Effects of pre-slaughter handling and post-slaughter treatment on meat quality in Korean pork processing industry

Kyung Hyun Bae[1], Kyung hwan Kim[1], Kyung Sun Lee[1], Kyung Ok Lee[1], Gill Boo Jin[1] and Seong Gu Hwang[2]
[1]Dodram Pig Farmer's Co-operative / Korea institute of planning & Evaluation for Technology in Food, Agriculture, Forestry & Fisheries, [2]Hankyong National University

Abstract - **The present study was undertaken to find out current problems causing deterioration of pork quality with special emphasis on process before and after slaughter in Korea. It is evident that production and slaughter factors can be used to control technological quality traits. However, most of the present study is based on investigation into a pre-slaughter handling and slaughter procedures causing much drip loss. 40 pig farms and 20 slaughtering houses were chosen and loading, transportation, unloading, stunning and chilling condition were checked. Drip loss, cooking loss, water holding capacity and pH were also measured in each condition. In general, 12–15 h pre-slaughter fasting is a common practice to reduce the risk of microbial cross contamination during slaughter but most of the pigs were not fasted before slaughter in Korea. Two types of trucks are used; single and double decker trucks. The respective capacities are 44 pigs in the single decker truck and 65 pigs in the double decker truck. The average live weight was informed to be 111kg ranging from 85 ~125kg. Unnecessary force and disturbances were observed in driving pigs out of the pens to the driveway and in the driveway. This goes for usage of electric pipes, shovels and electrical pipes. The transportation time from farm to slaughterhouse varies from ½ hour to 4 hours. The two most widely used stunning methods are carbon dioxide (CO2) and electrical stunning in pigs but there were no slaughtering house which introduced carbon dioxide stunning method in our study. Time measurements of the slaughter line showed that the total retention time from sticking to entrance of the chilling room takes approx. 28 minutes, which is shorter than in a Danish slaughter process. Due to facts that the pig handling before the killing is not optimal, the stress level of the pigs at slaughter house is substantial and limits the possibility for a high meat quality level. Further on the process it becomes difficult to repair poor meat quality, but a quick chilling process may to some extent reduce the undesirable pre-handling caused drip loss. The heat extraction from pig carcass chilled from hot carcass temperature to 1.5°C cutting temperature. Out of total 10,250kj of heat extraction, 4,500kj equal to 44% of this heat extraction is caused by evaporation from the carcass surface in the chilling process. The carcass chilling in the present blast chilling process is a very slow process and must be improved to achieve optimal meat quality and chilling weight loss. The present air velocity is fine according to the test, but it is important that the air temperature starts at the lowest level and stays low until the carcass surface has attained the temperature below the freezing point. The efficiency of the blast chilling tunnel evaporators was too poor. This indicates that either the total surface is too small or the heat transfer coefficient is too small due to frost on the surface of the evaporator which limits the performance. In summary, any process before or after slaughter that increase speed of the pH decline increase drip loss and decrease muscle temperature decrease drip loss.**

Index Terms— **meat quality, drip loss, pre-slaughter handling, fasting, chilling process, pork**

I. INTRODUCTION

Pork quality covers inherent properties decisive for the suitability of the meat for further processing and storage including retail display. The main attributes of interest are water-holding capacity, color, fat content and composition, oxidative stability and uniformity. Technological quality is a complex and multivariate property of the meat, which is influenced by multiple interacting factors. These include breed, genotype, feed and feeding, pre-slaughter handling, stunning, chilling and storage conditions (Rosenvold et al., 2003). The eating quality of meat is still the most important factor for the consumers in relation to re-buying meat products. The single eating quality attributes of interest are appearance for color, fluid retaining characteristics and fat content of meat and flavor depending on constituents in the fresh meat, e.g., fat composition, peptides, glycogen concentration, vitamin content, especially thiamine and vitamin E, etc., and the heat treatment of the product. Tenderness and juiciness are associated with the amount of moisture present in the cooked product and the amount of intramuscular fat.

It is known that transport of pigs may influence final pork quality. Thus, 8 h of transport compared to 0.5 h has been found to improve tenderness due to reduced glycolytic potential at the time of slaughter and subsequent higher ultimate pH (Leheska et al., 2003). In addition, van der Wal et al. (1997) found that 3 to 4 h resting period before slaughter was optimal with respect to pork quality.

Chilling rate has been found to influence tenderness development in meat and both too rapid and too slow chilling rates results in inferior tenderness development. However, moderate chilling rates, which slow down postmortem process and hereby minimize muscle contraction, have been developed and implemented as a control tool in the production of beef and lamb meat in many countries. In the present study, we investigated the factors causing drip loss and lowering pork quality from the loading process of pigs to the postmortem chilling system by checking the present condition of pig farms and slaughter house in Korea

II. MATERIALS AND METHODS

40 pig farms and 20 slaughtering house were chosen. Loading, transportation, unloading, stunning, chilling conditions were checked. Drip loss, cooking loss, water holding capacity and pH were measured by using the sample from each condition.

III. RESULTS AND DISCUSSION

Two types of trucks are used; single and double decker trucks. The respective capacities are 44 pigs on the single decker truck and 65 pigs on the double decker truck.

The average live weight was informed to be 111 kg and the maximum weight is 125 kg and the minimum weight to be 86 kg.

The openings in the sides for ventilation are too low – pigs do not like to look to the surroundings. The height from the floor to ceiling when loaded with pigs is very small, the backs of the pigs is very close to the angle bars in the ceiling.

The transportation time from farm to slaughterhouse varies from ½ hour to 4 hours. The flooring in the trucks is made of steel and in some with aluminium in a non-slippery pattern. Saw dust was not used as spread on the decks. Steel flooring when wet is slippery and does not absorb shocks and does not provide insulation against noise from the hooves. Bleedings in the hip joint was observed at the cutting plant, which could occur from leg spreading.

Pigs do not like edges, steps and shadows which would not imply the pigs to move forwards, but instead make them to stop.

Some of the trucks do not have any siding to the surroundings. It is recommendable to close the lower part of the individual decks because pigs do not like movement to the sides that disturbs them. The pigs coming out from the barn to the runway (when loading to the trucks) walks towards an open fencing, which pigs considers that they can pass and they don't understand that they should turn to the left.

The fencing should be closed and the runway should be approx. 1.5 meter wide. With closed fencing the pigs don't get disturbed of what is happening outside the fencing. The ramp was made of shattered steel plate, which makes noise when pigs walk on it which pigs do not like and the same situation was observed when entering to the truck.

In winter time, very early in the morning when loading pigs to trucks, the outside light conditions were insufficient. The light towards the truck must be brighter than the present condition. It was recommended to install some lights that can make the pigs movement easier.

A lot of squealing from the pigs in the lairage was observed and the pigs are not resting. They were standing up or fighting. There could be many reasons for this, for example, stressed handling when driving towards the electrical stunner and when unloading, high squealing from ungentle handling and unnecessary use of electrical prodder when driving the pigs to the pen strings or towards the electrical stunner, insufficient light conditions towards the electrical stunner, the continuous misting of the pigs and thereby reducing the body temperature too much, inappropriate design with 50-60 pigs in a group and no easy access for the operators to the pen strings which led to long time starvation, which might contribute to a reduction of the meat quality.

The drainage in the floor was positioned in each end of the pen strings. Therefore urine has a long way to flow before it reaches the drain. Urine burnings has been observed all over the skin surface. A better design is to place the drains along one side in each pen string.

Unnecessary force and disturbance used to be observed when driving pigs out of the pens to the driveway and in the driveway. This goes for usage of electric pipes, shovels and electrical prodders. Operators are not to be blamed but they instead need the right tool box such as a right system and education.

It is known that pigs should not be fed immediately prior to transport, because pigs with full guts show higher mortality during transport (Warriss et al., 1994). So, 12–15 h pre-slaughter fasting is common practice to

reduce the risk of microbial cross contamination during slaughter but most of the pigs were not fasted before slaughter in Korea. Fasting for 24 h has been investigated as a way of reducing muscle glycogen stores in pigs at the time of slaughter to increase pH and hereby improve WHC and color. More than 24 h fasting is necessary to observe any significant differences in meat quality (Eikelenboom,Bolink, & Sybesma, 1991; Fernandez, 1994).

Extended lairage does, however, raise other issues. The welfare of the pig may be compromised simply due to fasting as well as fighting in groups of mixed pigs (Faucitano et al., 2006).

Pre-slaughter stress can roughly be divided into long term stress, such as on farm handling, mixing, loading and transport, and short-term stress, including lairage conditions and driving to the stunner. The two types of stress should not be considered as two separate things although long-term stress mainly leads to meat quality associated with that of DFD meat while short-term stress mainly leads to quality associated with RSE or PSE meat. Inadequate farm handling increases the susceptibility to pre-slaughter stress (Webb et al., 2010). The negative handlings resulted in significantly lower muscle glycogen stores early post mortem and lower pH at 24 h, as well as a higher incidence of PSE meat compared to pigs that were handled correctly on the farm.

The two most widely used stunning methods are carbon dioxide (CO_2) and electrical stunning in pigs but there were no slaughtering house which introduced carbon dioxide stunning method in our study. The total bleeding time should be 6 minutes, but it was 4 minutes and 40 seconds. Time measurements of the slaughter line showed that the total retention time from sticking to entrance of the chilling room takes approx. 28 minutes, which is shorter than in a Danish slaughter process.

To keep a good meat quality, it is very important to chill the carcasses as soon as possible after slaughtering in a chilling process that is able to extract heat within an acceptable time.

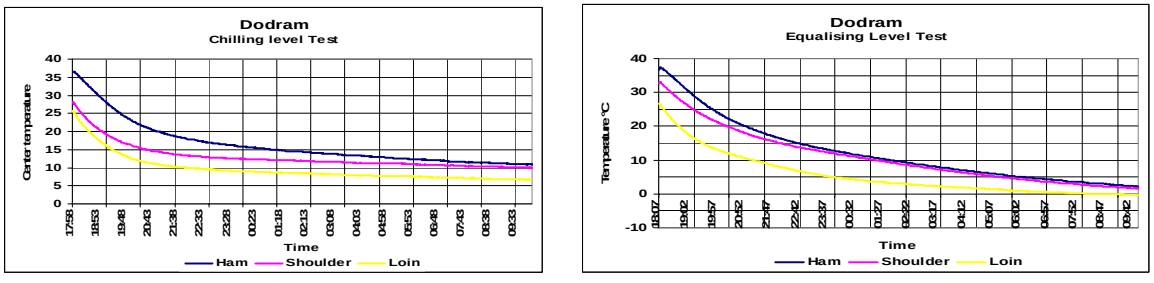
The pressure shift freezing (PSF) also provides impact on the quality of the pork, employing pressure above 150 MPA caused very significant color changes in the pork muscle during PSF process (Songming *et al*,2004).PSF at elevated pressure resulted in denaturation of myofibrillar proteins which might lead to significant increase in the toughness of the pork muscle.

We measured the drip loss, pH, temperature of carcass and weight loss by chilling from the samples from 8 slaughter house and mean values were compared to those of Danish results.

Table 1. The comparison of parameters between the Korean and Danish slaughter houses

	A	B	C	D	E	F	G	H	Mean	Danish
Drip loss (%)	5.10	4.41	2.02	3.38	2.70	2.70	3.60	2.00	3.24	3.70
Hot Carcass pH	6.07	6.41	6.33	6.13	6.52	6.2	6.62	6.16	6.30	6.60
Cold Carcass pH	5.75	5.84	5.72	5.78	5.75	5.71	5.85	5.78	5.77	5.56
Hot Carcass Loin temperature(℃)	36.60	35.90	39.00	39.85	39.50	38.27	36.90	40.20	38.28	36.70
Cold Carcass Loin temperature(℃)	0.51	2.53	1.21	2.40	2.70	3.10	0.46	1.10	1.75	5.00
Wt loss by chilling	2.08%	2.10%	1.50%	2.40%	2.20%	2.41%	2.35%	2.50%	2.19%	1.30

Long retention time on killing line will affect the meat quality in a negative direction. Due to that the pig handling before the killing is not optimal, the stress level of the pigs is substantial and limits the possibility for a high meat quality level.



A B

Figure 2(A). The temperature profile development during chilling and equalizing insulated from the

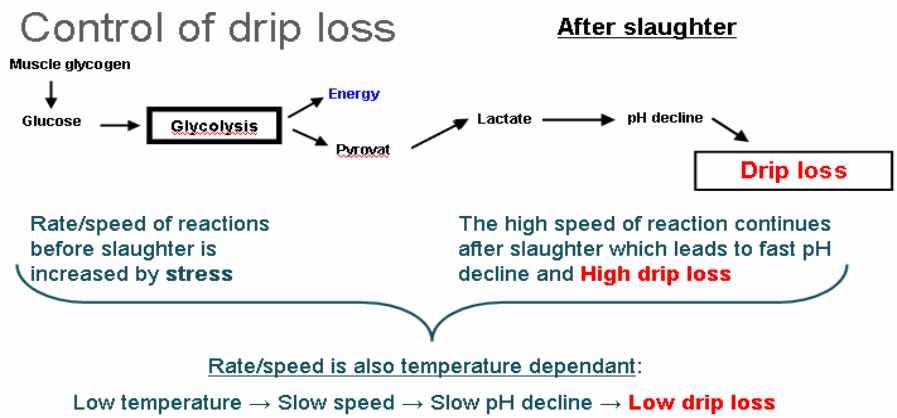
environmental influence (Sleeping bag test) and Figure 2(B). The temperature profile development during equalizing and post chilled in the equalizing chill.

It has been demonstrated that further on the process it becomes difficult to repair poor meat quality, but a quick chilling process may to some extent reduce the unsuccessful pre-handling.

There were observed several incidence of PSE in the loin when inspecting the meat de-boning process. Appearance of juice on the surface leaves the impression of poor water holding capacity. When pressed by a finger the finger collects free juice droplets. This tendency is particular noticeable around the bones. These observations very much emphasize the poor water holding capacity of the meat. The carcass chilling in the present blast chilling process is a very slow process and must be improved to achieve optimal meat quality and chilling weight loss.

Two tests have been carried out in order to investigate in detail in which way the present chilling and equalization process affect the product temperature before cutting. The efficiency of the blast chilling tunnel evaporators was too poor.

In summary as below, it is demonstrated that any process before or after slaughter that increase speed of the pH decline increase drip loss and decrease muscle temperature decrease drip loss.



REFERENCES

Katja Rosenvold, Henrik J. (2003). Andersen Factors of significance for pork quality. *Meat Science*, Volume 64, Issue 3, 219-237

Leheska, J.M. Leheska, D.M. Wulf and R.J. Maddock. (2003). Effects of fasting and transportation on pork quality development and extent of postmortem metabolism, *J. Anim. Sci*. 81, pp. 3194–3202.

P.G. van der Wal, B. Engel and B. Hulsegge. (1997). Causes for variation in pork quality, *Meat Sci*. 46, pp. 319–327.

P.D. Warriss, S.N. Brown, S.J.M. Adams, I.K. Corlett. (1994).Relationships between subjective and objective assessments of stress at slaughter and meat quality in pigs. *Meat Science*, Volume 38, Issue 2, Pages 329-340

G. Eikelenboom, A.H. Bolink, W. Sybesma. (1991). Effects of feed withdrawal before delivery on pork quality and carcass yield. *Meat Science*, Volume 29, Issue 1, Pages 25-30

X. Fernandez, A. Forslid, Eva Tornberg. (1994). The effect of high post-mortem temperature on the development of pale, soft and exudative pork: Interaction with ultimate pH, *Meat Science*, Volume 37, Issue 1, Pages 133-147

L. Faucitano, L. Saucier, J.A. Correa, S. Méthot, A. Giguère, A. Foury, P. Mormède, R. Bergeron. (2006). Effect of feed texture, meal frequency and pre-slaughter fasting on carcass and meat quality, and urinary cortisol in pigs. *Meat Science*, Volume 74, Issue 4, Pages 697-703

E.C. Webb, N.H. Casey. (2010). Physiological limits to growth and the related effects on meat quality Livestock Science, Volume 130, Issues 1-3, Pages 33-40

Songming Zhu, Alain Le Bail, Nicolas Chapleau, Hosahalli S. Ramaswamy, and Marie de Lamballerie-Anton. (2004). Pressure Shift Freezing of Pork Muscle: Effect on Color, Drip Loss, Texture, and Protein Stability. *Biotechnol. Prog. 20*, 939-945