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The Quality of Meat from British Heavy Hogs and some of the Factors which Influence it.

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THE QUALITY OF MEAT BROM BRITISH HEAVY HOGS AND SOME OF THE FACTORS WHICH INFLUENCE IT.

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The work described in this paper forms part of a long term programme to develop a pig which is an optimum single source of raw material for a range of products including sausages, bacon and ham. Large scale trials over a number of years have led to production of a hybrid pig based on selected animals from three basic British breeds, Large White, Landrace and Saddleback. The resulting animals have many advantages from the practical point of view. In particular they provide an economic source of lean meat due to low cost of the weaner pigs, rapid growth to killing weight (260 lbs or 118 kg), efficient food conversion with feeding ad libitum and carcases with high lean content (1).

The tests on breeding, feeding and husbandry have been paralleled during recent years by a programme of work to assess the quality of these and similar pigs in comparison with current supplies (2) (3) (4). In view of the importance of the stress variable (5) our general approach has been to use a pattern of stress which would be typical of standard production conditions. This has led to an experimental technique based on a large number of pigs, handled by standard transport to our main London slaughterhouse and slaughtered under typical production conditions. In our initial experiments we also worked with pigs from a single production farm to establish a reference base for further work; an interim account of this work has already been presented (3) (4).

The present paper gives the main results of this experiment carried out over 18 months, and outlines some of the factors that we have encountered in extending it to cover other farms, particularly our Research farms, where newer types of animals are usually first available for test. These results show very clearly the need for standardising techniques if results are to have practical meaning in terms of a given production process.

Part I - Observation on Pigs from Kington Magna Farm.

The farm at Kington Magna is one of our Company Demonstration farms. It aims to produce heavy hogs under normal agricultural conditions, and send them by road to our main London factory. The journey is 120 miles over good main roads; the vehicle arrives at the factory in the afternoon and the pigs are held overnight in the lairages for slaughter next morning. A study of these pigs has many advantages in that most aspects of their history are known and can be taken into account in assessing the results. The methods used have been described in earlier interim communications (2) (3) (4).

Our experiment has covered a number of different breeds of animal, of which the major proportion were the progeny of Large White boars and Saddleback sows (215 animals) or Landrace boars and Saddleback sows (315). Only 41 were pure bred (Large White) and the remainder were various crosses of Large White, Saddleback and Landrace. None of these crosses was representative of our recommended hybrid but the results in total should indicate the performance of typical cross bred pigs.

1381 pigs have been examined between August, 1964 and January, 1966. Tests have been carried out in some detail up to the cooled carcase stage, including measurement of pH at various times after death with a temperature-compensated glass electrode system.

The distribution of pH at various times after slaughter averaged over the period of test is shown in Table 1. together with overall assessments of exudative character and incidence of pale colour. All observations have been taken in the l.dorsi at the 5th rib. It will be seen that only a small percentage was in a truly pale and exudative condition, although a higher proportion showed obvious impairment of one or other of these qualities. The pH at 45 minutes generally exceeded 5.8, but a more acid fraction was apparent in the distribution at 120 minutes. The majority of samples had an ultimate pH of 5.4 to 5.8 .

Table 2 shows how the monthly average pH varies throughout the year. There is no obvious time when pH immediately after death is noticeably lower, as reported by other workers; there is, however, a higher ultimate pH in mid-summer, together with an associated higher pH immediately after death.

It must be presumed that exhaustion of the pig during handling in hot weather is the major factor involved in this case, overriding any tendency to poor quality due to stress at the point of slaughter.

The earlier paper (3) had concluded that different types of housing on the farm had no major effect on meat quality, other than sweathouse conditions, which tended to produce paler meat. Stress caused by difficult loading at the farm, however, caused marked raising of ultimate pH. In the absence of such prior stress it was also shown that stress immediately before slaughter was one of the main factors which gave rise to a low pH in the first two hours after death. No further experimental work on these factors has been carried out, and the conclusions remain unchanged.

The final processing qualities of 200 of the carcases have been investigated and the results are being analysed by computer. This analysis is not yet completed but the interim conclusions do not materially change those which have already been reported (4) for a shorter period of test.

Part II - Observations on Pigs from Research Farms.

We have now extended this work to cover two other farms, namely our Progeny Testing Station at Tring, about 35 miles from the factory, and our Research farm at Thanestead, about 25 miles from the factory. The journey time is correspondingly less than from the Kington Magna farm, and the pigs often arrive at the factory sufficiently early in the day to be slaughtered without holding overnight. The resulting differing pattern of stress is a complicating factor which could influence the carcase quality enough to obscure smaller effects due to breed or conditions on the farms. We have therefore attempted to isolate the effect of individual variables.

Effect of overnight holding in the factory.

Loads of hogs and gilts of various breeds from the Tring farm were divided on arrival at the factory, half being slaughtered within $1\frac{1}{2}$ hours of arrival and the remainder being slaughtered on the following morning. Table 3 gives the combined pH averages and quality scores, together with a breakdown of the breeds. The pigs held overnight showed a higher ultimate pH, a redder colour and a reduced percentage of exudative samples. A similar pattern has also been observed with various intact loads of pigs which have been held

overnight before slaughter, as compared with batches from the same source slaughtered on the day of arrival.

The particular stress factor involved has not been identified, but it may be presumed that a pig reared in the relatively sheltered environment of a farm would be under stress throughout our experiments, even if apparently resting overnight in lairages. The conditions of the lairages are not obviously unusual, individual pens holding approximately 40 animals; water is available and the pens are cleaned out after every batch of pigs.

Length of Journey.

Some indication of the effect of journey length can be shown by comparing the performance of pigs of similar breed from two farms. Table 4 shows a comparison between pigs from the Tring Farm (35 miles) and Kington Magna Farm (120 miles), pure Large White pigs being used in both cases. The higher ultimate pH with the Kington Magna Farm pigs indicates a greater degree of prior exhaustion, and, although there is no major effect on the pH soon after death, there is obviously a much smaller incidence of exudative character.

Less extensive tests with cross bred pigs have shown less evidence of exhaustion even after a long journey and overnight holding. Ultimate pH has been lower and incidence of exudative muscle has been higher.

Other Influences.

These results show that useful conclusions can be drawn by considering the average performance of a number of pigs. Natural variation occurs within each group and an understanding and control of this variation is a long term aim of our experiments. Wide deviation from the average response can be seen with a small proportion of pigs and may at first sight be attributed to a high sensitivity to stress. We have, however, seen cases where the stress suffered by the pig has proved to be greater than had originally been supposed and it is interesting to quote two examples:

(a) In an experiment involving handling and slaughter with as little stress as possible we used four apparently comparable pigs. Three had pH_{45}, pH_{120} and pH_{ult} of the expected order but one showed much lower values. On further examination this pig proved to be in the early stages of an attack of pneumonia.

(b) A batch of young pigs was held overnight in the factory lairages and three showed high pH and deep red colour typical of exhaustion. These proved to be three young boars which had been held in a pen with hogs and gilts.

Effect of Lean Content.

Comparison of the performance of specific breeds and animals must clearly take into account experimental variables such as this study has outlined. At present we feel that the most useful single test condition is a fairly short journey lasting approximately an hour followed by slaughter in the factory on the same day approximately an hour after arrival. While this is within normal production variation it tends to emphasise any tendency to poor quality due to pH effects.

Table 5 shows the results of all the tests in which pure bred pigs from the Tring and Thanestead farms were handled in this way, with the exception of a small proportion with high pH indicative of exhaustion. It can be seen that there is a clear pattern of decreasing quality with increasing lean content. This is no proof that very high lean content is inevitably linked with poor quality but it indicates the need for care.

Discussion.

Many of the observations presented in this paper are not new in themselves. They do, however, show the need for an integrated appreciation of all aspects of the handling of pigs in attempting to define the quality of the resulting carcases. Four points stand out clearly:

(a) Transport and handling in the lairages are major variables and their effect may differ on differing pigs. In general, increased stress at these times tends to raise ultimate pH and decrease tendency to exudative character.

(b) Any such effects must be balanced against the effect of stress at the point of slaughter, which increases the rate of pH fall and increases the tendency to exudative character.

(c) Short journey followed by slaughter soon after arrival in the slaughterhouse are conducive to producing meat with pale exudative character.

(d) It may be necessary to take much greater care in handling animals with high lean content.

References

1. J.A.P. Friedlander. Agriculture, 1965 (Oct.) p.485
2. D.J.Locke and R.Vetterlein. 10th European Meeting of Meat Research Workers, Roskilde, 1964.
3. R. Vetterlein and A.J. Kidney, 11th European Meeting of Meat Research Workers, Belgrade, 1965.
4. W.D.McLean and A.J.Kidney, 11th European of Meeting Meat Research Workers, Belgrade, 1965.
5. E.J.Briskey, Advances in Food Research, 1964, 13, 89-178.

Table I - Distribution of quality factors in 1381 pigs from Kington Magna Farm averaged over the period August, 1964 - January, 1966

	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8
	Percentage of pigs.																
	0.1	0.4	0.6	1.1	1.8	3.0	5.8	12.0	13.1	17.4	19.5	13.7	7.4	2.5	1.3	0.2	
	0.2	0.8	3.2	6.0	8.3	8.4	14.5	14.4	15.3	12.7	8.7	4.1	1.6	1.2	0.3	0.1	0.1
	0.3	2.8	17.1	23.8	19.7	14.4	9.3	6.6	3.2	2.7	1.7	1.2	0.3	0.3	0.2	0.1	0.1

% Exudative	19.2 (b)
% Pale	5.6 (c)
% Pale and exudative	2.2

pH measured in the l.dorsi at the 5th rib, 45 minutes, 120 minutes or approximately 1 day after slaughter.

Wetness of the l.dorsi at the 5th rib estimated visually approximately 1 day after slaughter.

Colour of the l. dorsi at the 5th rib estimated by three observers approximately 1 day after slaughter.

Table 2. - Monthly average of pH readings on pigs from Kington Magna Farm taken 45 minutes, 120 minutes or approximately 1 day after slaughter in the l.dorsi at the 5th rib.

	1964 Aug.	Sept.	Oct.	Nov.	Dec.	1965 Jan.	Feb.	Mar.	Apr.
ber of pigs	108	99	50	71	62	89	105	54	28
45	6.17	6.11	6.22	6.16	6.21	6.21	6.21	6.19	6.10
120	6.06	5.86	5.85	5.93	5.95	5.82	5.85	5.93	5.80
1t	5.81	5.58	5.70	5.73	5.69	5.57	5.60	5.60	5.60

	1965 May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1966 Jan.
ber of pigs	103	106	103	30	63	97	38	85	90
45	6.23	6.18	6.17	6.23	6.24	6.19	6.15	6.24	6.17
120	5.91	5.82	5.84	6.10	5.92	5.90	5.75	5.93	5.95
1t	5.64	5.66	5.52	5.70	5.62	5.64	5.56	5.61	5.71

Table 3. - Quality factors of three loads of pigs from Tring Farm, half of each load slaughtered on the day of arrival at the factory, and the other half held overnight.

	Slaughtered on day of arrival.	Slaughtered on day after arrival
Total no. of pigs	39	40
pH_{45}	6.18	6.18
pH_{120}	5.88	5.92
pH_{ult}	5.55	5.66
lean meat colour (a)	4.7	4.3
% exudative	51.3	22.5
Breeds: Large White	16	16
Landrace or Welsh	9	11
Wessex or Essex	10	11
Wessex/Essex Cross	2	2
Landrace/Large White Cross	2	-

(a) Average visual score by three observers using a 7 point scale, pale meat having a high score.

Table 4. - Quality factors for pure Large White heavy hogs receiving three pre-slaughter treatments.

Treatment:	Tring Farm same day slaughter	Tring Farm held overnight	Kington Magna Farm held overnight
No. of pigs.	81	33	41
pH_{45}	6.19	6.31	6.26
pH_{120}	5.83	5.94	5.95
$pH_{ult.}$	5.52	5.61	5.67
lean meat colour	4.9	4.6	4.4
% exudative	55.6	27.3	12.8

Table 5. - Quality factors of pigs of various pure breeds (Large White, Landrace, Welsh, and Wessex and Essex Saddlebacks) classified in terms of lean content of the carcase.

Lean Content	No. of pigs	pH_{45}	pH_{120}	pH_{ult}	Lean meat colour	% Exudative
33.0 - 35.99	5	6.24	5.80	5.42	5.1	40
36.0 - 38.99	27	6.15	5.89	5.49	4.7	33
39.0 - 41.99	40	6.16	5.80	5.50	4.9	50
42.0 - 44.99	42	6.18	5.81	5.49	5.1	69
45.0 - 47.99	25	6.06	5.73	5.45	5.1	80
48.0 - 50.99	5	5.65	5.52	5.42	5.9	100

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ABSTRACT.

Observations have been made on large numbers of heavy hogs (260 lb wt.) handled by typical production methods. Animals from three farms have been used; a typical production farm 120 miles from the Factory, a progeny testing station 35 miles from the Factory and a research farm 25 miles from the Factory.

1381 pigs from the production farm have been examined over a period of 18 months. Few carcases showed pale and exudative characteristics but a much larger proportion was either pale or exudative. There was a trend towards higher ultimate pH in midsummer.

Extension of the work to the other farms closer to the factory has shown that overnight holding at the factory before slaughter increases ultimate pH, improves lean meat colour and reduces exudation. As the total stress undergone by a pig well before slaughter has been increased, the colour has improved and tendency to exudation has decreased. Under conditions of minimum pre-slaughter stress, the leanest pigs have yielded the palest and most exudative meat.

The importance of considering pre-slaughter conditions in any programme involving quality assessment is stressed. A short journey to the point of slaughter followed by slaughter soon after arrival is conducive to the production of pale and exudative meat, with the leanest animals most at risk.

La qualité de la viande obtenue à partir des "Heavy Hogs" (gros porcs) britanniques et quelques-uns des facteurs l'influencant.

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Résumé

Un grand nombre de "heavy hogs" (porcs pesant 140 kg.) manipulés selon des méthodes de production typiques ont été observés. On a utilisé les animaux de trois fermes; une ferme de production typique à 200 km. de l'usine, une station spécialisée dans l'analyse de descendance à 56 km. de l'usine et une ferme de recherche à 40 km. de l'usine.

On a examiné 1381 porcs de la ferme de production pendant une période de 18 mois. Peu de carcasses étaient à la fois pâles et exsudatives mais une proportion beaucoup plus importante était soit pâle soit exsudative. Le pH ultime avait tendance à être plus élevé au milieu de l'été.

Après qu'on ait étendu l'expérience aux autres fermes plus proches de l'usine on a trouvé que le séjour des animaux dans l'usine pendant la nuit avant l'abattage augmentait le pH ultime, améliorait la couleur de la viande maigre et réduisait l'exsudation. Comme la tension totale éprouvée par un porc bien avant l'abattage a augmenté, la couleur s'en est trouvée améliorée et la tendance à l'exsudation réduite. Dans des conditions de tension minimum avant l'abattage la viande des porcs les plus maigres était la plus pâle et la plus exsudative.

On souligne l'importance de considérer les conditions précédant l'abattage dans tout programme comportant l'évaluation de la qualité. Un court voyage au point d'abattage suivi par l'abattage peu après l'arrivée contribue à la production d'une viande pâle et exsudative, les animaux les plus maigres étant les plus susceptibles de présenter ces caractéristiques.

Die Qualität des Fleisches englischer "Heavy Hogs" (schwere Schweine) und einige der sie beeinflussenden Faktoren

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Zusammenfassung.

Beobachtungen über eine grosse Anzahl von nach typischen Produktionsmethoden behandelten "Heavy Hogs" (140 kg schwer). Die Tiere kamen von drei verschiedenen Gütern; einem typischen Produktionsgut 200 km von der Fabrik entfernt, einer Nachkommenschaftsversuchsstation 56 km von der Fabrik entfernt und einem Forschungsgut in einer Entfernung von 40 km von der Fabrik.

Im Laufe von 18 Monaten wurden 1381 Produktionsgutsschweine untersucht. Nur wenige der Schlachtkörper wiesen gleichzeitig blasse Farbe und Exudationsmerkmale auf, doch zeigten eine viel grössere Anzahl entweder blasse Farbe oder Exudationsmerkmale auf. Es zeigte sich ein Trend in Richtung höherer End-pH-Werte im Hochsommer.

Eine Ausdehnung der Arbeit auf die anderen, der Fabrik näher liegenden Güter hat gezeigt, dass durch ein Übernachten der Tiere in der Fabrik vor der Schlachtung der End-pH-Wert gesteigert, die Magerfleischfarbe verbessert und die Exudation verringert wird. Da die Gesamtbeanspruchung des Schweines längere Zeit vor der Schlachtung zunahm, verbesserte sich die Farbe und verringerte sich die Neigung zur Exudation. Unter minimalen Beanspruchungsbedingungen vor der Schlachtung ergaben die magersten Schweine das blasseste Fleisch mit höchster Exudation.

Auf die Bedeutsamkeit einer Berücksichtigung der Vorschlachtungsbedingungen in jedem die Qualitätsbeurteilung umfassenden Programm wird hingewiesen. Ein kurzer Weg zur Schlachtstelle mit kurz nach der Ankunft erfolgender Schlachtung führt zur Erzeugung von blassfarbigem und wässerigem Fleisch; dies trifft besonders bei den magersten Tieren zu.

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