

### Introduction

At the 16th Meeting of European Meat Research Workers, plans were made to organize a Symposium on PSE meat and it was intended to report the main results of this Symposium at the 17th Meeting of European Meat Research Workers in Bristol in 1971. The Symposium was held at the Research Institute for Animal Husbandry in Zeist from 22-24th March, 1971. Forty-three papers were sent in and a total of fifty participants were registered. The following subjects were raised: Muscle metabolism, Stunning, Transport and Fresh Pork.

The introduction to each subject was followed by a review of the related papers and the various aspects of the problems concerning PSE were discussed. With the help of several participants Prof. Dr. R.A. Lawrie formulated the summaries of each section and these summaries, together with a list of papers, are attached to this report.

This report is an overall survey which is only intended to convey a general impression. It is divided into the following sections:

1. Fresh Pork and Technology.
2. Stress susceptibility.
3. Environmental influences.
4. Breeding implications.
5. Practical implications.

### 1.0 Fresh Pork and Technology

The whole PSE problem is primarily a problem of a deviation in meat quality in which the meat is pale, soft and exudative. No new meat quality parameters were brought forward during this Symposium.

Rigor mortis and especially pH<sub>1</sub> measurements, shortly after slaughter have a limited value as predictions of meat quality at 24 hours. In paper FP8 (Leest et al.), data were presented on PSE loins from high and low pH<sub>1</sub> carcasses, which differ in technological properties. Reliable methods to be used are at 24 hours after slaughter: colour measurements with the help of the Göfo method, transmission value method according to Hart and visual examination. In order to determine dark, firm and dry meat (DFD) it is necessary to measure pH 24 hours after slaughter. The appearance of PSE is not always caused by the same train of events and it was established that, as in the case of several myopathies, PSE may develop from different causes.

### 1.1 Fresh Pork

There were some doubts about the economic importance of PSE in fresh meat. In prepacked form drip should not only cause losses, but also affect its acceptability to the consumer. The colour is not as important as was expected. An investigation into this aspect of consumer behaviour showed that fat content is considered far more important (Zuidam et al, FP6). Different colours in the same meat will give rise to stronger objections from the customer.

### 1.2 Technological aspects

During storage the difference in tenderness between PSE meat and normal meat increases in favour of normal meat (Buchter and Zeuthen, FP1). The thiobarbituric acid value (TBA), which is an indication of rancidity, is twice as high in PSE meat as in normal meat (Merkel, FP3). The value increases with storage time and, if a certain TBA concentration has been reached, the consumers start to complain. Cooking losses are higher and emulsifying capacity is lower (Merkel, FP3; Leest et al, FP8). However, all these differences are too slight to be recognized by the normal consumer. In many products the present differences in cooking losses can be diminished by the use of polyphosphates.

### 1.3 Conclusion

The overall conclusion was that the economic losses, although they do exist, are fairly slight. Drip is the only factor which is a serious problem in some countries. Greater economic harm can be attributed to losses from stress susceptibility.

### 2.0 Stress susceptibility

Stress susceptibility is another word for physiological instability. There was general agreement on the close relationship between this physiological instability and the cause of PSE meat.

### 2.1 Endocrinology

Hormonal balance was thought to be one of the causes of PSE. Paper M4 (Judge) treated the adrenal function and its link with PSE. The total production of ACTH is not impaired in stress susceptible pigs, but the adrenal cortex system is probably less reactive.

### 2.2 Blood analyses

An indication of tissue metabolism can be obtained by studying several components of blood. Enzymes, especially Creatine phosphokinase (CPK) were the subject of intense discussion. Enzymes in blood as an indication of PSE or stress susceptibility were described in paper M2 (Bickhardt). CPK might be used as a predictive component for both myopathy and PSE. Metabolites, such as lactate and blood gases, especially  $CO_2$ , are closely related to the metabolic state of the tissue. Stress susceptible pigs are more prone to develop acidosis, with a high  $PCO_2$  in the blood (Kallweit and Haase, T3). An induction of acidosis is not very suitable for use in selection programmes. On this aspect it was stated that the application of heat stress is a more reliable method of detecting susceptible pigs than the application of exertion stress. A blood circulation phenomenon, such as the water shift in the preshock state which induces a higher haematocrite, was mentioned in two papers M1 (Berman and Kench) and T3 (Kallweit and Haase). Erythrocytosis was also observed after the application of a certain degree of stress (Haase and Steinhilber, T2). The analyses given in paper FP3 (Merkel) showed no relationship between meat quality and blood cell parameters. The lower number of capillaries per sq. mm of muscle was related to the significantly larger fibres found in PSE muscle.

### 2.3 Muscle metabolism

The basic facts of muscle metabolism were discussed in the first introduction of the Symposium by Van den Bergh (M1). The question arose how far the aerobic muscle metabolism in the live animal is related to the anaerobic metabolism post mortem. Several papers (Eikelenboom and Van den Berg, M7; Van Roon, M9; Berman and Kench, M1) reported the disfunction of the oxidative phosphorylation in stress susceptible pigs. Hyperthermia in pigs, sometimes due to Halothane or other anaesthetics, might be related to this phenomenon. A higher ATPase activity of myofibrillar origin is also an indication of predisposition to the development of a PSE condition (Berman and Kench, M1; Bickhardt, M2; Heffron and McLoughlin, M14). A diminished  $Ca^{++}$ -binding capacity of the sarcoplasmic reticulum is probably an important factor and may have an adverse affect on meat quality. It was suggested that there must be an unknown trigger mechanism which only reveals itself post mortem. The defective mechanism of oxidative phosphorylation (Eikelenboom and Van den Bergh, M7; Berman and Kench, M1) and glycolytic activity could be detected and measured by means of muscle biopsies. (Schmidt et al, M8; Bickhardt, M2).



A correlation was found in the biopsies between lactate content and meat quality; a higher correlation was found, however, between glucose -6-phosphate (G-6-P) and meat quality. The opinion was expressed that determination of enzyme activities in muscular tissue could not be used for prediction purposes.

Enzyme activities may be the limiting factor only in pathological circumstances.

## 2.4 Conclusion

CPK analyses of blood and muscle biopsy data are promising methods which it may be possible to use in the future for selection on stress susceptibility and therefore on PSE meat.

## 3.0 Environmental influences

Stress susceptibility in pigs means that pigs are less able to respond adequately to stress influences. The effect of stress on oxygen metabolism in boars was studied by Haase and Steinhauf (T2).

The effects of transport stress and stress of stunning on meat quality were discussed.

### 3.1 Transport stress

The effect of transport is brought about by various factors.

The treatment of the animals during loading, transportation and at the slaughterhouse determines the effort and excitation of the pigs. In most of the Western European countries transport losses are still rising every year. In paper T7 (Lendfers) it was clearly shown that environmental temperature overshadows all other factors, such as loading degree, distance and time of arrival at the slaughterhouse.

Miss Barton (T1) indicated the different reactions of different metabolic types of muscle to transport stress. Holding time at the slaughterhouse had a favourable effect on meat quality: white muscle had a tendency to turn PSE after transport over a short distance, while red muscle tended to become DFD after transport over a long distance. Scheper (FP4) also observed differences in reaction to transport of loin and ham. Container transport and transport at night were also recommended in order to reduce losses, to complement the efforts being directed towards breeding a more resistant pig (Van Putten, TI).

### 3.2 Stunning

Even after transport under ideal circumstances, the effect of stunning may have so strong an influence that all efforts made at pre-stunning are of little help in controlling meat quality (Ratcliff, SR). There were only a few papers on this subject. The methods of stunning, whether electrical or by CO<sub>2</sub>, have certain specific effects (Van der Wal, S2, S3). CO<sub>2</sub> produces anoxia which results in a discharge of adrenaline. Electrical stunning exerts its influence by intensive muscle contractions which reduce the pH very rapidly. Captive-bolt stunning releases large amounts of catecholamines, as a result of continuous stimulation of the medulla oblongata, caused by the penetration of the skull. This adrenaline release may be avoided by means of a knocker, which is very successfully used on cattle. It is still not certain whether adrenaline secretion during stunning is significant for meat quality, but it may give information on the intensity of stress experienced by the animal. No stunning at all might be the best solution from the point of view of meat quality (McLoughlin, SI). The effect of pre-stunning treatment on meat quality is sometimes as serious as the stunning itself. It was evident that there is little hope at the present time of solving this problem or finding new, improved stunning methods and research into electrophysiology should therefore be promoted.

### 3.3 Tranquillizers

Tranquillizers can be regarded as anti-stress agents and as such they have proved to be effective in improving meat quality and lowering transport losses (Devloo et al, T6; Oldigs and Unshelm, T4). One should bear in mind, however, that residues in the meat cannot be tolerated. The beneficial effect of pre-slaughter magnesium sulphate injection should be mentioned in this context (Lister and Ratcliff, S1). The reduced rate of post mortem glycolysis in Piétrains resulted in improved water-binding without changing the colour of the meat.

### 3.4 Conclusion

The conclusions reached on environmental stress can be summarized as follows: Transport losses can be reduced by appropriate measures directed towards the minimization of temperature effects and the prevention of excitation. Tranquillizers can be a help, especially when environmental conditions are expected to become bad. However, the problem remains of residues in the carcass.

### 4.0 Breeding implications

From the comparative breed studies of Unshelm et al (T5) it was concluded that the less favourable anatomical and physiological disposition of the pig has deteriorated by selection on higher muscle-forming capacity. Several papers were presented in which the relation between carcass quality and meat quality was discussed. In selection on backfat thickness and meatiness, meatiness seems to have a more deleterious effect on meat quality than backfat thickness. Not all breeds showed the same pattern. Good carcass characteristics and good meat quality can be obtained simultaneously, however (Charpentier et al, FP2). Improvement of meat and carcass quality can be achieved by crossing and the outcome of crossing experiments (Van de Pas and Walstra, FP9) showed no definite positive heterosis with regard to meat quality. The heritability of certain criteria used in selection was a subject of intense debate. The  $h^2$  of colour and visual examination is about 0.3. The cured end product should have a  $h^2$  of about 0.7. Although no heritability coefficients were presented, the outcome of experiments with muscle biopsy analyses on metabolites of glycolysis, especially G-6-P, appeared promising for use in performance tests. Enzymes in the blood e.g. CPK, should also be mentioned in this context.

### 5.0 Practical implications

With fresh pork more research should be done on the consumer acceptability of PSE or pale pork. PSE is now less important technologically than it was in the past. The effect of environment on the pig is dependent on its stress susceptibility, and it is not possible, therefore, to study one factor without considering the other. Improvement of transport and stunning facilities, an area on which more research should be concentrated, has to go together with breeding of a more resistant pig. There is an urgent need for criteria which can be used in selection programmes, especially in the live animal. No reliable methods exist yet, but muscle biopsy analyses might be an answer.