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COLOUR OF CANNED HAMS PRODUCED FROM PORK CHILLED AND CURED BY DIFFERENT PROCEDURES

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The muscle colour depends upon several ingredients the most important of which is myoglobin. Apart from these compounds the colour is also influenced by the post mortem state of muscle. That is, in a "closed" structure the muscle has a darker colour whereas by entering an "open" structure its colour gets paler.

Bate-Smith (3) reports that, among others, one of the properties of a "closed" structure muscle is a slower penetration of curing salts than it is the case with an "open" structure muscle. Such an explanation of post mortem muscle state influence upon the curing process leads to a conclusion that the curing of "warm" meat, i.e. while it is in a "closed" structure is unfavourable when compared with curing of chilled meat, that is, when it is in an "open" structure.

Mullins et al. have, however, according to a quotation of Arganosa and Henrickson (1), established that the brine penetrates only slightly slower into a muscle in a "closed" structure than it does into a muscle in an "open" one. Arganosa and Henrickson (1) have found that the brine penetrates at equal rate into muscles cured immediately post mortem and into those cured after chilling. To similar results have come Rahelić et al.(14). Moreover, Arganosa and Henrickson (1) while examining the influence of curing time post mortem, obtained results on the basis of which can be seen that nitrosomyoglobin (NOMb) is formed more rapidly in muscles cured one hour post mortem than in those cured 24 hours post mortem. Poor and Henrickson (13) have proved this result and found that NOMb formed in muscle cured in a warm state is more stabile than the compound which is formed in a muscle cured after chilling. Rahelić et al.(14) ahve not ascertained a significant curing time influence upon the process of NOMb formation.

More papers have been published in which it is stated that a different post mortem curing time of pork does not influence either the quality of the final product or its colour (Kassai and Kárpáthy, Cosart, Weiner at al, Davidson et al, Reddy and Henrickson).

Having evaluated this problem as important for the procession of products made of cured meat we have decided to examine the influence of various chilling and curing procedures of pig hams upon (a) NOMb forming process as well as upon (b) NOMb stability, that is, muscle colour in canned ham during storage. In the same way it has been decided to examine the $NaNO_2$ concentration changes and the amount of free SH groups in canned ham muscle during storage.

Investigations

Materials - As subject of examination swedish landrace pig hams were used, the weight of pigs varying between 105 and 115 kg. All pigs were bred on the same farm, held and fed in the same manner. The pigs were slaughtered in the usual way with electrical stunning. The carcasses were processed in 30 or 40 minutes.

The hams were cut off the carcasses in the level of 2nd lumbal vertebra and the skin and a part of fat were trimmed off. The hams cured in the warm state were processed in 2 hours post mortem and the controls were cut off the carcasses previously chilled for 24 hours at 0 to +3°C. Totaly, 32 hams were examined 8 plus 8 controls by procedure I and 8 plus 8 controls by procedure II.

Methods - The hams were rapidly chilled and cured immediately post mortem by two procedures in the following manner:

I procedure: the trimmed rightside hams were dipped two hours post mortem into a brine of 0°C with a ratio 1:3. The hams were chilled to 10°C at the depth of m.semitendineus (along os femoris) and were transferred later into a brine of 5°C. 24 hours post mortem the hams were injected with 12% brine at 4°C.

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II procedure: the trimmed rightside hams were injected two hours post mortem with 12% brine of the same composition as in the first procedure. Immediately after that the hams were dipped into brine same as in procedure I.

The leftside control hams, already chilled, were injected 24 hours post mortem with 13% brine and then dipped into the curing solution. The brine used for dipping and injecting was of same composition as in the previous procedures.

Hams processed by the first and the seond procedure were held in brine for three days and the controls for two. After this they were drained for one day at 5°C. From the hams treated in this way "flat" type tins were produced by the ordinary method with the weight of 10-14 lbs.

8 canned hams of each procedure together with the same number of controls were stored at 8°C. Three samples of each procedure together with three corresponding controls were examined on the 7th, 45th and 90th day of storage.

Methods of investigation

The forming of NOMb during curing is expressed as percentage of conversion and was established after a method of Hornsey (9).

The content of $NaNO_2$ in muscle was determined in the medial sample of m.biceps femoris after a method of Griess-Ilosvay. The reflextion of canned ham muscle was determined by reflecting supplement of the "Baush-Lomb" spectrophotometer, Spectronic 20, on a wavelength of 540 mμ after the method of Barton et al.(2). The average deviation from the mean reflection value was used as a colour uniformity indicator.

Colour stability was determined by the method of Hornsey (10). Comminuted medial sample of m.biceps femoris was spread evenly in an amount of 10 g onto two petri dishes with Ø 100 mm. The samples were put into a dark chamber and were illuminated for 30 and 90 minutes respectively with a lamp of 100 W from a distance of 50 cm. The stability was expressed as percentage of

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NOMb reduction after illuminating in comparison to the amount before illuminating.

The number of free SH groups was determined by the amperometric titration with 10^{-3} molar $AgNO_3$ after the method of Hamm and Hoffman (7).

The colour intensity and uniformity of canned ham muscle was always determined by the same group of five experts, according to the following scale:

Mark	Colour intensity	Colour uniformity
1	very pale	very ununiform
2-4	pale	ununiform, with expressed pale and dark fields
5	optimal red-pink	uniform, with less expressed pale and dark fields
6-8	darker red-pink	uniform with slight differences in colour
9	dark red	uniform

Results and discussion

The results of conversion percentage determination of Mb into NOMb in the m.biceps femoris of hams after injection of brine and during 72 hours of curing are shown in fig.1. These data show that about 45% of Mb converts into NOMb already during the first eight hours of curing whereas during the further period the conversion percentage is increased only for about 5%. The question is whether Mb does not convert into NOMb more rapidly, i.e. even earlier after the injection of brine? This presumption can be proved by results of Rahelić et al.(14

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who have found that in 200 g heavy pieces of m.long.dorsi of pigs already 6 hours after dipping an amount of NOMb is formed which is not increased during the rest of the curing time.

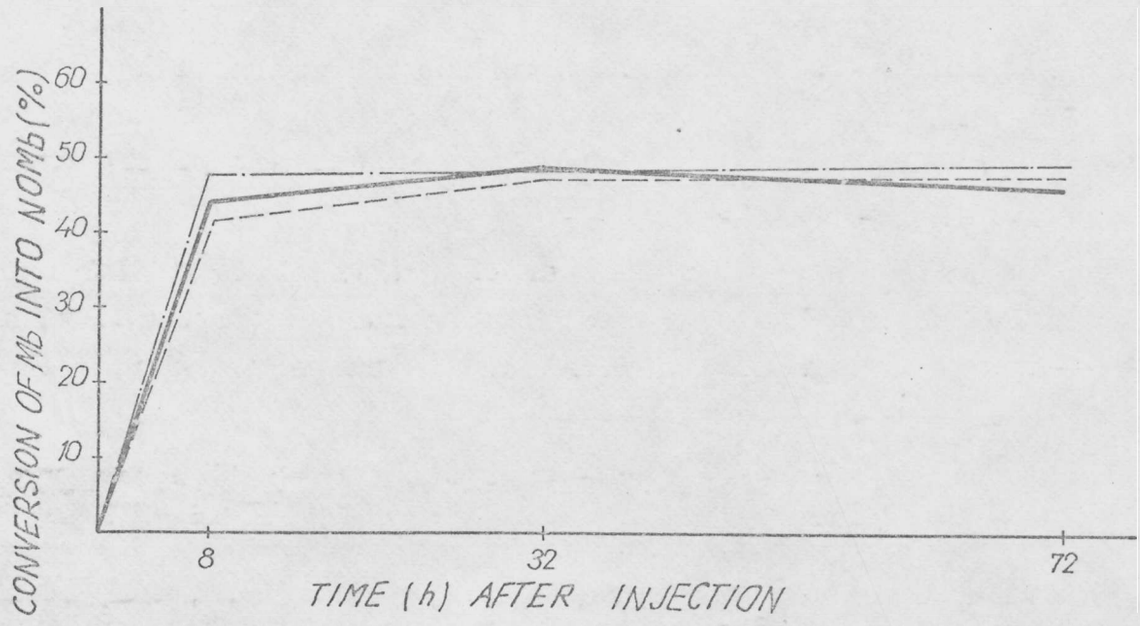

Figure 1. Conversion course of Mb into NOMb in cured muscle after injection of brine

- - - - - = procedure I
_•_•_ = procedure II
——— = controls

The obtained results show that the post mortem state of muscle structure does not influence the course of NOMb formation during curing since this compound is generally developed at the same rate in muscles injected 2 and 24 hours post mortem.

During cooking of canned hams the percentage of NOMb is increased by anout 20%. According to this, the percentage in m.biceps femoris of canned ham after cooking was the following:

a) in tins produced of hams from procedure I	70,7;	8,12
aa) in controls	64,0;	8,6
b) in tins produced of hams from procedure II	71,2;	4,2
bb) in controls	67,0;	6,3

From these data it can be seen that somewhat more Mb is converte into NOMb in canned hams produced from pork treated by procedure I and II, i.e. those that were chilled by a rapid process, by dipping into a cold brine, than those first chilled for 24 hours and then cured. This finding is in accordance with the results of Henrickson (8), and Reddy and Henrickson (15) who have also found a larger quantity of NOMb in canned ham muscle produced of warmly cured hams, i.e. before chilling.

The increase of conversion percentage of Mb into NOMb during cooking when related to quantity in muscle prior to it, is the result of temperature increase that brings to intensification of the chemical reaction.

The conversion percentage of Mb into NOMb and the content of $NaNO_2$ and SH groups in canned hams (n 3) during 90 days of storage at 8°C

Table 1.

curing procedure	storage time (days)	conversion of Mb (%) $\bar{x}$	$NaNO_2$ (mg%) $\bar{x}$	SH groups (mg/g protein) $\bar{x}$
I	7	66,88	9,63	4,23
control	7	72,30	9,00	4,40
I	45	64,53	4,97	4,08
control	45	62,67	4,27	5,15
I	90	81,50	3,78	4,25
control	90	67,70	2,73	4,18
II	7	72,40	11,33	4,38
control	7	72,40	8,87	4,29
II	45	63,53	5,42	3,92
control	45	61,70	4,07	4,04
II	90	79,85	3,03	4,30
control	90	69,30	2,95	4,34

The results of conversion percentage determination of Mb into NOMb after cooking of hams as well as during storage show that this percentage is somewhat higher in samples treated by procedures I and II then in the controls but these differences are not significant. This finding is important for the praxis if

viewed from the standpoint of "warm" meat curing. These results also show that the NOMb amount does not vary significantly in the hams during 90 days of storage.

Results given in table 1. show that $NaNO_2$ is succesively decomposed during storage whereas after 90 days it is reduced at about 1/3 of initial value. This finding is in accordance with those of Nordin et al.(12).

The number of free SH groups does not vary during storage. However, the amount of $NaNO_2$ is reduced at the same time as mentioned before for about 2/3 and therefore one can conclude that the decomposition of this compound is in no relation with the oxidation of SH groups. Erdman and Watts (6) report that SH groups react with nitrites only when present in larger quantities.

The canned ham colour intensity and uniformity during storage was evaluated sensorically (intensity: optimal 5; uniformity: optimal 9). The obtained results are shown in table 2.

Evaluation of colour intensity and uniformity on the through-cut section of canned ham (n 3) during storage at 8°C

Table 2.

curing proc.	storage (days)	reflectance $\lambda = 540$ $\bar{x}$	reflectance $\lambda = 540$ σ	evaluation of colour intensity $\bar{x}$	evaluation of colour intensity σ	uniformity $\bar{x}$	uniformity σ
I	7	30,5	4,23	5,5	0,33	6,8	0,90
control	7	32,1	5,42	4,8	0,90	6,2	1,90
I	45	30,3	3,10	6,1	0,37	7,4	0,13
control	45	30,5	4,22	5,8	0,23	4,9	0,73
I	90	31,5	4,04	5,5	0,50	7,0	0,0
control	90	29,1	4,00	4,9	0,15	7,0	0,30
II	7	29,1	3,27	5,5	0,69	6,7	0,57
control	7	31,0	3,49	6,6	0,30	4,8	0,58
II	45	30,3	2,87	5,9	0,27	6,7	0,27
control	45	29,8	2,13	5,9	0,93	6,8	0,80
II	90	27,5	3,78	7,35	0,65	4,85	1,15
control	90	28,7	4,67	7,65	0,35	5,15	1,45

From the data in this table it can be seen that the muscle colour of hams treated by procedure I, i.e. chilled by dipping into brine 2 hours post mortem, is more intensively red than that of controls, i.e. of the colour of hams produced from pork chilled

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by the ordinary procedure and then cured. The muscle colour of hams treated by procedure II is weaker in intensity than the colour of control hams. The ascertained differences in colour intensity between the hams treated by procedures I and II and the controls, i.e. those produced from pork treated in the ordinary way, are not significant.

Hams produced from pork treated by procedure I are of significantly more uniform colour than the corresponding controls.

The results of investigations of canned ham muscle colour stability during 90 days of storage are given in table 3. From the obtained results it can be seen that

Canned ham colour stability (n 3) during 90 days storage at 8°C

Table 3.

curing procedure	storage time (days)	% of NOMb decomposition after illumin. (min) 0	30	90
I	7	0	25,7	45,4
control	7	0	35,0	49,9
I	45	0	27,3	55,2
control	45	0	27,6	64,4
I	90	0	21,3	55,0
control	90	0	14,2	52,7
II	7	0	36,6	51,5
control	7	0	33,8	46,2
II	45	0	21,5	55,6
control	45	0	12,0	50,1
II	90	0	30,7	50,9
control	90	0	21,3	51,0

canned ham muscle colour with tins produced of pork treated by procedure I is more stabile than that of control samples. With hams treated by procedure II the results is contrary. These differences in stability, however, are not significant.

Henrickson (8) and Reddy and Henrickson (15) have found that the colour of canned ham muscle cured while warm is more stabile than the colour of hams cured after chilling. The results obtained in this paper, however, do not give reason to conclude that curing time post mortem is of influence upon canned ham colour stability.

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