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The Effects of Road Transportation and Lairage Treatment on Pig Muscle.

Introduction

When animals are exposed to stress, there is a release of hormones from the adrenal gland, which is similar irrespective of the nature of the stressor. This response has been defined as the "general adaptation syndrome" (Selye, 1950).

Lawrie (1966) listed the nature of the stressors which are capable of causing disturbance of muscle metabolism. These are activity, temperature, humidity, atmospheric pressure, oxygen tension, nutrition, pathology, drugs, radiation, electric shock, and emotional excitement such as fear and rage. Of the meat animals the pig is particularly susceptible to stress with the subsequent development of carbohydrate imbalance.

From the farm until slaughter the pig can be subjected to most of the described effects. The stress during transport and the holding period prior to killing on post mortem glycolysis has been examined by Callow (1935, 1936, 1937, 1938), Gibbons & Rose (1950), Howard & Lawrie (1956), Briskey et. al. (1959), Wismer-Pedersen (1959), Saffle & Cole (1960), Lewis et al. (1961), Hall et al. (1961), Patterson & Carson (1962), Forrest et al. (1965), Scheper

(1965), Briskey (1966), Vrchlabský (1967), and Cole, Ramsey & Saffle (1967).

In this paper the effects of stress caused by road transportation were examined. Factory lairage conditions were included to determine the conditions conducive to recovery from stress. The effect of stress on meat quality was estimated by pH, colour, and expressible fluid values.

Experimental

Methods and material. In this study Landrace and Large White pigs, liveweight of ca. 200 lbs (75 kg), were used.

The pH of the psoas major and longissimus dorsi at the 12 - 14th thoracic vertebra was measured 20 - 24 hr post mortem with a combined glass/calomel electrode and a portable pH meter (Analytical Measurements, England).

Colour of both muscles was determined (24 hr post mortem) with an Optica CF4R reflectance spectrophotometer, using a 15 mm thick muscle sample (Elliott, 1967). The results were expressed as brightness, "Y", by C.I.E. calculations (Elliott, 1968).

Expressible fluid was determined on a sample adjacent to that taken for colour analysis; 2,5 g of muscle were subjected to a pressure of 500 lb/in^2 for 10min. The volume expressed is reported as a percentage of the muscle volume (Elliott, to be published).

Expt. 1. The effect of transport distance. Pigs from the same farm, fed the evening before collection, were transported on a lorry which had a capacity for 40 - 42 pigs. Three loads of pigs were transported directly from farm to factory A, a distance of 20 miles (32 km). A further three loads of pigs were transported from the same farm by a route of 100 miles (161 km) to the same factory.

On arrival at the factory each load of 40 pigs was divided into 4 groups of 10. Group a pigs were killed on arrival,

group b rested 2 hrs without food, group c held overnight, no food, and group d held overnight, fed 2 lbs sugar. Water was available to all groups.

Expt. 2. The effect of type of transport. In this experiment muscle quality was judged by l.dorsi pH values alone. All pigs were delivered from farms within 30 miles to a central collection unit, factory B. The effects of three types of lorry for long distance transportation of these pigs (100 miles/161 km) to factory C were examined.

Short lorry: Two loads each of 40 pigs were slaughtered after being held in the lairage for 2 hr without food.

Long lorry: One load of 80 pigs were slaughtered after being held overnight in the lairage without food.

Double decker lorry: This experiment was divided into 3 parts:

(a) One load of pigs, 40 on each deck, were slaughtered after being held in the lairage for 2 hr without food.

(b) As for (a), except that the pigs were held overnight without food before slaughter.

(c) 40 pigs from the same source as those used in Expt. 1 were transported to factory B, mixed with another 40 pigs and then delivered to factory C. This load was divided into 4 groups of 10 for lairage treatments as described in Expt. 1.

Results

The effect of transport distance. The ultimate pH means and standard deviations of the l. dorsi and p. major muscles are summarized in Fig. 1. There were only small differences between distances or lairage treatments.

Colour brightness measurements are shown in Fig. 2. Differences were found between the short and long distance groups when slaughtered on arrival at the factory or after

resting for 2 hr; this was evident in both the l. dorsi and p. major. The l. dorsi was paler in the short journey pigs, whilst the p. major was darker. By holding the pigs overnight with or without sugar feeding, the colour of both muscles darkened and the effects of transport distance were reduced.

Expressible fluid measurements of the l. dorsi are shown in Fig. 3. There was little effect due to lairage conditions. The long distance pigs, with the exception of the overnight sugar-fed group, had slightly lower expressible fluid values when compared with the short journey pigs.

The effect of type of transport. The effect of lorry type on the pH of the l. dorsi is shown in Fig. 4. For comparison, the data on pigs transported 100 miles to factory A (Expt. 1) in a short lorry are included. There was little difference between these and the pigs transported in the same lorry a similar distance to factory C. The mean pHu and standard deviation were much higher in pigs transported by the doubledecker lorry. There was no effect of the two lairage treatments (i.e. held 2 hr and held overnight before slaughter) on the pH means of the l. dorsi of these pigs. There was no difference in l. dorsi pH_u of pigs between the top and bottom decks. The long lorry pigs had pH values intermediate between the short and double-decker lorry pigs.

The pH_u values of the l. dorsi and p. major of the pigs carried by the double-decker lorry from the same farm as used in Expt. 1, through factory B to factory C, are shown in Fig 5. Both muscles of the pigs killed on arrival at the factory had the highest pH and standard deviations. There was little difference between the other lairage treatments.

The pH values were much higher for both muscles in this experiment than for pigs transported a similar distance in a short lorry to factory A (cf. Fig. 1). However, the

values in treatments (b) and (c) were lower than those found in similar treatments of the other double-decker pigs (see Fig. 4). The only difference between these experiments is that the former were from one farm, whilst the latter were from many farms.

Discussion

Transport distance. Under the controlled conditions in Expt. 1 it has been shown that journeys of up to 100 miles (161 km) did not contribute significantly to stress. Of the three parameters examined, colour would appear to be the most sensitive indicator. A direct relationship between visual colour scores and transport stress has been reported by Scheper (1965).

In most investigations on the effects of distance, ultimate pH differences have been small, less than 0,2 units (Callow, 1938; Wismer-Pedersen, 1959; Scheper, 1965; Vrchlabský, 1967). Larger differences, 0,4 units were found by Cole et al. (1967) between 15 and 400 miles (24-640 km). Some of this data is difficult to interpret, since different forms (road and rail) and types (size and construction) of transport have been used. Control groups of pigs (zero miles) are not valid, unless they have been held in a lorry similar to the test groups and subjected to the same loading and unloading procedures.

It appears that distance alone will not contribute to stress, but other factors associated with the journey will determine the overall stress.

Type of transport. Callow (1938) reported that with pigs transported the same distance (40 ml/65 km) by road and rail, the former raised the p. major pH_u, whereas the latter did not. Jorgensen (1963) has described an improved lorry design and examined the nature of the stressors which can be introduced during the journey. The use of halters was advocated, when pigs from different farms were

mixed. Visual colour scores were darker when these were used.

Our results showed that severe stress occurred when pigs were transferred to a second lorry. This stress may be attributed to the type of lorry or differences in factory procedure. The pH_u values of pigs delivered by the short lorry from factory B to C indicated that additional stress did not occur during transfer at factory B. Pigs treated in the same way from farm to slaughter gave similar results, whether slaughtered at factory A or C. Of the other two types of lorry examined, the double-decker consistently produced the highest pH_u values. It was considered that this might be attributed to the loading and unloading of these lorries. Observation of these operations indicated that the top deck pigs would be more stressed than the bottom deck. We have found that this was not the case. The similarity between decks would also indicate that ventilation was not a stressor during transport.

These results have indicated that certain types of lorries cause excessive stress to pigs. It appears likely that this may be due to herd mixing and loading procedures (Jorgensen, 1963). Further unpublished work on double-decker lorries has produced high pH_u values after 20 mile (32 km) journeys.

Factory lairage treatment. The resting and feeding of pigs prior to slaughter has been the subject of much investigation. The interpretation of these results requires careful consideration of what can occur during this period. If the pig is not stressed on arrival at the factory, resting or feeding will not improve the meat quality, indeed the contrary may occur. The pig may become excited under these conditions and at time of death have mobilised its glycogen reserve and have a high muscle lactate content, resulting in pale, soft, exudati-

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ve muscle (Briskey, 1966). If the pig arrives in a stressed condition, rest and carbohydrate will alleviate the effect. A pig with a depleted glycogen store recovers only slowly from stress on resting (Callow, 1938; Gibbons & Rose, 1950). The feeding of sugar can reduce the recovery period to about 6 hours (Rose & Peterson, 1951; Wismer-Pedersen, 1959).

In the absence of detectable stress, no significant changes occurred within the 4 lairage treatments. Where stress was present, even short rest periods were beneficial. With the overnight resting treatments, the feeding of 2 lb sugar per pig did not significantly improve the amount of recovery. Although both overnight treatments reduced the mean pH_u and standard deviations of the groups, many of the muscles still had a pH above 6.2.

The overall results indicate that a pig can be easily stressed, but requires a long recovery period. When pigs are transported in large groups of mixed herds, a rest period of at least 2 hr will result in improved meat quality.

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