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COLOUR OF MEAT AS INFLUENCED BY PLANE OF NUTRITION IN PIGS*)

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The plane of nutrition seems to play an essential role in the formation of meat color in pigs (McMeekan, 1940). On the other hand, there are experiments and opinions suggesting the protein malnutrition and excess of carbohydrates in feed as a source of white muscle disease (Hupka, 1952; Ludvigsen, 1960). The exact interpretation of these nutritional effects is, however, difficult because of lack of more detailed data on the influence of feed on the quality of meat.

It was the purpose of our work to study the color and related properties of meat as influenced by level of protein and quantity of food intake in pigs.

EXPERIMENTAL PROCEDURE

The pig carcasses for this study were obtained from an experiment designed to determine the influence of protein level on growth and development of swines for the production of hams. Forty five Large White pigs, 25 kg l. w., were randomly assigned to 3 lots receiving various levels of digestible protein (d. p.): control (C), 15 g d. p. in oats feed unit (f. u.) less than control (L) and 15 g d. p. in f. u. more (M). Each lot was further divided into 3 groups fed rations differing by 0.3 f. u. daily: control (II), 0.3 f. u. less than control (I) and 0.3 f. u. more (III). The animals were fed individually and slaughtered under standard conditions at 110 kg l. w.

After forty-eight hours' refrigeration 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 the meat which had been well refrigerated.

In the meat samples the following determinations were made: water content (by drying at 105° C after ethyl alcohol denaturation of proteins), fat content (Soxhlet method), protein content (Kjeldahl procedure), pH (glass

electrode), water-holding capacity (Pohja and Niinivaara, 1957), total pigment content (Poel, 1949), myoglobin content (Poel, 1949), color of meat (Janicki and Kolaczyk, 1960) and stability of meat color (Janicki et al., 1961).

The results obtained were statistically computed by aid of 2-way analysis of variance (Snedecor, 1956).

The experiment was repeated twice giving essentially the same results. The data presented here concern the second experiment.

RESULTS

The general characteristics of the feeding experiment are given in Table 1, the results of meat analyses in Table 2. The tables also contain statistical significances of the computed differences.

Table 1.
The results of feeding pigs the different rations (30–110 kg. l. w.)

Dig. protein in f. u.	L			C			M			Stat. signif. of differences
F. u. per pig daily	I	II	III	I	II	III	I	II	III	Prot. f. u.
Av. daily feed f. u.	2.56	2.84	3.20	2.62	2.90	3.19	2.60	2.90	3.07	xx xx
protein, g.	193.2	219.1	242.9	234.7	258.8	282.0	270.7	307.1	327.1	xx xx
Feed per kg of gain f. u.	4.52	4.93	5.18	4.42	4.65	4.94	4.28	4.52	4.66	xx xx
protein, g.	340.4	380.2	392.6	396.4	413.7	435.6	444.8	478.7	498.9	xx xx
Av. daily gain, g.	568.0	578.0	621.0	591.7	623.7	648.5	612.2	643.4	657.0	xx xx
Age, days	248.6	237.0	220.5	242.7	230.2	217.3	230.8	221.2	212.2	xx xx

Table 2.
The properties of meat of pigs fed different rations

Dig. protein in f. u.	L			C			M			Stat. signif. of differences
F. u. per pig daily	I	II	III	I	II	III	I	II	III	Prot. f. u.
Water %	73.47	73.40	73.26	73.22	72.98	72.51	73.36	72.72	72.63	x
Fat %	2.69	2.56	3.13	2.22	2.58	3.14	2.44	2.63	3.27	
Protein (Nx6.25) %	22.76	23.51	22.68	23.68	23.77	23.19	23.25	23.65	23.52	xx x
Color, % reflectance	24.3	28.6	28.6	25.2	27.0	30.7	24.7	30.4	30.7	xx
Color stability	0.846	0.540	0.545	0.568	0.613	0.742	0.598	0.854	0.572	
Myoglobin, mg %	78.54	70.46	55.56	84.81	72.44	63.44	74.36	70.65	52.95	xx
Total pigment, mg %	110.5	104.9	78.86	125.1	107.2	84.84	106.6	105.2	84.60	xx
pH	5.49	5.45	5.49	5.48	5.48	5.46	5.47	5.51	5.47	
WHC, cm ²	7.98	8.87	7.88	8.30	8.39	8.53	7.94	8.89	9.03	

As can be seen from Table 2, the protein level in feed unit has had a small influence on the meat, the protein content in meat only being affected. The feed units (with the same protein : carbohydrates ratio) have exerted more pronounced effect. Fat content in meat, protein content, color, myoglobin content, and total pigment content have been observed to be changed significantly.

DISCUSSION

It is known that a high energy intake, especially when accompanied by a raised protein intake, increases metabolism in man and animal (Kleitman, 1926; Treichler and Mitchell, 1941; Mukherjee and Mitchell, 1949). It was, therefore, to be expected that in pigs fed the rich rations the raised levels of meat characteristics closely connected with metabolism e. g. pigments, color etc. would be observed, because the relationship between these meat properties and metabolism has been proved (Lawrie, 1952; Janicki and Witkowska, 1962).

On the other hand, better nutrition is followed by better weight gains and, in consequence, animals reaching the standard slaughter weight are younger. Since the general correspondence between age of animals and color or myoglobin content in muscles is known (McMeekan, 1940; Lawrie, 1950), it may be inferred that higher plane of nutrition will be associated with lower content of pigments and paler meat color.

In this situation, the effect of protein level and quantity of feed in diet is not clear so far as meat color properties are concerned and its evaluation is of practical importance.

In contrast to the results of Lawrie (1950) who has failed to disclose any essential role of plane of nutrition in myoglobin level in meat, the data of our experiment point out that the feed rations do influence myoglobin and meat color. In this respect our results are similar to those of McMeekan (1940).

Though the proteins seem to stimulate metabolism in animal, the level of protein (i. e. protein: carbohydrates ratio) in diet has not changed the meat color properties in our experiment (Table 2). The differences found in these traits are within the limits of normal variation being statistically nonsignificant.

The explanation of this fact may be based on the additional influence of age, the animals fed diet of higher protein ration being younger at the slaughter weight. The differences in age in groups were not great, but it must also be said that the differences in protein consumption were also small (Table 1).

The statement made above is of some practical importance. Namely, it is clear that weight gains in pigs obtained by higher protein ratio do not decrease the values of color properties in meat.

A different situation exists when we take into consideration the weight gains obtained by raised quantities of feed given to animals. In this case the meat becomes paler and contains less pigment (Table 2). There is no doubt that this influence can not be interpreted as a result of age differences. The elimination of the influence of age by dividing the myoglobin content by days of pig life (Table 3) shows that even then the said differences remain strongly significant.

Table 3.

The relative myoglobin content as influenced by different feed units consumption with the same protein : carbohydrates ratio in pigs

F. u. per pig daily	I	II	III	Stat. signif. of differences
Ratio of myoglobin content to days of pig life	0.3303	0.3174	0.2679	xx

The similar observations on meat color in swines were already made by McMeekan (1940). He was able to perceive lighter colored meat in his high fed animals. The phenomenon was explained by him by the influence of age and by less active existence of animals receiving more feed. It must, however, be stressed that the differences in feeding in McMeekan's experiment were purposely extreme and that the animals in his low fed group were, without doubt, very hungry.

That had not been the case in our experiment, where the differences in rations were small and there were no signs of particular hunger in the animals' behaviour. Therefore, the interpretation of the phenomenon by the activity of the animals' existence seems to be inadequate in our experiment.

Summary

The experiment carried out on 45 Large White pigs slaughtered at 110 kg l. w. has proved the significant influence of plane of nutrition on the color properties of meat. The higher energy rations with the same protein : carbohydrates ratio produce significantly paler meats with less pigment content. It has been suggested that the phenomenon is not to be ascribed to the age differences of animals.

The increased protein : carbohydrates ratio in diet does not diminish the values for color and pigments in meat though the animals are younger at slaughter weight.

REFERENCES

1. Hupka E. 1952
Deutsch. tierärztl. Wochenschr. 59:145.
2. Janicki M. A. and S. Kolaczyk. 1960
Relationship between colour and other quality components in fresh pork meat. VI-th Meeting of Meat Research Institutes, Utrecht.
3. Janicki M. A., A. Thomas and J. Kortz. 1961
Colour stability of fresh pork meat. VII-th Meeting of Meat Research Institutes, Warsaw.
4. Janicki M. A. and A. Witkowska. 1962
Roczn. Nauk Roln. 79-B-2:53.
5. Kleitman N. 1926
Am. J. Physiol., 77:233.
6. Lawrie R. A. 1950
J. Agric. Sci., 40:356.
7. Lawrie R. A. 1952
Nature, 170:122.
8. Ludvigsen J. B. 1960
Maladaptation syndromes in pigs. II. Intern. Anim. Congr., Madrid, 357.
9. McMeekan C. P. 1940
J. Agric. Sci., 30:511.
10. Mukherjee R. and H. H. Mitchell. 1949.
J. Nutrition, 37:303.
11. Poel W. E. 1949.
Am. J. Physiol., 156:44.
12. Pohja M. S. and P. P. Niinivaara. 1957
Fleischwirtsch., 9-4:193.
13. Snedecor G. W. 1956
Statistical Methods, 5-th ed. Ames, Iowa. The Iowa State College Press.
14. Treichler R. and H. H. Mitchell 1941
J. Nutrition, 22:33.