EVALUATION OF MEAT QUALITY IN COMMERCIAL PIGS IN NEW ZEALAND

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This thesis is dedicated to my beloved father (Atty Sergio Brillantes Gelera) and to my late loving mother (Mrs. Anita Gallano Gelera)

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by

Simone G. Gelera

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ABSTRACT

Evaluation was undertaken of 144 carcasses at two abattoirs in the Manawatu region (New Zealand) to study pork quality characteristics. Surveys were made of farmers, transporters and abattoirs on how they handle the pigs before slaughter. Measurements were made of pH_1, pH_u, colour (visual and Hunter LAB), water holding capacity (WHC) by filter paper press, drip loss and protein solubility of the *Semitendinosus* and *Longissimus dorsi* muscles.

The pH_1 was measured at 45 minutes. After 24 hours storage in the chiller, the pH_{24} and WHC were measured and after 30 minutes bloom, the colour measurements (Hunter L A B) and visual colour scores (0 = DFD, 1 = MDFD, 2 = normal, 3 = MPSE, 4 = PSE) were made. The protein solubility was measured within 48 hours postmortem and the drip loss was measured after 48 hours. The carcasses were subjectively classified as DFD (dark, firm, dry), MDFD (mild DFD), normal, MPSE (mild PSE) and PSE (pale, soft, exudative). Sex, breed, age, transport time, distance, last feeding time, weather condition, bruises and laceration/scratches, and stunning time were also recorded.

The total incidence of **PSEo** was *41.98 %* in the **ST** and *72.41 %* in the **LD**, and the **DFDo** incidence was *10.65 %* in the **LD** and *36.05 %* in the **ST**. Almost all the meat quality traits were highly correlated (r = *0.35* to *0.92*) and highly significant ($p < 0.001$) with each other in both muscles used. *pH* (pH_1 and pH_{24}) was the most dependable technique used in this study. There is no obvious relationship between occurrence of pork quality problem in the pigs and the lairage period or transport distance. However, sex had low but significant correlations with pH_1 suggesting a possible advantage in treating sexes differently after they leave the farm.

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Chapter I

INTRODUCTION

The New Zealand Pork Industry Board is in the process of improving the visual and eating quality of pork as a consequence of numerous consumer complaints relating to the extreme variability of pork currently available in the butchery and food stores.

The demand for lean pork has increased slightly in New Zealand in recent years (Anon., 1993). The intensive production of pigs in New Zealand has rapidly moved towards the use of modern intensive fattening units. With this intensification of production, pork quality problems have emerged, especially those attributable to breeds (Pietrain and Landrace). These breeds tend to be more stress susceptible leading to a high incidence of pale, soft, exudative pig meat (MacDougall and Jones, 1975; Evan et al., 1978; Oliver et al., 1991). The occurrence of muscles with PSE (pale, soft and exudative) and DFD (dark, firm and dry) characteristics are undesirable since both give rise to meat of lower quality. PSE and DFD meat are the most important quality defects in pork (Briskey and Wismer-Pedersen, 1961). PSE meat has a pale colour, soft consistency, low initial pH (pH_{45}) less water holding capacity (WHC) and more drip loss. On the other hand, DFD meat has a darker colour, higher ultimate pH (pH), higher WHC and less drip loss than normal meat. Several studies have been performed to find out the causes of these defects (Briskey, 1964; Bendall and Lawrie, 1964; Dildey *et al.*, 1970; Asghar and Pearson, 1980; Honikel and

Kim, 1985 & 1986). Pigs carrying the halothane-gene are generally prone to stress, which may result in a higher incidence of PSE and thus lower meat quality than pigs without this gene (Lundstrom *et al.*, 1989, Archibald, 1991). These genes are genetically conditioned and activated by stress factors associated with the transport and slaughtering procedure (Wismer-Pedersen and Hamm, 1960; Barton-Gade, 1974 & 1979; Fortin, 1974), which leads to abnormal biochemical metabolism in the musculature (Briskey and Wismer-Pedersen, 1961a; Topel *et al.*, 1966; Bendall, 1973; Cassen *et al.*, 1975; Cassens, 1977). The handling of the animals prior to slaughter, as well as too short a resting period at the lairage within the abattoir also influences the development of both PSE and DFD as reviewed by Warris (1987). The incidence of (PSE and DFD) meat in commercial carcasses was recently estimated as high as 70% within the New Zealand industry (Confidential record, Massey University).

In Switzerland, the incidence of PSE is now 4 - 6 % of all pigs slaughtered at registered meat killing facilities (private comm., Dr. Patrick Morrel). Ten years ago the PSE incidence in Switzerland was 20 - 30 %. This reduction in PSe has been achieved by systematic screening and elimination of breeding animals known to carry the genes responsible for PSS and PSE. The Swiss pork industry is now in the enviable position of having less than 6% of slaughtered pigs with PSE meat.

Likewise in Australia, the average incidence of PSE and DFD was 32% and 15%, respectively; this varies from 5 to 65% for PSE and 0 to 45% for DFD (Trout *et al.*, 1991). The Australians are now trying to improve their pork quality by eliminating animals known to bear the genes that makes them susceptible to

stress and also improving their pre-slaughter handling techniques..

PSE development is usually attributed to increased glycolysis rate post-mortem (Briskey and Wismer-Pedersen, 1961). In DFD muscles, the muscle glycogen is already depleted before slaughter (Bendall and Swatland, 1988). This gives less glycogen for the post-mortem glycolysis and the ultimate pH becomes higher than normal (Lawrie, 1991). When PSE develops in a muscle, pH drops to values lower than 5.8 at 45 min post-mortem (Briskey, 1964). Normal muscle in pH decreases from approximately 7 (living muscles) to values between 5.3 and 5.8 after 24 hours post-mortem (Wismer-Pedersen, 1959; Briskey and Wismer-Pedersen, 1961). High carcass temperatures (≥ 35 C) in muscles (particularly in PSE), combined with a low pH values (pH 6.0 or less) in the first hour post-mortem, causes the muscle protein to denature (Wismer-Pedersen, 1959; Penney, 1967; Honikel and Kim, 1986; Offer, 1991). This contributes to the pale colour in PSE muscle (Wismer-Pedersen and Briskey, 1961; Martin et al., 1980; Honikel and Kim, 1986) and also reduces the water holding capacity of the muscles (Wismer-Pedersen, 1959; Offer *et al.*, 1988). Offer (1991) claimed that denaturation of sarcoplasmic proteins in the PSE muscle had a major influence on the increased paleness, while denaturation of the myofibrillar proteins was responsible for the decrease in water holding capacity.

If pigs are exposed to stress prior to slaughter there may be an increased metabolic activity in the muscles (Bendall, 1973; Lister *et al.*, 1981). It is therefore widely accepted that both the rate and the extent of glycolysis of pork muscles after slaughter has a serious effect on pork quality.

Whereas much of the early research on pork quality clearly showed that normal pigs could produce PSE pork (Briskey, 1964; Honikel and Kim, 1986), normal pigs appear to produce far less PSE pork than PSS pigs. The PSE produced from normal (halothane-negative) pigs (i.e., Landrace breed) may have an exceptionally high drip loss (Eikelenboom & Nanni Costa, 1988).

In addition, PSE and DFD pork were recognized as major determinants of fresh pork consumption and in the economics of the manufacture of processed pork products (Hutchings, 1977).

1.1 Goals and Objectives

The goals of this research were; *firstly* to assess pork quality in two abattoir (Longburn and Levin) located in North Island (New Zealand). *Secondly* to evaluate the incidence of PSE and DFD, and to find out whether values for these conditions could be established for the normal population. *Thirdly*, to establish whether any of the following pre-slaughter factors affected the incidence of either PSE or DFD: sex, carcass weight, breed, transport time, distance of travel, time in lairage and time of year. To achieve these goals, a questionnaire was sent to the farmers, transporters and abattoir management and the meat quality traits (pH_1, pH , WHC, drip loss, colour, and protein solubility) were evaluated.

The *final* objective of this study was to established whether there were differences in:

a) the rate of pH fall 45 minutes after slaughter;

b) the final pH after 24 hours post-mortem;

c) water holding capacity (after 24 hours post-mortem);

d) drip loss (after 48 hours post mortem);

e) visual scores (wetness, colour and texture);

f) colourquest hunter L A B values (after 24 hours post mortem);

g) protein solubility (within 48 hours post mortem); and

h) PSE and DFD between Semitendinosus (ST) and Longissimus dorsi (LD) muscles.