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QUALITY CHARACTERISTICS OF MEAT PRODUCED FROM CATTLE GROWN AND FATTENED BY INTENSIVE TECHNOLOGY

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INTRODUCTION

The quality of meat products and the efficiency of their manufacture are, to a great extent, determined with the properties of the raw meat processed. The functionally significant properties can be schematically divided into 3 basic groups as follows:

- the state of protein systems, including the stability of the connective tissue which determine WHC and hence processing losses;
- characteristics of raw meat pigments, which are critical for the colour of the finished products;
- the condition of oxidation-reduction systems which determine oxidation stability of lipids and, thus, affect product quality and shelf-life.

The purpose of this paper was to find out possible abnormalities in raw meat quality when cattle is grown according to intensive technologies, and to study some functionally significant meat properties.

MATERIALS AND METHODS

The investigation was carried out on the meat of steers from big commercial growin-&-fattening stations at the south-west and north-west of this country. Two series of experiments were performed on 700 18-20-month-old steers with the average liveweight of 500 kg.

Cattle fattening technology at animal-breeding stations provides for group maintenance of young animals in crates restricting their movements and for concentrate feeding.

Steers were truck-transported to meat packing plants for the distance of up to 200 km. They were kept at the plants for 24 hours prior to slaughter. Animals were elctrostunned (50 Hz, 90-100 V) by applying the electrostick for 8-10 s onto the occiput and piercing the skin no deeper than 5 mm. After dressing, pH_1 (45-60 min p.m.) and pH_{24} (24 hrs p.m. at 0-2°C) were measured. Carcasses were classified into the following groups of meat quality based on the above pH-values:

	N	PSE	DFD
pH_1	6.5	6.2	6.3
pH_{24}	5.7-5.8	6.2	6.3

Percentage distribution of the carcasses studied is shown in Fig.1.

Samples of l.dorsi at the 9-12th ribs were taken 24 hrs post slaughter, kept at 4-8°C while being supplied to the laboratory and tested 48 hrs p.m. Meat pH was measured potentiometrically with an Ultrax TM6 pH-meter, 3002 Type (Germany).

To evaluate the process of colour development and for colour comparisons, model sausages were prepared from l.dorsi of the above carcass groups under laboratory conditions. Meat (100-150 g) was ground; 30% of water, 2.5% of NaCl and 7.5 mg% of nitrite were added. Blended material was filled with a manual stuffer into natural sheep casings as 10-13 cm lengths. Sausages were hot-smoked for 40 min at 90°C, water-cooked for 30 min at 80-85°C, chilled under the running water down to the room temperature and then for 16-18 hrs more at 8-10°C. 30 min post blending samples of sausage meat were taken for analyzing for free nitrite.

The level of pigments was determined by measuring the optical density of aqueous acetone extracts and by separating them into the total and nitroso pigments; the results were expressed in mg of hematin hydrochloride per kg of meat /1/ or in mg% heme pigments /2/.

Reflection spectra in the vizible region were taken with a recording spectrophotometer SF 18. The proportion of different forms of myoglobin was determined from the reflection spectra of samples kept for 30 min at room temperatures in the dark /3/; the stability of nitroso pigment - by its level in the samples exposed to electric bulb for 1 hr /4/; hydroxyproline - with the procedure of Neuman and Logan /5/; nitrite - according to ISO recommendations /6/.

RESULTS

Moisture content in the tested samples of l.dorsi was similar irrespective of the quality group (74.6-74.7%). Typical differences in cooking losses were noted in N, PSE and DFD meat (Fig.2) (34,40 and 24%, respectively). Such losses are not, however adequate to the level of free water in the raw meat, which was found by the press-method /7/. The losses also include loosely bound water which is removed during heating and which level is different in N, PSE and DFD meat.

The total content of the connective tissue was nearly similar, while its quality (digestibility, in particular) was somewhat lower in PSE and DFD meat (Fig.2).

Colour is one of the most important features charactrizing defects in meat quality. Colour characteristics of N, PSE and DFD meat are given in Table 1 which shows that DFD meat is much darker (L = 34.1 as compared to 44.0 in N-meat) and typically shifted towards the purple-violet field of the spectrum (λ_d > 750). This is often attributed to optical effects due to a specific closed structure of meat surface, rather than to pigment concentration /8/. In our experiments however this meat contained twice as much heme pigments as compared to N-meat. Differences in N- and PSE meat are less pronounced, especially 48 hrs p.m.

It follows from the data obtained that PSE beef with a typical p.m. dynamics of pH may be almost similar to the normal meat in colour intensity and contain more pigment.

At the same time some peculiar features of the chemical condition of myoglobin in these types of meat should be emphasized (Fig.3).

The surface layer of freshly cut N-meat kept in the dark under atmospheric oxygen does not practically contain MetMb, 12% of the total MetMb being represented by MbO_2. In PSE meat the distribution of myoglobin derivatives is close to that of N-meat but oxidative changes are more pronounces (MetMb is thrice as high).

Quite an opposite picture is observed in DFD meat, i.e. complete absence of MbO_2, a ten-fold level of MetMb. These changes in the surface layer cannot be explained only by differences in oxygen diffusion due to specificity of such meat microstructure /9/. Of great significance here is, undoubtedly, oxygen consumption due to more intensive and longer lasting cellular breathing at high pH-values /10/. At the same time, worse oxidation-reduction conditions because of the absence of reducing substances are possible. Here, this causes more MetMb formation and characteristic shifts in the reflection spectrum. The latter may affect the colour stability of the finished products prepared from such meat.

Table 2 allows to follow the behaviour of pigments in model sausages prepared from the same l.dorsi muscles. Some quantitative advantages of PSE meat pigmentation are also evident in model sausages, viz., they contain both more total and nitroso pigments, This does not contradict to the existing opinion since the pH condition in the PSE meat is more favourable for NO formation from nitrite. However, nitroso pigment stability is slightly lower than in the sausages prepared from normal meat.

As for DFD meat, despite a high level of the total pigment, only about 40% of it is involved in the process of colour development (against 62% in N-meat). At the same time, the nitrite-binding ability of DFD meat proteins is even higher as compared to normal and PSE meat (42, 35 and 39%, respectively). However, pH of DFD meat does not stimulate nitrite reduction to NO, and during heating nitrite "binding" (consumption) is nearly twice as low as compared to normal meat.

CONCLUSIONS

The experiments results confirm the necessity of breeding stress resistent cattle; of developing such technologies of cattle transportation, pre-slaughter maintenance at meat packing plants and such slaughter technique which would allow to decrease, to the maximum extent, the amount of meat of abnormal quality; of designing technological procedures which ensure the rational differentiated utilization of abnormal meat.

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Table 1

Colour characteristics of l. dorsi m. as related to beef quality (n = 6÷7)

Meat quality		pH_1	pH_{24}	Heme pigments, mg%	Colour characteristics			
					λ_d, nm	L*	a*	b*
N	$\bar{x}$	6.5	5.7	370	617–628	44.0	23.0	10.4
	S	0.08	0.23	63	–	3.75	2.32	2.18
PSE	$\bar{x}$	5.9	5.7	450	618–639	41.6	22.7	9.5
	S	0.13	0.18	67	–	2.45	1.55	1.48
DFD	$\bar{x}$	6.9	6.9	600	632->750	34.1	15.3	4.7
	S	0.19	0.14	129	–	2.20	2.60	1.95

$\bar{x}$ - arithmetic mean; S - average quadratic error; * - in the CIE 1976 colour system

Table 2

Characteristics of colour and colour development process in model sausages (n = 4÷7)

Meat quality		Pigments*		Nitroso pigment stability, %	Colour development intensity				
		total pigment	nitroso pigment		Pigment involved in color development, %	Nitrite bound, %			Residual nitrite, mg%
						in settling	in cooking	total	
N	$\bar{x}$	132.5	81.0	62.2	61.9	34.9	26.7	61.6	2.9
	S	37.90	24.52	8.63	15.03	4.67	9.98	3.89	0.52
PSE	$\bar{x}$	142.0	100.0	58.0	71.1	39.4	24.1	63.6	2.7
	S	12.33	13.18	18.95	10.39	6.81	7.48	3.76	0.29
DFD	$\bar{x}$	178.2	70.3	59.3	39.7	42.4	14.1	56.5	3.3
	S	12.53	8.73	5.12	5.23	4.71	10.44	5.81	0.44

* hematin·HCl, mg/kg (ppm)

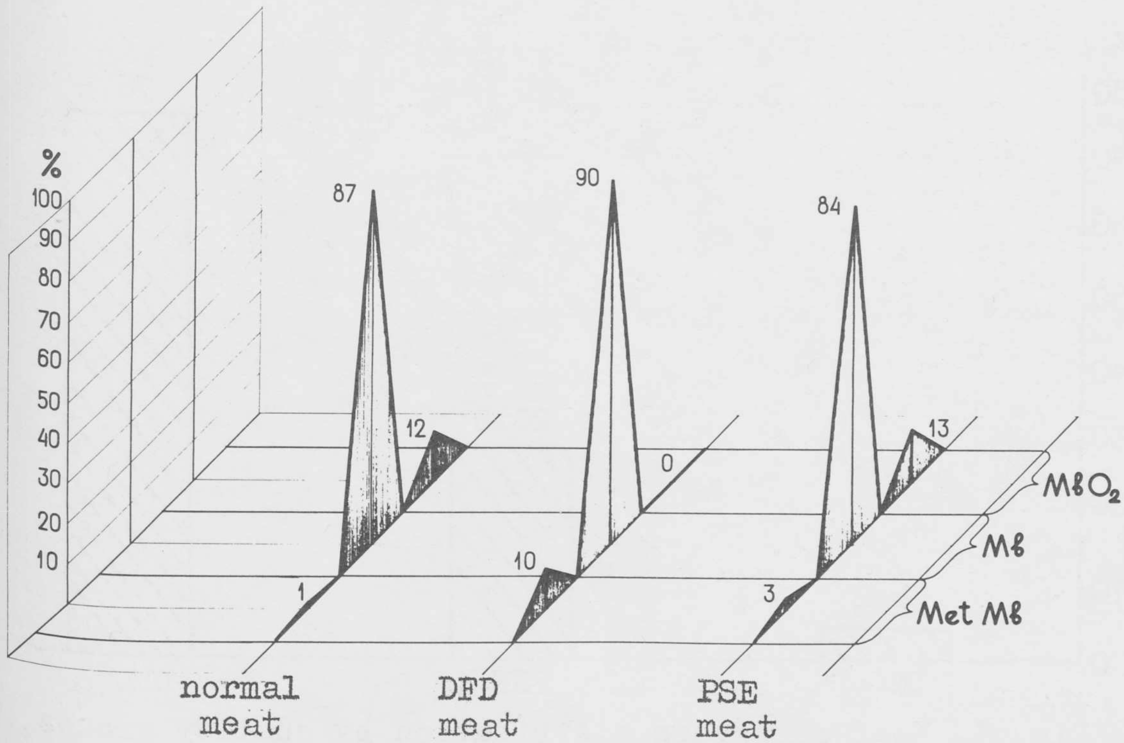

Fig. 3. Proportions of myoglobin forms as related to beef quality

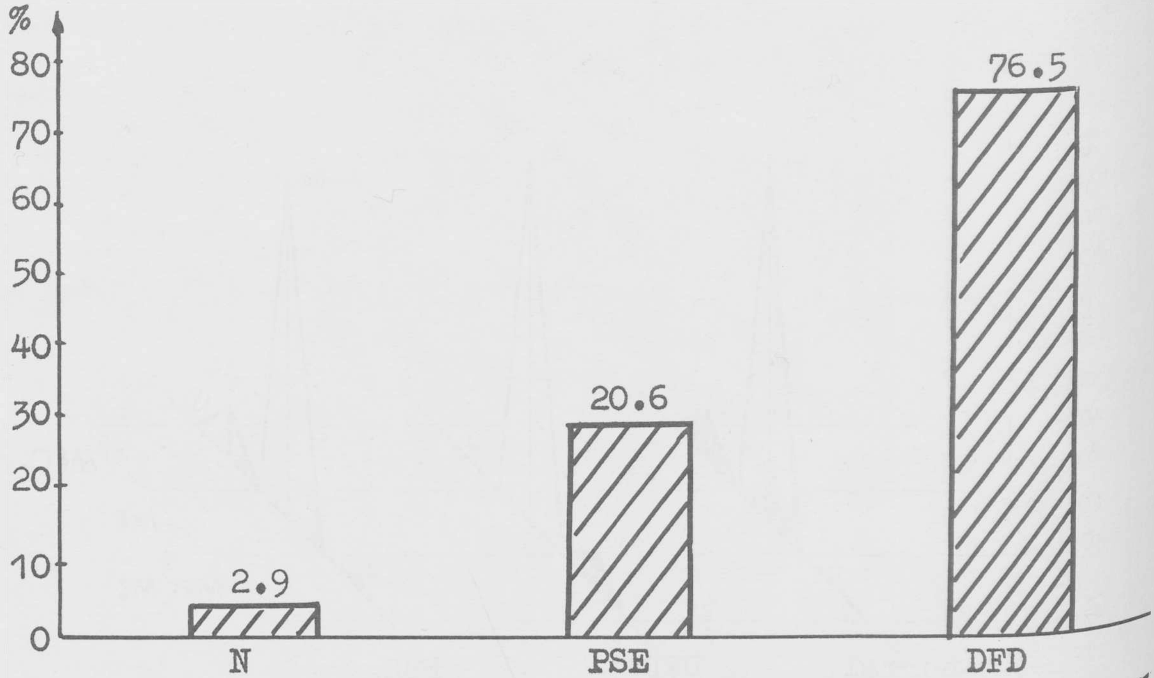

Fig. 1. Beef carcasses distribution by quality groups, %

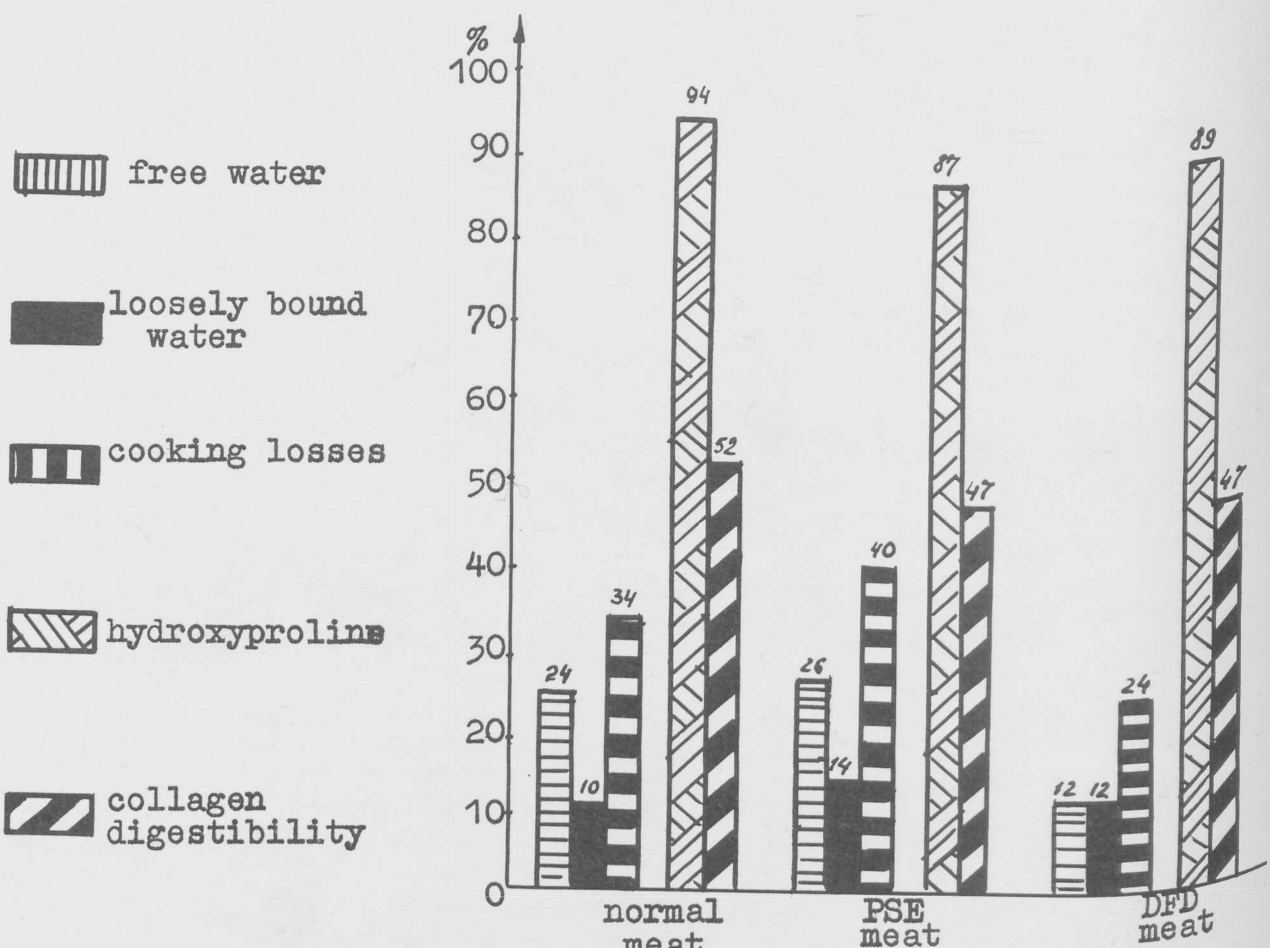

Fig.2. Physico-chemical characteristics of beef quality