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FACTORS AFFECTING THE COLOUR FORMATION IN PORK MATURED IN THE ABSENCE OF NITRITES AND NITRATES

M. Bellatti, G. Parolari, R. Virgili

Stazione Sperimentale per l'Industria delle Conserve Alimentari
PARMA - ITALY

Researches on colour formation in ham matured in the absence of nitrites and nitrates led us to assume that sodium chloride together with its capability to penetrate into the muscle are the factors responsible for the development of the red pigment.

In order to confirm this hypothesis, and also considering the factors connected to the characteristics of the raw material and the technological variables, researches were started where the studied parameters were made to change according to the following fixed working scheme:

The raw material consisted of fresh longissimus dorsi swine muscles, in pieces of 1.5 kg each, previously freed from superficial fat and connective. The salting process occured through two following phases by sprinkling medium granule dry salt. Then the meat was made to rest in a single layer on metal nets. Successively, the pork was washed, introduced into natural casings and matured. Either the fully-matured samples and those selected during the processing period underwent chemical analysis and instrumental organoleptic measurement of the colour.

Chemical analysis: moisture, proteins, salt and fat, according to the AOAC methods.

Colour: a panel trained to measure the most evenly red colour by help of a zero-to-five arbitrary scale expressed its judge on the colour of the ham when cut.

The lighting conditions were those usually recommended for the visual evaluation of meats (1,2). Then the evaluation was completed with an instrumental analysis of the colour, by recording Hunter's a/b value of the lengthwise cut product. In fact, previous experiments had shown the existence of a close correlation between the a/b value and the visual score of hams and freshly-cut loins (3).

The opportunity to examine a wide range of variables, capable of influencing the colour formation, comes from a preliminary research on the colour changes during maturation.

Statement and purposes of this research together with the studied parameters are summarized in the following scheme:

I° TEST: colour formation.

Working scheme:
I° series: samples salted following the described method; added salt: 1.5% + 1.0%.
II° series: samples salted in piled-up layers, in tank; added salt: 0.7% + 0.7%.
III° series: samples salted in piled-up layers in tank; added salt: 1.5 + 1.0%.
Studied parameters: added amount of salt, different relative humidity while salting.
Sample drawing: progressively on different days up to the 72nd day.
Sample total number: 34.
Test result and observations:

The colour develops in a way similar to the ham (3), with a starting browning (minimum in the a/b ratio), which is followed by the progressive formation of the red colour (Fig. 1). In general, the colour development seems to be helped by an early overcoming of the a/b minimum, in accordance with the process which sees the conversion to metmyoglobin as the starting stage of the reaction.

These results seem to prove that the reaction can be accelerated either by providing favourable conditions to salt penetration (series II e III) or by increasing the salt availability (series III). It must be born in mind, however, that the development of the red colour is achieved in all the three series, despite the salt final amount and, above all, the salt to moisture ratio turn out to be quite different (the average salt concentration and the average salt-to-moisture ratio were, respectively, 4.0 and 7.0 in the I° series, 5.8 and 9.0 in the II° series, 6.4 and 10.8 in the III° series). Actually, it is already well-known that a low salt to moisture proportion does not necessarily go with a poor colour, and viceversa. If the salt diffusion rapidity can therefore be considered an acquired factor, it will be reasonable to study other parameters, in addition to the salt/moisture ratio followed in the previous test.

The parameters, we are concerned with, are those capable of affecting the colour formation process: that is reaction temperature and time (i.e. considering the whole maturing process); then the intrinsic factors of the raw material, capable of opposing the salt permeation, such as the intra-muscular fat and the fresh meat thickness; finally, the existence and the consequences of dehydration, through the total loss of weight and the muscular contraction, which predisposes the myoglobin to the interaction with the ligand, providing the steric condition required by the hypothesized process (3).

While studying these parameters and their effects on the colour, possible interdipendences among variables could not be considered; therefore, the data of the correlation must be read as the resultant of various

variables, the role of which was sometime found after the experiment had already been started.
Reaction time and temperature were studied through the times and the temperatures of the maturing phase, that is, of the most important phase as for the chromatic reaction, since in this case the maturing temperature is higher and the maturing time longer than in all the other phases.

II° TEST: effect of the maturing temperature.

Working scheme: Three series of samples, salted in the same way used in Test I°.
Rest: same conditions and same time for the three series.
Maturing: the samples of each series were divided into two groups and each group was matured at different temperatures (respectively 13C° and 19C°) and for the same period (68 days).
Studied parameters: maturing temperature.
Sample drawing: all at the end of the maturing process.
Sample total number: 56, 32 of which at 13C° and 24 at 19C°.
Test result and comments:
Statistically, the samples matured at higher temperatures have a better colour when cut. The samples matured at higher temperatures, however, show a significantly higher salt-moisture ratio, due to dehydration. The test, moreover, does not consider the variables of the raw material.

III° TEST: effect of the maturing time.

Working scheme: A series of samples was prepared as described for the third series of the first test, and matured for 68 days. Some of the samples were matured for 78 days, under the same conditions of temperature and humidity previously used.
Studied parameters: maturing time.
Sample drawing: on 68th and 78th day.
Sample total number: 39, 25 of which tested after 68 days and 14 after 78 days.
Test result and observations:
Statistics show that the samples tested on 78th day have a better colour. Unlike the previous test, an extention of the maturing time does not cause a significant increase of the salt/moisture ratio. Once again the variables of the raw material were not considered.

The inclusion of the variables related to the raw material and to the decrease of the muscular volume refers to the amount of internal fat, and to the measure of dehydration and its consequences on the product. In the following experiment to the traditional variables are added the muscular fat percentage, the starting thickness of the fresh meat (its height), the final loss in weight and the percent decrease of the thickness in the phase preceding the maturing process. The measurement of the muscular contraction is carried out in the cold period,

in order to achieve a better expression of the product tendency to the chromatic reaction, which starts, as we saw, when the meat is brought to the maturing temperature.
In this test four working schemes were followed, which differ from one another in the given salting and resting times; for each working scheme either the dry salting, and the wet salting were carried out. These eight working lines try to reproduce technological conditions really used in ham factories with the purpose of providing samples with different degrees of contraction, as this phenomenon mainly depends on the processing conditions. Maturing time and temperature are the same for all the products, so as to reduce the influence of the parameters, the effect of which on the colour can be considered acquired.

IV° TEST : effect of working conditions and of the raw materials.

Working scheme: 8 series of samples, all equally salted.
The series 1-4 were laid in one layer on metal nets. The series 5-8 in piled-up layers into a tank. Maturing time and resting time varied from series to series. They were the same for the couples 1-5, 2-6, 3-7 and 4-8, which mainly differed in the humidity of the salting process. While maturing all the samples were kept at the same temperature and for the same length of time.
Parameters studied: raw material (i.e. intramuscular fat) and starting thickness; physical changes caused by different technologies: loss of weight and thickness decrease.
Sample drawing: all on 47th day.
Sample total number: 48 (6 for each series)
Test result and observations:
The data relating to the 8 series are reported in table I. The table also offers a comparison between all the samples salted on net, that is at low R.U. (H_1), and those salted in tank at higher R.H. (H_2). This comparison confirms what came out in the first test, that is a salting carried out at high R.H. helps the colour development; it is necessary to point out that in this case the values of the S/H and H/Prot ratios are the same in both series and that the starting thickness is not different.
The data which significantly distinguish these two series are the starting fat amount (larger in the series where the colour will be the worst) and the thickness decrease, greater in the II° series. A similar situation occurs in series 6, where the starting thickness and the H/Prot., S/H ratios, less favourable than in other series, go with a higher a/b ratio; the fat amount, on the contrary, is lower and the volume reduction greater. The comparison between this series and those of group H_2 shows that contraction and lower concentration of fat are highly favouring factors, other condition being equal, and that they even become prevailing in the presence of unfavourable conditions as for dehydration and salt concentration. The importance of contraction is also confirmed by the comparison between series 1 and 5: the series with a more definite colour (series 5) only differs from series 1 in the greater volume reduction, whereas the other parameters either do not differ (fat, H/Prot, S/H) or favour series 1 (loss of weight, starting thickness). Got rid of the inhibiting effect of fat, the

role of volume contraction achieved in the cold phase on colour development is, therefore, well clear. Besides, all the technological factors which help the volume contraction become important. It is necessary to notice, at last, how these factors, which are clearly enhanced in the wet salting, cause a contradictory trend of the H/Prot ratio and of the loss of weight, as a consequence of a dehydrating process. Further researches are needed on this subject.

Table 1;
IV test results. Average data of the 8 series and of the two groups subjected to different salting process.

Series	a/b	starting thickness (mm)	Fat %	salt% humid.	moisture prot.	thickn. change %	loss weight %
1	2.41	37	5.5	13.9	1.60	- 6	45
2	2.22	42	4.7	12.1	1.71	- 8	50
3	2.42	45	5.4	13.7	1.75	- 8	46
4	2.55	41	5.5	16.0	1.46	- 6	43
5	2.76	45	4.5	14.2	1.63	- 12	34
6	3.24	40	3.8	12.9	1.64	- 19	40
7	2.85	38	3.1	14.9	1.61	- 7	38
8	2.73	48	4.1	12.0	1.81	- 11	35
H_1	2.39	41	5.5	13.9	1.63	- 7	46
H_2	2.90	43	3.8	13.5	1.67	- 12	37

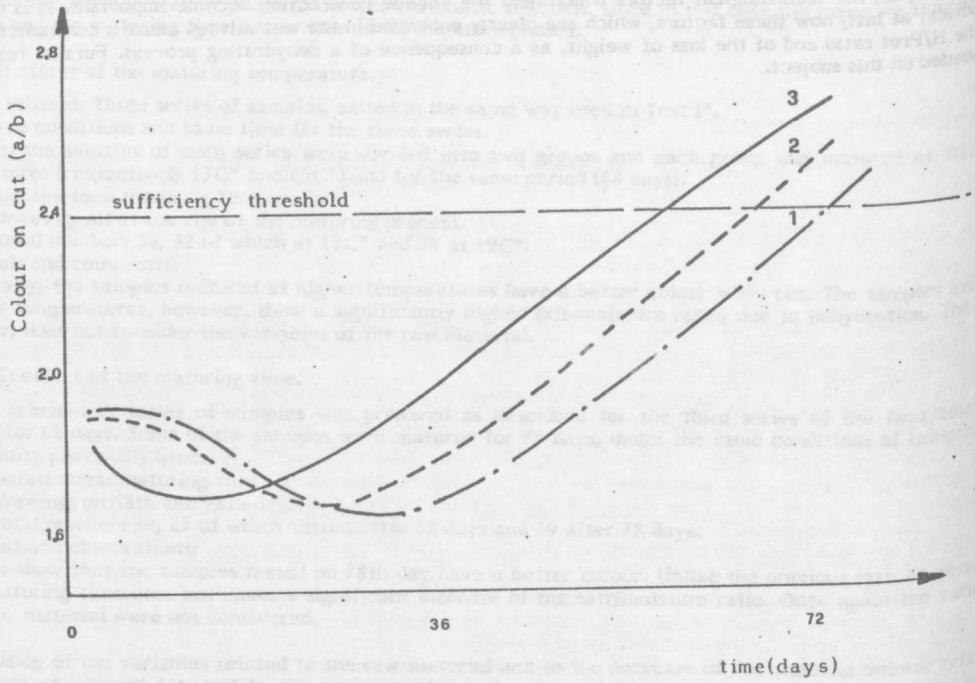

Fig. 1 Colour changes in meat processed with salt only. (Test 1)
In series 3 salt is more rapidly available to the internal layers.

REFERENCES

1) W. D. WRIGHT The Measurement of Colour, 3° Ed. Hilger and Watts, London, (1964).

2) R. J. ELLIOTT, J. Sci. Food Agric., 19, 685, (1968).

3) G. PAROLARI, R. CHIZZOLINI, M. BELLATTI and G. DAZZI, Ind. Conserve, 58, 147, (1983).

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