14 Warsaw Pol/1 248

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Colour stability of fresh pork meat

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The rapid development of self-service merchandising stores, in which meats packaged in transparent wrappers wait sometimes quite long for the purchaser, has made the stability of meat colour a problem of practical importance in this country. The information in the literature of the subject deal mainly with fading of colour of cured meat. The discoloration of fresh meat is less known and only external factors, such as light, air, packaging etc. have caused the greater interest.

Therefore, the subject of this work was to study the influence of internal factors, determined by the properties of meat itself, on the stability of fresh meat colour. These factors are little explored though there are indications in the literature showing their practical importance /Pirko and Ayres, 1957/.

Material and methods.

The investigation was carried out on forty samples of pork meat taken from carcasses of bacon hogs from a Progeny Testing Station, fed uniformly and slaughtered under standard conditions /Kielanowski et al. 1957/

After forty-eight hours' refrigeration as wholesale cuts, the loins were carved out and the visible aggregates of connective tissue and fat were carefully trimmed off. The segments of longiss. dorsi muscles situated against the last six thoracic vertebrae were quickly

cut up and minced twice in a meat grinder then mixed thoroughly.All operations of preparation of samples were performed in a cool dark place upon meat,which had been well refrigerated.

For the study of meat discoloration the method elaborated by Erdman and Watts /1957a/ was applied and adopted to fresh meat investigation by measuring the extinction ratios at about 543/633 mu.The stability of colour was expressed by a difference of extinction ratios taken before and after exposure of meat to light.

The meat samples,in the Petri dishes,were located in the water vapour saturated atmosphere and exposed for four hours to "soft white" fluorescent light of 1250 lux measured on the surface of meat.Reflectance measurements at 541 and 633 mu resp./with maximal tra smittance/were made with filters No K_4 and No K_1, using a Zeiss 'Pulfrich reflectometer with Ulbricht ball /Kürbs 1953/.

Lightness of meat colour was expressed as per cent reflectance measured with a K_4 filter of a Pulfrich reflectometer /Hofmann and Kürbs 1956/.

To evaluate the reducing properties of meat 10 per cent extracts were used prepared by homogenizing the meat sample in 0,1 M phosphate buffer of pH=7,0 and centrifuging.Reducing activity of extracts was estimated by the method of Tysarowski and Kwiek /1956/ based on the reduction of iron-ethylenediaminetetraacetic acid complex measured with o-fenanthroline.The activity was expressed as mg Fe reduced by 100 g of meat.

Water content in the meat was determined by drying at 105°C,fat content by the Soxhlett method,protein content by the method of Kjeldhal and water-holding capacity by that of Grau and Hamm as modified by Pohja and Niinivaara /1957/.For the determination of total pigments the method of Wierbicki et al./1955/ ,and of myoglobin that of Ginger et al./1954/ were used,pH was measured by glass electrode.

Statistical analyses were made by methods given by

250

Snedecor /1956/.

Results.

Data shwoing the mean values of the characteristics investigated, including their variations are presented in Table 1. The greatest variability was found in colour stability, reducing activity and water-holding capacity of meat, the least one-in pH and water as well, as protein content.

Table 1.

Mean values /$\bar{x}$/, their standard deviations /s/ and coefficients of variation /C/ of the characteristics investigated.

Characteristics investigated	$\bar{x}$	s	C
Colour stability/as difference of extinction ratios/	0,67	0,26	39,3
Reducing activity/mg per cent of Fe/	6,60	1,96	29,7
Lightness of colour/per cent of reflectance/	26,35	2,75	10,4
Total pigments/mg per cent/	87,05	11,45	13,1
Myoglobin /mg per per cent/	64,43	10,36	16,1
Water-holding capacity/per cent of loose water/	30,89	10,53	34,1
Protein/per cent Nx 6.25/	22,37	0,83	3,7
Fat /per cent/	2,48	0,67	26,9
Water /per cent/	74,81	1,01	1,4
pH	5,44	0,11	1,9

Simple correlation coefficients obtained between colour stability and other meat properties are given in Table 2, showing also the degree of statistical significance of the correlations computed. Significant coefficients have been found between colour stability and reducing activity, water-holding capacity, lightness of

colour as well as myoglobin content of meat. The value of pH and the content of protein, fat and total pigment did not reveal in this investigation any closer relationship with colour stability.

Table 2.

Simple correlation coefficients /r/ between colour stability and other properties of fresh meat.

Property investigated	r	
Reducing activity	-0.5431	xx
Myoglobin content	-0.4657	xx
Total pigment content	-0.1702	
Water-holding capacity	-0.5569	xx
pH	-0.1459	
Lightness of colour	-0.5447	xx
Water content	-0.3826	x
Fat content	0.2992	
Protein content	0.1226	

xx significant at $P < 0.01$
x " " $P < 0.05$

Discussion.

Discoloration of fresh meat is due to oxidation of red ferrous haem pigments, myoglobin and haemoglobin. The result of oxidation are brown ferric compounds, metmyoglobin and methaemoglobin and, less frequently, green or faded decomposition products of the porphyrin ring /Watts, 1954/. Under the conditions of our colour stability tests no green discolorations were observed and, therefore, the extinction ratios characterizing the formation of "met" pigments were only used.

Mincing of meat samples was applied because the pork loin slices were uneven in colour /Janicki and Kołaczyk,1961/ and for the purpose of accelerating the oxidation process,which proceeds relatively slowly in fresh meats /Urbain and Ramsbottom,1948; Ramsbottom et al.1951/.The application of the extinction ratios method for colour stability test was based on the close correlation /r=0.9/ found between extinction ratios and visual score of faded meats /Erdman and Watts,1957a/.

The results obtained in this investigation point out that,in spite of standard conditions of feeding, management and slaughtering of animals and notwithstanding the great uniformity in treating the meat after slaughter,the individual differences in rate of discoloration of fresh meat are very distinct /Table 1/.This variability stresses the practical importance of the problem and,on the other hand,offers to breeders the large possibilities of selection.

The computation of our results shows the significant correlation between colour stability of fresh meat and reducing activity of meat.Colour stability increases with increasing reducing activity /Table 2/ The same trend has been observed in experiments with cured meat /Hornsey.1959/.The importance of reducing compounds,especially of sulfhydryl groups,to prevent the fading of cured meat has been stated by Watts /Kelley and Watts,1957; Erdman and Watts,1957b/.

The similar pattern of discoloration of fresh and cured meat can be due to the fact that both fresh and cured meat pigments are oxidized along the same pathways.Both the oxymyoglobin and the nitric oxide myoglobin must dissociate to myoglobin before oxidation to the brown ferric metmyoglobin takes place/Watts, 1954/.

In connection with the significance of reducing activity of the muscle to keep the right colour, it would be important to know the conditions controlling this property of meat. From this point of view the next correlation stated in our experiment is very essential. It concerns the relationship between colour stability and myoglobin content in meat /Table 2/. The correlation points out that the stability increases together with myoglobin content.

This statement is interesting because it is konwn that myoglobin content corresponds to respiratory enzymes activity in meat /Lawrie, 1952/. It is also proved that myoglobin content is associated with protein bound iodine in blood of animals /Janicki and Witkowska, 1961/ It means in the practice that the meat from animals with greater basal metaholic rate will keep better its colour.

No correlation was found between the degree of discoloration of fresh meat and total pigment content. It may be caused by the fact, that the haemoglobin content in meat depends on the completeness of bleeding of the animals and therefore is rather highly variable, masking the correlation found between discoloration and myoglobin content.

A high-the highest in thsis investigation-correlation was found between colour stability of fresh meat and its water-holding capacity. This result is in agreement with the older literature which makes the oxidation of pigments of fresh meat dependent on the pH value of meat /Brooks, 1938; Greenwood et al. 1940; Watts and Lehman, 1952/, correlated-as it is known-with water-holding-capacity /Hamm, 1960/. This relationship between colour stability and water-holding capacity is based probably on the influence exercised by water-holding capacity on the structure of meat controlling the rate

of oxygen diffusion to the meat pigments /Hall et al. 1944/.

No influence of pH on the colour stability of fresh meat was discovered in our experiment. It seems to be a consequence of the very small variation of pH encountered in the meat samples investigated /Table 1/.

Significant correlation found between colour stability and lightness of colour /Tabel 2/ may be interpreted on the base of high correlations of colour lightness with myoglobin content and water-holding capacity /Janicki and Kołaczyk, 1961/, both those last factors being significantly correlated with colour stability.

Protein content and fat content did not reveal any greater influence on the rate of discoloration, though the coefficient of correlation between fat content and colour stability is not far from statistical significance /Table 2/. This may explain the relation found between colour stability and water content in fresh meat as the close correlation exsiting between water content and fat content in meat is well known.

Summary:

The investigation carried out on the 40 meat samples of normal bacon hogs aimed to establish the influence of internal meat factors on the colour stability of fresh pork meat. Reducing activity of meat, its water-holding capacity, lightness of colour, myoglobin content and water content were found to be correlated with the rate of meat discoloration. Protein, fat and total pigment content as well as pH value of meat did not show any closer relationship to colour stability of fresh meat in this investigation.

The theoretical and practical consequences of the correlations found were discussed.

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