

Some Physical Aspects of the Porcine Stress Syndrome

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In recent years the number of porcine carcasses which show pale-watery muscle within 3–4 hours after slaughter has increased. Presently, this phenomenon is a serious economic problem in the pork industry (Topel *et al*, 1968). This phenomenon of pale-watery muscle may be encountered in the literature as Porcine Stress Syndrome (PSS) or Pale Soft Exudative Pork (PSEP). It is said to be similar in many aspects to Herztod in swine described by Jubb and Kennedey (1963). It is characterized by a rapid glycolysis of the muscle shortly after death, and a rapid postmortem decline in muscle pH while the muscle has a temperature close to that of the body temperature (Briskey, 1964). The palesoft muscle is markedly noticed in the loin and the ham muscles (Wismer-Pedersen, 1968). Presently, most investigators of PSEP agree that this phenomenon is related to environmental stresses just prior to slaughter.

The purpose of this paper is to review the literature concerning the physiopathology of the PSS mainly with regards to hormones, nutrition and environment.

The majority of PSEP cases occur in short, meaty pigs which have well developed hams (Wismer-Pedersen, 1968). It is reported that growth hormone (G.H.) is a factor in efficiency and improved muscling in pigs (Clausen *et al*, 1967). A correlation between the high level of G.H. in blood and PS susceptibility is suspected.

Pigs with high levels of G.H. in blood are reported to have lower meat color scores due to lower pH in the muscle (Clausen *et al*, 1962). It is known that G.H. is capable of activating glycolytic enzymes present in the muscle (Russell *et al*, 1960).

A correlation between the high level of G.H. production and low level of ACTH release has been suggested (Ludvigsen, 1955 and Henry *et al*, 1958). The cytophysiology of this correlation has not been well understood although both hormones are secreted by the pars distalis of the pituitary gland. More detailed study on the pituitary gland should be carried out to shed some light on this obscure point.

Far more important than the effect of G.H. on the PSS is the effect of the low blood level of corticosteroids on the PSS. Generally, it is known that animals with low corticosteroid blood levels are less resistant to environmental stress, and Topel *et al* (1967) have reported that PS susceptible animals have low blood levels of glucocorticoids. The adrenal cortex of animals which develop PSEP have marked accumulation of large, fatty inclusions, especially in the zona reticularis (Cassens *et al*, 1965). These fatty bodies were assumed to be a result of degenerative processes. Work is in progress by investigators in the Department of Animal Science and the Veterinary Medical Research Institute of Iowa State University to clarify the questions arising from the adrenal changes noted in stress susceptible pigs.

It is reported that degenerative processes in the adrenal gland characterized by accumulations of lipid in the zona reticularis of hamsters (Meyers *et al*, 1956) and

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of dogs (Hullinger, 1966, and Hullinger, 1968) are associated with aging. The correlation between high levels of lipid accumulations in the zona reticularis and the sharp decline in pH in the muscles of PS susceptible animals (Howe *et al*, 1969) is noteworthy, but the association of such changes with age-related phenomena are not clear.

Since the corticosteroids are directly involved with PSS, the mineral blood levels have been studied. Henry *et al* (1958) reported a high potassium blood level which was thought due to mobilization of potassium ions from the muscle mass of animals which developed PSEP.

Concerning the thyroid gland it has been stated that this gland plays a minor role in the PSS (Wismer-Pedersen, 1968). However, Briskey *et al* (1968) attributed some significance to the low level of thyroid hormone in the blood of PS susceptible animals; they assumed that this low level, together with low blood corticosteroid level, may be the reason for the lack of stimulation of oxidative metabolic processes in the muscle. Topel *et al* (1966) report no significant increase in the susceptibility to PSEP condition in animals which are fed with goiterogens.

Sink *et al* (1967) reports no significant correlation between the amount of fat depot in the muscle and the PSE muscle.

A high phospholipid level in the myofibrils, sarcoplasmic reticulum and sarcolemma was correlated with the low post mortem pH in the muscle (Krzywickiet *et al*, 1967). Apparently, the p-lipid amount, which effects the physicochemical composition of the muscular membranes has an effect on the metabolic processes of the muscle.

Briskey *et al* (1968) noted that it is acceptable to believe that genetics plays a role in the susceptibility of pigs to the PSEP condition. Certain breeds and strains vary in their resistance to the PSEP condition. This genetic factor is influenced greatly by the nutritional and environmental conditions of the pigs.

Clausen *et al* (1957) reported a higher frequency of PSEP condition among animals fed a high sucrose diet. The diet with low levels of Vitamin E and high

levels of unsaturated fatty acids was reported to increase the incidence of PSEP (Lannek *et al*, 1961). Comparing reports of Lindberg *et al* (1966) and Clausen (1961) it is apparent that a selenium deficient diet could be a cause of PSEP condition. However, most investigators believe that muscular dystrophy due to Vitamin E deficiency and/or selenium is a separate entity, unrelated to the condition of pigs which develop PSS.

Briskey *et al* (1959) mention that fasting in combination with exercise just prior to slaughter results in an increase of the pH and the darkness of the muscle, and also prevents PSS. Additional information on exercise and training of pigs in order to prevent PSS was published in Wismer-Pedersen's review of 1968, in which the author concluded with the following words: ". . . training the pigs during the feeding period might improve the ultimate muscle characteristics but the exercise must be effective."

A report on environmental temperature and its effect on PSS animals was published by Howe *et al* (1969). Their results showed that pigs reared in temperatures of 17° C, 21° C, 32° C and at extreme humidity levels developed susceptibility to PSS and that the adrenal cortex of these pigs showed large accumulations of lipid masses in the zona reticularis.

A great deal of interest has been shown in the problem of PSS because of its economic importance. If we attempt to eliminate this problem, more studies should be carried on dealing with the problem in order to provide us with more information about the following:

1. Exercise, well balanced diet and optimal temperatures and humidity are desirable factors which may prevent PSEP.
2. The genetic factor should be revealed so that the producer could eliminate the problem by selection and breeding processes.
3. Drugs may be used (Hedrick *et al*, 1963). However, these drugs should be safe to the animals and to the consumers; also, these drugs should be effective and convenient for administration.

LITERATURE CITED

1. Briskey, E. J., Bray, R. W., Hoekstra, W. G., Grummer, R. H., and Phillips, P. H.: The effects of various levels of exercise in altering the chemical and physical characteristics of certain pork ham muscles. *J. Ani. Sci.*, 18, 153; 1959.
2. Briskey, E. J.: Etiological status and associated studies of pale, soft, exudative porcine musculature. Mark, M. E., and Stewart, G. F. (eds.). *Advances in Food Research*, Academic Press, New York, 13, 89:184; 1964.
3. Briskey, E. J., and Lister, D.: Influence of stress syndrome on chemical and physical characteristics of muscle post mortem. in, *The Pork Industry: Problems and Progress*, Topel, D. G. (ed.) I.S.U. Press, Ames, Iowa, 178; 1968.
4. Cassens, R. G., Judge, M. D., Sink, J. D., and Briskey, E. J.: Porcine adrenocortical lipids in relation to striated muscle characteristics. *Proc. Soc. Exp. Bio. Med.*, 120, 845; 1965.
5. Clausen, H. *et al.*: Bilag til forsøgslaboratoriets. Copenhagen, 1957.
6. ———: *ibid.*, 1961.
7. Clausen, H., and Nortoft Thomsen, R.: 50. beretning om sammenlignende forsøg med svin fra statsanerkendte avlscentre. 331. beretning fra forsøgslaboratoriet. Copenhagen, 1962.
8. Clausen, H. *et al.*: 55. beretning om sammenlignende forsøg med svin. 360. betæring fra forsøgslaboratoriet. Copenhagen, 1967.
9. Hedrick, H. B., Bailey, M. E., Parrish, F. C., and Naumann, H. D.: Effect of adrenaline stress on pork quality Abstr. Ann. Meeting, Soc. Ani. Sci. 1963.
10. Henry, M., Romani, J. D., and Joubert, L.: La myopathie exudative de pigmentaire du porc. Maladie de l'adaptation. Essai pathogénique et conséquences pratique. *Rev. Pathol. Gen. Physiol. Clin.* 696; 355; 1958.
11. Howe, J. M., Addis, P. B., Howard, R. D., and Judge, M. D.: Environment-induced adrenocortical lipid in "Stress-Susceptible" pigs. *J. Ani. Sci.* 28; 70; 1969.
12. Hullinger, R. L.: M. Sc. Thesis. Iowa State University. p. 52, 1966.
13. Hullinger, R. L.: Ph.D. Thesis. Iowa State University. p. 122, 1968.
14. Jubb, K. V. F., and Kennedy, P. C.: *Pathology of Domestic Animals*. Academic Press. New York and London. vol. 2; p. 421; 1963.
15. Krzywicki, K., and Ratcliff, P. W.: The phospholipids of pork muscle, and their relation to the post-mortem rate of glycolysis. *J. Sci. Food Agr.* 18; 252; 1967.
16. Lannek, N. *et al.*: Production of vitamin E deficiency and muscular dystrophy in pigs. *Res. Vet. Sci.* 2; 65; 1961.
17. Lindeberg, P., and Tanhuanpää, E.: Nutritionellt betingad muskede-generation hos svin. *Proc. 10. Nordic VVet. Congress II.*, 832; 1966.
18. Ludvigsen, J.: Undersøgelser over den såkaldte "muskledeneration" hos svin. 279. og 284. beretning fra forsøgslaboratoriet. Copenhagen, 1967.
19. Myeres, M. W., and Charppier, H. A.: A histological and cytological study of the adrenal gland of golden hamster (*Cricetus auratus*) in relation to age. *Anat. Rec.* 124; 1; 1965.
20. Russell, J. A., and Wilhelmi, A. E.: *Endocrines and Muscles. Structure and Function of Muscle*. Bourne, G. H. (ed.). Academic Press, Vol. 2; 1960.
21. Sink, J. D. *et al.*: Lipid composition of normal and pale, soft, exudative muscle. *J. Food Sci.* 32; 258; 1967.
22. Topel, D. G., and Merkel, R. A.: Effect of exogenous goiterogens upon some physical and biochemical properties of porcine muscle and adrenal gland. *J. Ani. Sci.* 25; 1154; 1966.
23. Topel, D. G., Merkel, R. A. and Wismer-Pedersen, J.: Relationship of plasma 17-hydroxycorticosteroid levels to some physical and biochemical properties of porcine muscle. *J. Ani. Sci.* 14; 7; 1967.
24. Topel, D. G., Bicknell, E. G., Preston, K. S., Christian, L. L., Mutsushima, C. Y.: Porcine Stress Syndrome. *Modern Vet. Practice.* 49; 40; 1968.
25. Wismer-Pedersen, J.: Modern production practices and their influence on stress condition. In, *The Pork Industry: Problems and Progress*. Topel, D. G. (ed.). I.S.U. Press. Ames, Iowa. p. 163; 1968.

The Differential Diagnosis of Three Common Swine Problems

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Swine exhibiting nervous disorders or a weak, incoordinated posterior gait can often present a problem in diagnosis. This review will be based mainly on clinical signs and post-mortem lesions in the differential diagnosis of organic arsenic toxicity, water deprivation syndrome, and edema disease. Several conditions may

give similar clinical symptoms but these three may give the most problem in differential diagnosis.

ORGANIC ARSENICAL TOXICITY

Organic arsenicals are used mainly in swine as feed additives, treatment for vibriotic dysentery, other enteritis conditions and blood parasite problems. The two main forms that are used are

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