

## A3. THE STRESS SYNDROME AND MEAT QUALITY

## THE INHERITANCE OF MEAT QUALITY IN PIGS

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Pigmeat which is pale, soft and exudes large amounts of fluid (PSE) is a major problem in many countries. Meat of this type is particularly unsuitable for processing. The susceptibility of a carcass to PSE can be assessed by measuring the pH value in the lumbar region of the longissimus dorsi muscle at 45 minutes post-mortem (pH<sub>45</sub>). It is an index of the rate of post-mortem anaerobic glycolysis and is related to the characteristics of the fresh meat. In general, when the pH<sub>45</sub> value is low, the meat will tend to be pale, soft and watery to various extents.

Since October 1970, the measurement of pH<sub>45</sub> has been included in the national pig testing procedure in Ireland, and it has been recorded on all slaughtered pigs, i.e. castrates, females and culled boars. A total of 2775 pig records, including the progeny of 129 Landrace and 126 Large White boars, from two test stations spanning two years (1971 and 1972) were available for this investigation. The effect of breed, station, sex and season on pH<sub>45</sub> was investigated. The heritability of pH<sub>45</sub> and its genetic correlation with other performance characteristics were determined within each breed.

Landrace pigs had significantly lower values than Large White pigs, indicating a greater susceptibility to PSE in the former. There was no significant difference between the values for boars, castrates and females. There were marked differences from month to month, but no definite seasonal pattern was present nor was there any apparent long-term trend.

The heritability for the Landrace breed was higher than that for the Large White breed and both values indicate that pH<sub>45</sub> would respond to selection. The genetic correlations between pH<sub>45</sub> and daily gain, food conversion efficiency and backfat (two measurements) were for the most part low and the standard errors relatively high, indicating that there was no strong relationship between pH<sub>45</sub> and these performance characteristics.

## L'HERITABILITE DE LA QUALITE DE LA VIANDE CHEZ LE PORC

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Les viandes de porc qui se caractérisent par une affection dénommée "myopathie exudative et dépigmentaire" (PSE) est un problème dans beaucoup de pays. Le rendement technologique de ce type de viande est mauvais. On peut évaluer la sensibilité d'une carcasse à cette affection par mesure du pH au niveau de la région lombaire du muscle longissimus dorsi, 45 minutes après l'abattage (pH<sub>45</sub>). C'est un indice du taux de glycolyse anaérobie post-mortem, qui est lié aux caractéristiques de la viande crue. En général, quand le pH<sub>45</sub> est peu élevé, la viande se dirigera vers une exudation abondante une coloration insuffisante.

Depuis octobre 1970, la mesure de pH<sub>45</sub> était comprise dans la méthode de contrôle chez les stations de 'testage' en Irlande; on a mesuré tous les porcs abattus, c'est à dire, les mâles castrés, les femelles et les jeunes verrats non-choisis. On a utilisé les données de 2775 porcs de deux stations, y compris les descendances de 129 verrats de la race Landrace et de 126 verrats de la race Large White; les données sont recueillies de 1971 à 1972 inclusif. Les effets de race, station, sexe et saison sont estimés. L'heritabilité de pH<sub>45</sub> et ses corrélations génétiques avec les autres caractères de performance, sont calculés en chaque race.

Les porcs de la race Landrace avaient des pH<sub>45</sub> plus bas que les porcs de la race Large White, indiquant que la première est plus sensible à PSE. Il n'y avait pas une différence significative entre les moyennes des verrats, des mâles castrés et des femelles. Les différences d'un mois à l'autre étaient hautement significatives, mais il n'y avait pas des différences définies de saison.

L'heritabilité de pH<sub>45</sub> dans la race Landrace était plus élevée que celui dans la race Large White, et ces résultats pour les deux races ont indiqué que pH<sub>45</sub> répondrait à la sélection. Les corrélations génétiques entre pH<sub>45</sub> et gain moyen quotidien, indice de consommation, épaisseur du lard (quatre mesures) étaient en général, basses et les erreurs - types relativement élevés, indiquant qu'il n'y avait pas une relation forte entre pH<sub>45</sub> et les autres caractères.

## DIE VERERBUNG VON FLEISCH QUALITÄT IN SCHWEINEN

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Schweinefleisch, das hell, weich und grosse Mengen von Flüssigkeit (PSE) hat, ist in vielen Ländern ein grosses Problem. Fleisch dieser Art ist besonders ungeeignet zur Verarbeitung. Die Empfänglichkeit eines Kadavers zu PSE kann taxiert werden durch Messung des pH Wertes in der Lendengegend des longissimus dorsi Muskels bei 45 Minuten Leichenöffnung (pH<sub>45</sub>). Es ist ein Zeichen des Massstabes von Leichenöffnung anaerobic glycolysis und ist verknüpft mit den Eigentümlichkeiten des frischen Fleisches. Wenn der pH<sub>45</sub> Wert niedrig ist, neigt das Fleisch im allgemeinen dazu, hell, weich und wässrig in den verschiedensten Graden zu sein.

Seit Oktober 1970 ist die Messung von pH<sub>45</sub> in den nationalen Schweineversuchsverfahren eingeschlossen und es ist bei allen geschlachteten Schweinen, d.h. kastrierten, weiblichen und ausgesuchten Ebern registriert worden. Eine Gesamtzahl von 2775 Schweineregistrierungen einsch. der Jungen von 129 Landrace und 126 grossen weissen Ebern waren von zwei Versuchsstationen für eine Zeitspanne von 2 Jahren für diese Untersuchung verfügbar. Der Effekt von Rasse, Aufenthaltsort, Geschlecht und Saison auf pH<sub>45</sub> wurde untersucht. Die Vererblichkeit von pH<sub>45</sub> und seiner genetischen Abhängigkeit mit anderen auftretenden Eigentümlichkeiten wurden in jeder Rasse festgestellt.

Landrace Schweine hatten bedeutend niedrigere Werte als grosse weisse Schweine, was eine grossere Empfänglichkeit zu PSE in den ersteren beweist. Bedeutsame Unterschiede in den Werten von Ebern, kastrierten und weiblichen Schweinen bestanden nicht. Bemerkliche Unterschiede wurden von Monat zu Monat festgestellt, aber weder eine bestimmte Saisonschablone noch eine sichtbare Zeitspannen-Erscheinung konnten bemerkt werden.

Die Vererblichkeit für die Landrace Rasse war höher als für die grosse weisse Rasse und beide Werte zeigen an, dass pH<sub>45</sub> bei Zuchtwahl reagieren würde. Die genetische Abhängigkeiten zwischen pH<sub>45</sub> und täglicher Zunahme, Futternutzleistung und Rücken fett (4 Messungen) waren zum grössten Teil niedrig und die normalen Abweichungen relativ hoch, damit anzeigend, dass eine starke Verbindung zwischen pH<sub>45</sub> und diesen auftretenden Merkmalen nicht bestand.

## НАСЛЕДСТВЕННОСТЬ КАЧЕСТВА МЯСА В СВИНЯХ

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Большой проблемой во многих странах является свинина, бледная, мягкая и выделяющая большие количества жидкости (БМВ). Мясо такого рода исключительно непригодно для переработки. Восприимчивость туши к БМВ можно оценить определением pH около M. LONGISSIMUS DORSI через 45 мин. после убоя pH<sub>45</sub>. Эта величина является показателем скорости послеубойного анаэробного гликолиза, и относится к характеристикам свежего мяса. Вообще говоря, при низкой pH, мясо склоняется быть бледным, мягким и водянистым по разным степеням.

С октября 1970г. определение pH включалось в народную систему испытаний свиней, и регистрировано по отношению ко всем убойным свиньям - т.е. кастратам, свиньям и хрякам. Для нашего исследования мы имели данные о 2775 свиньях (включая потомков 129 Ландрас и 126 Крупных Белых) от двух исследовательских станций. Влияние породы, местоположения, пола и сезона на pH исследовалось. Определилось наследственность pH<sub>45</sub> и его генетическое отношение к другим показателям для каждой породы.

Величины для Ландрас были значительно ниже Крупных Белых, указывая на большую восприимчивость первых к БМВ. Никакой значительной разницы между хряками, кастратами или свиньями не было. Были заметные ежемесячные колебания, но ни определенной сезонной модели ни явной дальнейшей тенденции не появилось.

Наследственность породы Ландрас превышала Крупную Белую, а обе величины указывают на возможность, что pH<sub>45</sub> будет реагировать к системе выбора. Генетические соотношения между pH<sub>45</sub> и ежедневным приростом, эффективность пищеварения и индексом (два измерения) главным образом оказались низкими, а нормальная погрешность относительно высокой, что указывает на отсутствие значительного соотношения между pH<sub>45</sub> и вышеупомянутыми характеристиками.

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## MATERIALS AND METHODS

Since October 1970, the measurement of pH<sub>i</sub> has been included in the national pig testing procedure in this country, and it has been recorded on all slaughtered pigs, i.e. castrates, females and culled boars. A total of 2775 pig records from the two test stations spanning two years (1971 and 1972) were available for this investigation. pH<sub>i</sub> was measured on both the left and right side of each carcass, and the average of the two readings was used in this study.

Variance analyses were carried out separately on each year's data to investigate the effect of breed, station, sex and season on pH<sub>i</sub>. The heritability of pH<sub>i</sub> and its genetic correlation to other performance characteristics were determined on the pooled data for each breed. The relationship between leg weakness and meat quality was investigated in the boar pigs, as they were classified for leg condition from 1 (indicating soundness) down to 5 (severe leg weakness).

The influence of recent importations of pigs into this country was assessed by classifying the pigs according to the origin of their sires, i.e. Irish bred or imported.

## RESULTS AND DISCUSSION

Pigmeat which is pale, soft and exudes large amounts of fluid (PSE) is a major problem in many countries. Meat of this type is particularly unsuitable for processing. Certain breeds of pigs, e.g. the Pietrain, the Belgian Landrace and the Poland China, have a particularly high incidence of the condition. There is a widespread feeling that pale, soft exudative (PSE) muscle is more likely to develop in the lean, rapidly growing type of pig than in others. Meat colour is used as an indicator of this aspect of meat quality, and it has been shown to be moderately heritable in several breeds (Pease and Smith, 1965; Jensen et al. 1967; Moen et al. 1970; Staun, 1972).

The susceptibility of a carcass to PSE can also be assessed by measuring the pH value in the lumbar region of the longissimus dorsi muscle at 45 minutes post-mortem. It is an index of the rate of post-mortem anaerobic glycolysis and is related to the characteristics of the fresh meat. In general, when the pH<sub>i</sub> value is below 6.0 the meat will be pale, soft and watery to various extents; when it is below 5.6 it will be severely affected. Jonsson et al. 1971, found the heritability of pH<sub>i</sub> to be 0.32 in Danish Landrace pigs.

The objectives of this study were to investigate some of the factors influencing pH<sub>i</sub> and to determine its heritability in Irish Landrace and Large White pigs, as well as its genetic relationship to other economically important characteristics.

The mean pH<sub>i</sub> value for each breed as well as the means for stations and sexes in each year are given in Table 1. Landrace pigs had significantly lower pH<sub>i</sub> values than Large White pigs in both years, indicating a greater susceptibility to PSE in the former. The percentages of pH<sub>i</sub> values below 6.0 were 19% and 11% in the Landrace and Large White pigs respectively over the 2 year's data.

A significant difference between test station means was found in one year only; Cork had a lower average value than Thorndale in 1972. No significant difference was found between boar, castrate and gilt pigs in either year. While marked monthly variation was found, no definite seasonal pattern was present, nor was there any apparent long-term trend. The short-term fluctuations are most likely due to varying slaughter conditions at the bacon factories.

The heritability of pH<sub>i</sub>, calculated on the pooled data for each breed, including sires which had progeny from at least two dams, are shown in Table 2. The higher value for the Landrace breed, although consistent over both years, was not in fact significantly different from the value for the Large White breed. The heritabilities found in the current study are of the same order as that quoted by Jonsson et al. 1971.

The genetic correlations between pH<sub>i</sub> and daily gain, food conversion efficiency and backfat (4 measurements) are also shown in Table 2. For the most part, these correlations are low and the standard errors are relatively high, indicating that there is no strong relationship between pH<sub>i</sub> and these

performance traits. However there was a noticeable lack of agreement between the same correlations for the two breeds. In Large White, for food conversion efficiency and the four backfat measurements there were favourable correlations with pH<sub>i</sub>, whilst the opposite was true in the case of the Landrace pigs. This might indicate real differences in the two populations due to varying amounts of selection in the recent development of the breeds. The genetic correlations between pH<sub>i</sub> and the carcass traits which were measured only on gilts and castrates, i.e. length, eye muscle area, grade, weight of shoulder, weight of mid-back and weight of gammon, are also given in Table 2. Because these estimates are based on only about two-thirds of the data, the standard errors are large. Not forgetting the limited interpretation that can be placed on these estimates, it is interesting to note the low correlations between pH<sub>i</sub> and eye muscle area, indicating that there is no antagonism between meatiness and quality in these breeds. On the other hand, Jonsson et al. 1971, reported a negative genetic correlation between eye muscle area and meat colour (-0.29) in Danish Landrace pigs, and suggested that it was brought about by the recent selection for meat content in that breed.

Estimates of Expected Breeding Values (Cunningham, 1965) i.e. predicted average of all future progeny, for pH<sub>i</sub>, were calculated for all sires which had recorded progeny from at least two different sows. The actual number of progeny per sire ranged from 4 to 48 (average 9.4). The distribution of breeding values in both years for the 124 Landrace and 122 Large White sires are plotted in Figure 1. The generally lower level of pH<sub>i</sub> in the Landrace breed is further illustrated in this diagram.

No significant difference in the pH<sub>i</sub> means between the five groups of pigs classified according to leg condition, were found in either breed, as shown in Table 3, indicating that no relationship exists between these two problems.

The influence of sires of different geographical origin is shown in Table 4. Importations from Great Britain do not appear to have influenced the level of pH<sub>i</sub>. Norwegian pigs, from the international trial, where both parents were imported, had somewhat lower pH<sub>i</sub> values than Irish bred pigs. Descendants from Swedish importations also had lower pH<sub>i</sub> values generally speaking, although the numbers involved were relatively small.

In conclusion, these results indicate that (1) there is a distinct breed difference in pH<sub>i</sub>, the average being lower in the Landrace breed, (2) pH<sub>i</sub> is moderately heritable in both breeds, and (3) whilst there are no seriously unfavourable relationships between pH<sub>i</sub> and other economically important traits, there appears to be some evidence of breed differences in the genetic correlation values. The magnitude of the heritabilities indicate that this aspect of meat quality will respond to selection, and should be therefore taken into account in a breeding programme.

TABLE 1. Mean pH<sub>i</sub> values with standard errors for pigs classified by breed, station and sex

Breed	1 9 7 1		1 9 7 2	
	No. of pigs	pH <sub>i</sub> ± S.E.	No. of pigs	pH <sub>i</sub> ± S.E.
<b>Station</b>				
Landrace	599	6.28 ± .03	874	6.33 ± .03
Large White	555	6.43 ± .03	747	6.43 ± .03
<b>Sex</b>				
Thorndale	516	6.33 ± .03	780	6.47 ± .03
Cork	638	6.36 ± .03	841	6.29 ± .03
Boar	617	6.37 ± .03	896	6.39 ± .03
Castrate	261	6.35 ± .04	329	6.40 ± .04
Gilt	276	6.34 ± .03	396	6.36 ± .03