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Pig welfare

Quantifying pigs' welfare during transport using physiological measures

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Introduction

The welfare of an animal is its state as regards its attempts to cope with its environment (Broom, 1986). Hence the animal's welfare includes its health, its feelings, the extent to which coping attempts are succeeding and the amount which has to be done in order to cope. Welfare varies from very good to very poor and it can be measured. The concept and the ways in which it can be measured are discussed in detail by Broom and Johnson (1993). Some scientific studies of animal welfare involve assessing the preferences of the animal; others indicate how poor the welfare is, for example by assessing the extent of abnormalities of behaviour or physiology, the presence of injuries, or the degree of clinical signs of disease (Table 1, Table 2).

The measures described in Table 1 and Table 2 refer to long-term and short-term welfare problems. When assessing the welfare of animals it is important to use a wide range of welfare measures, including physiological, behavioural and meat quality measures. The different kinds of measures must be considered together because animals vary in the methods which they use to try to cope with adversity and in the effects which adverse conditions have on them.

The major aspects of transport which affect the welfare of pigs are loading and unloading procedures, including the effects of close proximity to humans, vehicle conditions, the way that the vehicle is driven, what happens during stops, and the duration of the journey. The response of the pig to these different aspects will depend on the genetically controlled adaptability of the pig, the physical condition of the pig and its previous experience. Our modern breeds of pig have been selected for large muscle blocks, fast growth and efficient feed conversion and nutrient partitioning. When the wild boar was compared with modern breeds of pig, the modern German Landrace was found to have muscles with a greater distance from the centre to the nearest blood vessel, more anaerobic fibres, and also a relatively smaller heart (Dämmrich, 1987). The least well adapted pigs for the stresses of transport are those which are extreme in these effects, for example those with the halothane positive gene, but all pigs have serious problems during transport which are generally reflected in some impairment of meat quality. It may well be that the meat quality of all pigs which are transported is worse than it would be if no transport occurred. Part

Table 1. Measures of poor welfare.

Reduced life-expectancy
Reduced ability to grow or breed
Body damage
Disease
Immunosuppression
Physiological attempts to cope
Behavioural attempts to cope
Behaviour pathology
Self narcotization
Extent of behavioural aversion shown
Extent of suppression of normal behaviour
Extent to which normal physiological processes and anatomical development are prevented

From Broom and Johnson, 1993.

Table 2. Measures of good welfare.

Variety of normal behaviours shown
Extent to which strongly preferred behaviours can be shown
Physiological indicators of pleasure
Behavioural indicators of pleasure

From Broom and Johnson, 1993.

The following paper was presented at a meeting related to an EC–AIR project on the heading, transport and lairage of slaughter pigs. The full proceedings of this meeting are now available for sale (see page 442 for information).

of the solution to this welfare and economic problem is to take account of what the pig will have to put up with during transport when developing genetic strains: pigs with smaller muscle blocks and a reduced risk from high levels of exercise and from stress could be selected.

The fact that pigs which are in poor physical condition, and pigs which have no previous experience of stimuli encountered during transport, are more likely to be adversely affected by transport should be taken into account by farmers and pig transporters. No animal which is in poor condition should be transported in the normal way. Animals which are weakened but not seriously ill or injured should be provided with better conditions than those needed by the average pig; for example, they should be given more space, deep bedding and especially considerate driving. Animals which have a broken bone or which are not able to stand and walk easily using all four legs should not be transported at all. Pigs are often frightened by human proximity or actions during loading and unloading. With careful, considerate behaviour on the part of human handlers, such adverse effects on pig welfare can be minimised. However, it has been shown (Hemsworth *et al.*, 1986) that a small amount of early handling, preferably gentle handling, can make pigs much easier to handle later in life. Indeed it may well be economically worthwhile, as well as better for pig welfare, if all pigs are accustomed to human handling and presence when young.

The physiological measures

Whenever physiological measurement is to be interpreted, it is important to ascertain the basal level for that measure and how it fluctuates over time. For example, plasma cortisol levels in pigs vary during the day and tend to be higher during the morning than during the afternoon. A decision must be taken for each measure concerning whether the information required is the difference from baseline or the absolute value. For small effects, e.g. a 10% increase in heart rate, the difference from baseline is the key value to use. For large effects where the response reaches the maximal possible level, for example plasma cortisol in very frightening circumstances, the absolute value should be used. In order to explain this, consider a pig severely frightened during the morning and showing an increase from a rather high baseline of 160 nmol l^{-1} but in the afternoon showing the same maximal response which is 200 nmol l^{-1} above the lower afternoon baseline. It is the actual value which is important here rather than a difference whose variation depends on baseline fluctuations.

Heart rate

Animals change their heart rate in response to changes in metabolic rate, but they also increase or decrease heart rate in preparation for an action which they predict as being necessary in the near future. It is the psychological preparation response which is of interest when assessing welfare, rather than the changes which merely reflect activity levels. A method of assessing heart rate responses to imposed treatments taking account of ongoing activity, is described for sheep by Baldock and Sibly (1990). Heart rate gives valuable information about the perception of loading and handling situations by pigs. Pigs which are prodded with rods, shouted at or driven up steep ramps show different heart rate increases according to what they perceive as the severity of the situation. The simplest recording system which is suitable for use in the assessment of pig welfare during transport is the Polar Sport Tester, originally designed for human athletes to monitor their own heart rates. The heart rate trace can be plotted and stored on a computer and then related to descriptions of behaviour, perhaps obtained from video-recording. In addition to monitoring pigs during loading or unloading, the heart rate record can be related to information recorded about events during a journey on a vehicle. Sudden movements or temporary increases in ambient temperature can be associated temporally with changes in heart rate.

Breathing rate, muscle tremor, foaming at the mouth

Direct observation of animals without any attachment of recording instruments or sampling of body fluids can provide information about physiological processes. Breathing rate can be observed directly or from good quality video recordings. The metabolic rate and level of muscular activity are major determinants of breathing rate, but an individual pig which is disturbed by events in its environment may suddenly start to breathe fast. Muscle tremor can be directly observed and is sometimes associated with fear. Foaming at the mouth can have a variety of causes, so care is needed in interpreting the observations, but its occurrence may provide some information about welfare.

Body temperature

Animals which have substantial adrenal cortex responses during handling and transport show increased body temperature (Trunkfield *et al.*, 1991). The increase is usually of the order of 1°C, but the actual value at the end of a journey will depend upon the extent to which any adaptation of the initial response has occurred. Hence, if the temperature of pig blood at the time of slaughter is measured, it is essential that the details of the journey are considered when interpreting the result. The body temperature can be

recorded during a journey with implanted or superficially attached temperature monitors linked directly or telemetrically to a data storage system.

Lysine vasopressin

In humans, vasopressin increases in the blood when the individual reports a feeling of nausea associated with motion sickness. Pigs also show motion sickness, retching and ejecting gut contents, especially when travelling along windy roads. These physical signs of motion sickness occur at the same time as increases in the levels of lysine vasopressin in the blood.

Oxytocin

This hormone increases in difficult conditions in rats but it is not clear at present that its measurement is useful in this respect in pigs.

Beta-endorphin

The release of corticotrophin releasing factor in the hypothalamus is followed by release of pro-opiomelanocortin in the anterior pituitary which quickly breaks down into components, namely adrenocorticotrophic hormone (ACTH) which travels in the blood to the adrenal cortex, and beta-endorphin. A rise in plasma beta-endorphin often accompanies ACTH increases in plasma but it is not yet clear what its function is. Although beta-endorphin can have analgesic effects via mu-receptors in the brain, this peptide hormone is also involved in the regulation of various reproductive hormones. Measurement of beta-endorphin levels in blood is useful in anticipation of our learning how to interpret such changes, or as a back up for ACTH or cortisol measurement.

Enzymes in blood

Creatine kinase is released into the blood when there is muscle damage, e.g. bruising, and when there is vigorous exercise. It is clear that some kinds of damage which affect welfare result in creatine kinase release, so it can be used in conjunction with other indicators as a welfare measure. Lactate dehydrogenase (LDH) also increases in the blood after muscle tissue damage but increases can occur in animals whose muscles are not damaged. Deer which are very frightened by capture show large LDH increases (Jones and Price, 1990). The isomer of LDH which occurs in striated muscle (LDH5) leaks into the blood when animals are very disturbed so the ratio of LDH5 to total LDH is of particular interest.

Water and food depletion measures

When pigs are transported they will be deprived of water to some extent. On long journeys they will have been unable to drink for many times longer than the normal interval between drinking bouts. This lack of control over interactions with the environment may be disturbing to the pigs and there are also likely to be physiological consequences. The most obvious and straightforward way to assess this is to measure the osmolality of the blood. When food reserves are used up there are various changes evident in the metabolites present in the blood. Several of these, for example beta-hydroxybutyrate, can be measured and indicate the extent to which the food reserve depletion is serious for the animal. Another measure which gives information about the significance for the animal of food deprivation is the delay since the last meal. Pigs are accustomed to feeding at regular times, and if feeding is prevented, especially when high rates of metabolism occur during journeys, the animals will be disturbed by this.

Blood cell measures

The haematocrit, a count of red blood cells, is altered when pigs are transported. If pigs encounter a problem, such as those which may occur when they are handled or transported, there can be a release of blood cells from the spleen resulting in a higher cell count. More prolonged problems, however, are likely to result in reduced cell counts.

The ability of the pig to react effectively to antigen challenge will depend upon the numbers of lymphocytes and the activity and efficiency of these lymphocytes. Measures of the ratios of white blood cells, for example the heterophil ratio, are affected by a variety of factors, but some kinds of restraint seem to affect the ratio consistently so they can give some information about welfare. Studies of T-cell activity, e.g. *in vitro* mitogen-stimulated cell proliferation, give information about the extent of immunosuppression resulting from the particular treatment. If the immune system is working less well because of a treatment, the animal is coping less well with its environment and the welfare is poorer than in an animal which is not immunosuppressed.

Glucocorticoid measures

One of the most widely used measures of pig welfare during transport is the level of glucocorticoids in the plasma. Glucocorticoid levels can increase during courtship and mating but there will be no confusion with this during transport. In most cases it is cortisol which is measured, but pigs produce as much as 30% of their glucocorticoid as corticosterone so this should also be measured. Glucocorticoid can be measured in saliva and urine as well as in plasma, and the collection of saliva and urine can sometimes be much less disturbing to the pigs than the collection of plasma samples.

In the plasma, most cortisol is bound to protein but it is the free cortisol which acts in the body. Hormones such as testosterone and cortisol can enter the saliva by diffusion in salivary gland cells. The rate of diffusion is high enough to

maintain an equilibrium between the free cortisol in plasma and in saliva. The level is ten or more times lower in saliva, but stimuli which cause plasma cortisol increases also cause comparable salivary cortisol increases in humans (Riad-Fahmy *et al.*, 1982), sheep (Fell *et al.*, 1985), pigs (Parrott *et al.*, 1989) and some other species. The injection of pilocarpine and sucking of citric acid crystals, which stimulate salivation, have no effect on the salivary cortisol concentration. However any rise in salivary cortisol levels following some stimulus is delayed a few minutes as compared with the comparable rise in plasma cortisol concentration. In recent studies using sows and young pigs (Mendl, Broom and Parrott, in preparation) plasma free cortisol and salivary cortisol varied in a similar way when a large change in level occurred, but fluctuated more when low level changes were occurring.

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