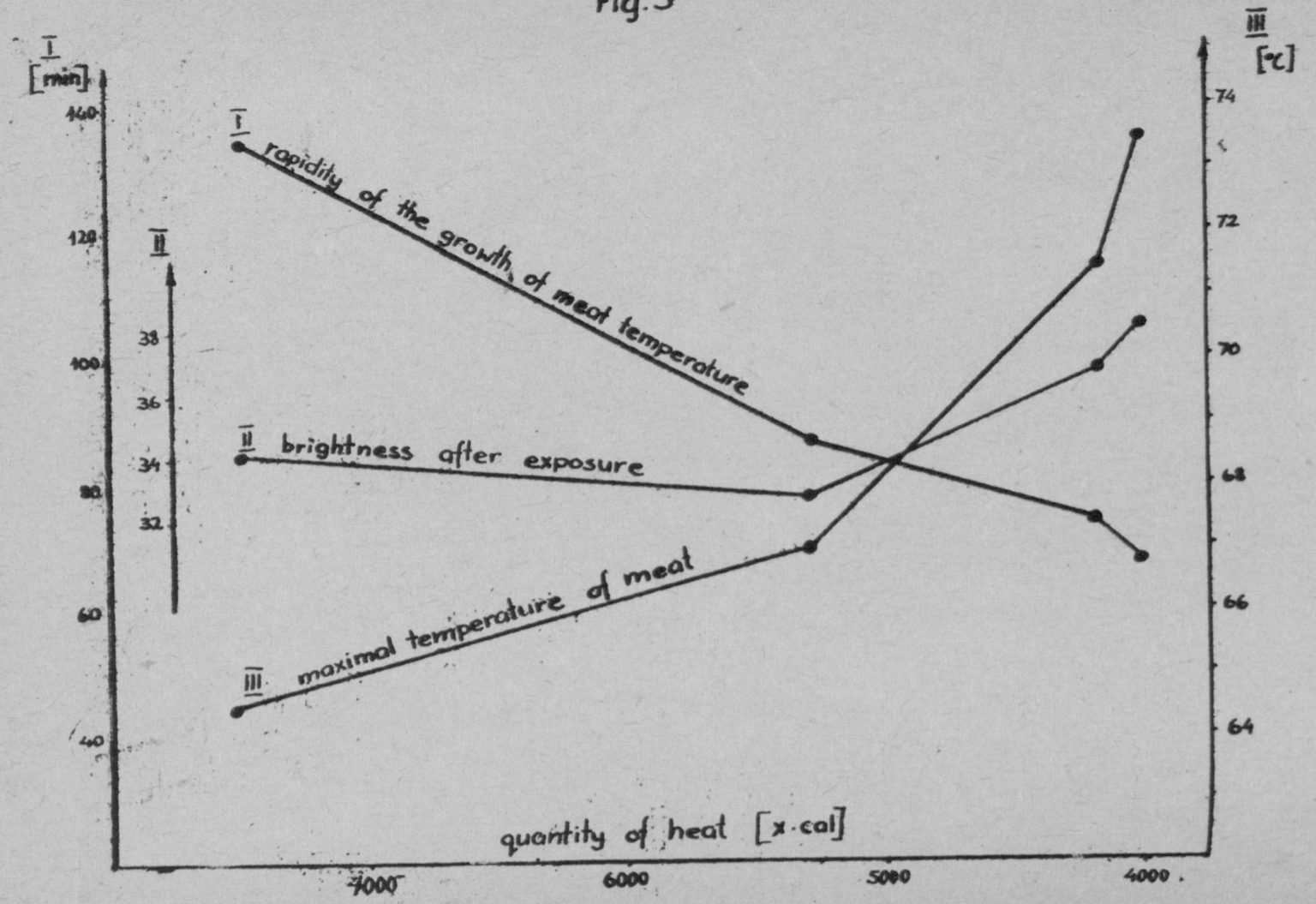

°C
100
80
heating water
60
40
20
meat temperature
A
B
C
D
CYCLE II
90
150
180
[min]

Fig.3


I
[min]
160
120
100
80
60
40
II
38
36
34
32
III
[°C]
74
72
70
68
66
64
I rapidity of the growth of meat temperature
II brightness after exposure
III maximal temperature of meat
quantity of heat [x·cal]
7000
6000
5000
4000