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MYOGLOBIN AND HYDRATION OF MEAT IN PIGS

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MYOGLOBIN AND HYDRATION OF MEAT IN PIGS[x/]

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Water-holding capacity of meat represents a problem of great practical and theoretical importance and has been in the last years a subject of manifold investigations /Hamm, I960/. Nevertheless, it is as yet very little known about physiological basis of meat hydration and only few works are concerned in relating this characteristic of meat to the properties of animal organism.

It was, therefore, the aim of this work to investigate the relationschip between hydration of muscle tissue and its content of myoglobin, which can be treated - to the some extent - as an index of metabolism in animal body /Lawrie,I953; Janicki and Witkowska, I962/.

Material and methods

The investigation was carried out on 4I healthy, normal bacon Large White pigs from a progeny testing station. The pigs were uniformly fed and slaughtered under standard conditions /Kielanowski et al.,I957/.

After 48 hours refrigerating in 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 cut up and minced twice in a meat grinder,then mixed and subjected to analysis.

Water in the meat was determined by drying at I05°C after denaturation of proteins by ethyl alcohol, fat by the Soxhlett method, protein by the Kjeldahl procedure and water-holding capacity by that of Grau and Hamm in Pohja and Niinivaara's modification /I957/. The amount of loose water was

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taken as a criterion of water-holding capacity. Thus, the water-holding capacity was the greater, the less was the per cent of loose water. For the purpose of determining total pigments the method of Wierbicki et al., /1955/ was used but with an overnight extraction. The content of myoglobin was determined according to Ginger et al., /1954/.

Statistical analyses were performed by the methods given by Snedecor /1956/.

R e s u l t s

The investigated characteristics of meat are shown in Table I. The simple correlation coefficients computed for myoglobin content and other properties of meat are given in Table 2. where also the statistical significance of coefficients can be seen.

Table I.

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

Property investigated	$\bar{x}$	s	C
Water content /%/	74.59	0.62	0.82
Fat content /%/	2.01	0.41	20.35
Protein content /%/	23.06	0.54	2.34
Myoglobin content /mg%/	65.38	12.61	19.28
Total pigments content /mg%/	84.62	17.75	20.97
Water-holding capacity /% of loose water in tissue/	27.36	3.39	12.40

Table 2.

Simple correlation coefficients /r/ between meat properties studied

Properties	r
Myoglobin content and water content	-0.3496^{x}
Myoglobin content and water-holding capacity	-0.5317^{xx}
Water content and water-holding capacity	-0.4439^{xx}

^{x} significant at $P < 0.05$

^{xx} " at $P < 0.01$

The statistically significant correlation was found between myoglobin content and water content as well as between myoglobin content and water-holding capacity. Simultaneously, the correlation coefficient between water content and water-holding capacity was stated to be statistically highly significant.

It was possible to obtain the additional informations about the found relationship by means of partial correlation technique /Table 3/.

Table 3.

Partial correlation coefficients /r,/ between meat properties studied[x]

Properties	r,
Myoglobin content and water content water-holding capacity held constant	- o.I497
Myoglobin content and water-holding capacity water content held constant	- o.4484[xx]
Water-holding capacity and water content myoglobin content held constant	- o.4098[xx]

x Marks for statistical significance of coefficients are the same as given in Table 2.

Discussion

The myoglobin content of meat can be considered as an partial index of metabolism in animal organism. Lawrie /I952/ has stated that the concentration of myoglobin corresponds to the activity of respiratory enzymes in muscles, while in our laboratory the significant correlation has been proved between myoglobin content in meat and protein bound iodine /PBI/ in pig blood serum /Janicki and Witkowska, I962/. The above-mentioned relationship was applied in this work to infer about the influence of metabolism on the hydration of muscle tissue in pigs.

The data derived from Callow /I947/ suggest that the water content in different meats is very similar but exhibits a definite variation. In our experiments, one source of this

variation was found in myoglobin content of meat /Table 2/. It may be inferred, therefore, that myoglobin itself, or more likely, factors controlling its concentration influence in some degree the water content of meat. Considering myoglobin as an index of metabolism it may be said that more oxidative type of metabolism is associated with lower water content in meat. Though the differences in water content in various meats are evidently not great /Table I/, the relation found is statistically significant /Table 2/.

The relationship stated between metabolism in animal and water content in meat alignes with the results of Scow /1952/ who has proved that thyroidectomy increases the ratio of water content to protein in animal body. On the other hand, the investigations of Helander /1961/ have given an evidence that long-lasting exercise - which intensifies, without doubt, the rate of oxidative metabolism - decreases the water content in muscular tissue.

As it is shown in Table 2. the myoglobin content is significantly associated with water-holding capacity of meat, the ralation being positive. It is, therefore, likely to be said that the type of metabolism in animal organism exercises an influence on the water-holding capacity of meat.

The nature of this influence is not quite clear. One way of interpretation may be based on the rate of pH fall post mortem in meat known to be lower in animals with higher cytochrome-oxidase activity /Lawrie, 1953/. Since, on the other hand, the association of rate of pH fall with water-holding capacity in meat has been recently proved /Briskey and Wismer-Pedersen, 1961/, the relationship stated by us between water-holding capacity and animal metabolism is in agreement with experimental data in the literature.

In connection with the correlation found between myoglobin content and both water content and water-holding capacity in meat it was interesting to check whether the changes in water content went parallel with water-holding capacity.

The first investigators on the field of meat hydration were inclined to think that the chief source of variation of water-holding capacity was involved in water content of

meat. However, the conception was soon abandonned when it was clear that the variation in water-holding capacity tended to be much greater than it was usually in water content /Janicki and Walczak, 1954/. At present, it is also the general opinion based on some papers that no correlation exists between water content in meat and its water-holding capacity /Hamm, 1960/.

Nevertheles,, the results presented here appear to offer a contrast /Table 2/. The correlation coefficient obtained between water content and water-holding capacity has been stated to be relatively high and cannot be any doubts as to its statistical significance. At the same time the variables are not correlated merely because of their common association with myoglobin as pointed out by partial correlation coefficient /Table 3/. It is, therefore, rather reasonable to infer that the real relationship exists between water content and water-holding capacity in meat. Our results are in agreement with Swift and Berman /1959/ who also received the significant negative correlation between water content and water-holding capacity.

To obtain data for more detailed analysis of the relations found in this study, the coefficients of partial correlation for myoglobin content, water content and water-holding capacity in meat have been computed /Table 3/.

The data obtained show that the partial correlation coefficient between myoglobin concentration and water content in meat is not statistically significant after elimination of water-holding capacity while this coefficient between myoglobin and water-holding capacity does not lose its significance if the water content being eliminated. It means that type of metabolism in animal influences physiological factors determining water-holding capacity of meat and controls in this way its water content.

This result is not in agreement with the opinion of Hamm /1960/ who thinks that factors other than the water-holding capacity of muscle tissue may be responsible for the content of total moisture physiologically present in muscle.

The relationship existing between water-holding capacity and metabolism in animal body ought to be considered in the

selection of meat animals. It is known that in the course of such selection we support the animals with a high feed efficiency i.e. with less oxidative metabolism. Consequently, the selection tends to diminish the water-holding capacity of meat.

Summary

Investigations were carried out on 4I pork loins, obtained from carcasses of bacon pigs fed uniformely and slaughtered under standard conditions. Myoglobin content, water content and water-holding capacity of the loin muscles were determined. The statistically sugnificant correlations were found between myoglobin content and water content, myoglobin content and water-holding capacity as well as between water content and water-holding capacity. With the aid of partial correlation technique it was stated that the real correlation existed between myolgobin content and water-holding capacity and between water-holding capacity and water content.

A discussion trying to bind the hydration of meat with animal metabolism was presented.

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