THE IMPORTANCE OF KNOWING THE DANISH MODEL FOR MEAT PROCESSING

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Abstract: *The Danish Crown group is an international food producer with production and sales across the world. At present it is the world's third largest and Europe's second largest pig slaughtering business and also Europe's largest meat processing company. The cooperative has achieved this status by setting and observing very high and strict quality standards at all stages in meat processing, which explains why its products are exported all over the world.*

Key words: slaughterhouse, pork, processing, quality, veterinary inspection

INTRODUCTION

The aim of this paper is to present the high quality standards achieved by Denmark in the field of meat processing. Our starting point is The Danish Crown group, an international food producer with production and sales across the world, which is now the world's third largest and Europe's second largest pig slaughtering business, Europe's largest meat processing company, Denmark's largest cattle slaughterhouse business, one of the two or three largest meat exporters in the world and the world's largest exporter of pork.

The first Danish co-operative pig slaughterhouse was established in the town of Horsens in 1887. During the following 40 or 50 years a large number of pig slaughterhouses were established around the country. In 1960 the co-operative slaughterhouses began to merge in order to acquire more strength to handle functions such as sale, marketing, and product development. As a global player, they have to be able to manoeuvre and alter their position on both a macro and micro scale. Individual market conditions change constantly, meaning that Danish Crown has to constantly react.

MATERIAL AND METHODS

Danish Crown develops more consumer ready-to-eat products, thus keeping as many links as possible in the value chain within the company. Consumers need new inspiration and new foods on their dinner tables that meet match their demands. Constant improvement and development of both raw and processed foods are matched to the needs of individual markets,

thus providing consumers with real choice. Their main markets are the EU, Japan, Russia, and the USA. Danish Crown offers about 200 standard cuts as well as special cuts to the specifications of the customer. Danish Crown pork provides assurance of:

- **Uniform products** - This uniformity has been achieved through more than a hundred years of breeding, which has made Danish pigs world famous for a high meat percentage and a good meat/fat distribution. Uniformity is also achieved by slaughtering the pigs when they are within a narrow weight range, and by carefully sorting the carcasses at the slaughterhouses after slaughtering.
- **Products of high quality** - Quality is the key concept in the production of the farmer as well as when the pigs are slaughtered and processed. The farmer provides optimum conditions for the pigs, resulting in good and healthy growth conditions as well as pork of a high nutritional quality. The slaughterhouses treat the pigs gently, which ensures a high meat quality, and their employees are trained to treat the meat with the utmost care so that it is of pristine quality
- **Products with veterinary approval** - The Danish veterinary inspection is one of the strictest in the world, both in the primary farming industry and at the slaughterhouses. The veterinary inspection at Danish Crown's plants operates independently of the plant, thereby ensuring a strict and objective inspection.

  - additional inspection by means of HACCP/in-house inspection - The veterinary inspection is supplemented with in-house inspection according to the HACCP principles. The object is to assure the consumers the maximum hygiene quality, and thus food safety, through preventive measures. All slaughterhouse employees have passed a hygiene course in order to be able to perform the day-to-day in-house inspection.

  - dependability of supply - The large tonnage handled by Danish Crown permits them to plan their production accurately and implement efficient logistics, and since they have their own shipping department and co-operate with leading transport companies they are able to assure the customers delivery of the right quality and the volume ordered at the agreed time.

RESULTS AND DISCUSSIONS

Pigs are slaughtered mainly in large slaughterhouses around the country. Pig slaughter consists of a long series of processes, as follows:

Transport and lairage. When a farmer is ready to supply pigs for slaughter, he contacts the slaughterhouse about a week before and tells how many pigs he expects to supply. This provides time for the slaughterhouse to plan collection and slaughter. The day of collection by the haulage contractor, or the previous day, he moves the pigs to a special delivery room, which is separated from the other production. The reason is to avoid that the transport driver, who might have other pigs on the lorry, transfers infection to the herd.

It is most common for the slaughterhouse to plan the collection of the pigs. The transport is done by private haulage contractors, but the slaughterhouse will normally plan the route to ensure that the pigs spend as short time as possible on the lorry. Nearly all Danish slaughter pigs spend less that three hours from the farm to the slaughterhouse - the transport will typically last 1-1 1/2 hours. This is far less than the maximum allowed transport time. According to the regulations animals may be transported for up to eight hours before they are fed and watered.

The pigs are transported to the slaughterhouse in special lorries with slip proof flooring, ventilation and division into compartments so that pigs from different herds do not fight. A few farmers choose to deliver the pigs themselves. At the slaughterhouse the pigs are driven out of the vehicles and checked by a veterinary surgeon to ensure that they are healthy; they are then driven to the lairage pens.

Stunning and sticking. After a couple of hours in the pens the pigs are driven to stunning. They are stunned with carbon dioxide (CO2) by being driven into a 'lift', which subsequently is lowered into a pit with carbon dioxide. The pigs become unconscious by breathing the carbon dioxide. The unconscious pigs are lifted up in a hind leg and conveyed to be stuck in the neck artery and die. They are often stuck with a special hollow knife with a hose attached, so that the blood is collected automatically via the knife. The blood is later centrifuged to separate it into plasma (ca. 60%) and haemoglobin, which are both frozen.

Unclean slaughterline. After stunning and sticking the first part of the process is the unclean section where the carcasses are scalded. They are pulled through a long vessel with warm water (61oC) where the hairs are loosened. The scalding can also be done with steam; then the carcasses are conveyed through a cabinet, while hot water vapour is blown over them.

The carcasses are then going through the dehairer, where hair and hooves are removed while the carcass passes between two cylinders. After

the dehairer the carcasses are transferred to gambrels with the ends going through each hind leg so the carcass hangs with its head downward. Each gambrel has a number, for example a bar code, a radio chip or a steel plate with punched numbers, which automatically records when the carcass moves through the different processes on the slaughterline. The carcass is then singed in a kiln with flames that carbonise the outer skin layer. This removes any remaining hairs and contributes to giving the skin the correct texture. The next stage is the rind treatment, where the black rind from the singeing is scraped off. The carcass is now ready in the 'unclean' part of the slaughterline and is transferred to the 'clean' part.

Clean slaughterline. The first thing that happens here is that the carcass is 'opened' i.e. cut open with a perpendicular ventral cut. The thorax bone is sawn through so that the carcass is open at the front. The viscera are taken out and divided into pluck (i.e. tongue, oesophagus, heart, lungs, liver and diaphragm) plus stomach and intestines. The viscera are conveyed parallel with the carcass to the veterinary meat inspection. The carcass is split. First it is cut from the dorsal side at both sides of the spinous processes of the backbone (called 'free cutting'); then it is split with a saw into two halves along its length through the backbone and chest to be joined by the snout only.

The carcass and the viscera are then checked by a veterinarian to ensure that the meat if free of disease. If there is sign of disease, the diseased parts are partly or completely condemned depending on the type of disease. Approved stomachs and intestines are sent to the casing cleaning department, and the other approved parts are being chilled. Then the carcass is weighed. The supplier's number (i.e. the farmer's number) is registered on a computer together with the carcass weight (carcass without blood and viscera). Then the carcass is classified and is ready for carcass chilling.

Classification and payment. In the classification the lean meat content is measured in each carcass. The meat content ('meat percent') is, in combination with the carcass weight, the basis for the payment to the farmer. He is paid according to the number of kg lean meat in the carcass. Each week the slaughterhouse companies determine their basic price per kg pig meat. Measurement of the lean meat content in the carcasses has hitherto been done in a special 'classification centre' where probes are inserted into the carcasses and measure - via light reflection - certain fat and meat thicknesses. Based on these measurements the meat percent is calculated for the carcass and for the major cuts.

The farmer gets the basic price for the pig if the carcass has the basic lean meat content (today 60%) and is within a certain weight interval. If the meat content is lower than the basic, there is a deduction from the payment, and if it is higher, the payment is increased up to 65%, where the payment is

not increased further. If the carcass weight is lower or higher than the optimum interval (typically between 67 and 81-82 kg) there is a gradual reduction in the payment. If the farmer produces special pigs (for example pigs with a special good eating quality or ethical quality) he gets a special addition to the basic price.

The slaughterhouses determine the criteria for payment according to the qualities required by the markets. It is important for the farmers to supply the pigs for slaughter when the meat content and carcass weight is at the optimum level in order to achieve maximum payment. Once a year the slaughterhouses pay an additional 'after-payment' to their members; this means that the annual profit is distributed according to the carcass weight supplied.

Health stamps. The last process is to apply health stamps onto the carcasses to certify that they have been checked and to be able to trace back in case of problems. Meat from slaughterhouses authorised for export, i.e. slaughterhouses fulfilling especially high hygiene requirements, will be stamped with oval stamps (at least 6.5 x 4.5 cm), which among other things show the plant's authorisation number. Meat from plants not authorised for export ('home market plants') are marked with a round stamp, which also contains the authorisation number of the plant. In addition to the official health stamps, the plants often apply their own quality stamps, for example for the selling classes that are marked A1, A and B.

Chilling. When the slaughter processes of the carcass have been completed, it has to be chilled. The temperature of the carcass is approximately 30oC after slaughter, and it must be chilled to a temperature below 7oC within 24 hours. The purpose of the carcass chilling is to arrest the bacterial development in order to improve the shelf-life and safety of the meat. The chilling also contributes to a reduction of the evaporation, so that the carcasses do not lose so much weight.

At the start of the chilling the carcasses are conveyed through the blast tunnel - a long corridor where very cold air (between -20 and -300^{o}C) is blown onto the carcasses to provide rapid cooling. The surface is actually frozen while the interior is still warm. After the chilling tunnel the carcasses are taken into a chill room at a temperature of 5oC. They hang here while the temperature in the muscles and the carcass equilibrates to a maximum of 7oC in the interior. It is often discussed whether the powerful chilling in the blast tunnel results in a poorer meat quality than a slower chilling in a chill room. Several investigations, e.g. by the Danish Meat Research Institute, have shown, however, that meat chilled correctly in a blast tunnel is at least as good as other meat.

Carcass cutting. The day after slaughter, when the carcass has been cooled, it will be cut. First the head and feet are cut off - this completes the

separation of the carcass into its two halves. Each of the carcass halves is then cut into three parts: Fore-end, middle and hind leg. The middle is often cut into loin and belly. These primal cuts constitute the basis for the further cutting and boning of the meat according to the customers' specifications.

The Danish pig meat export consists mainly of fresh (chilled) or frozen cuts. The fore-ends are for example sent to Germany and Russia, the middles are cut and exported to Great Britain and Japan and the hind legs are trimmed and/or boned and exported to France, Italy and Sweden.

Processing. Part of the pig meat is used for various processed meat products; for example bacon, cold cuts, sausages, cooked hams and various types of canned meats.

Hygiene. A good hygiene is a prerequisite for healthy products of good quality. The hygiene is influenced by many factors during slaughter, chilling, cutting, boning, processing, retailing and storage in the consumer's home. All links in this chain must understand the necessity of good hygiene.

Basically hygiene is to avoid contamination of the meat with undesired bacteria and to avoid growth of microorganisms. Hygiene is also aesthetics/appetising conditions. Few people will accept that food is made or handled in unappetising conditions. Living animals have a natural flora of microorganisms on the skin, in the nose, pharynx, intestinal tract and around anus and the genitals. Muscles and organs are, on the contrary, normally sterile. Microorganisms can occur in blood and tissues during infections, but the body's immune defence will normally combat them. During slaughter the interior of the carcass will be contaminated due to cutting and handling. Knives, saws and other equipment transfer microorganisms from the surface to the interior of the carcass. Contamination of the meat with bacteria from the pharynx and intestines, where pathogens can occur, is particularly critical. Continuous disinfection of knives and equipment, careful handling of the carcasses during the different slaughter processes and effective chilling are preconditions for a good hygiene with minimum microbiological contamination of the meat. It is not possible completely to avoid bacteria on the meat. However, the bacteria are only on the surfaces of the meat - not inside the muscles.

During cutting and boning further bacteria are transferred to the meat from the equipment and the handling of the products. The shelf-life is reduced because many new surfaces are created. Particularly when the meat is minced, where the surface is increased a lot and good conditions are created for bacterial growth.

Control. The control of hygiene and health is done by the public veterinary inspection and by the slaughterhouse.

CONCLUSIONS

Processed meat products are a broadly composed group ranging from whole muscle products such as cured pork loin, cured veal or marinated chicken portions to comminuted products, for example sausages, and from uncooked products to canned meats. Common for them all is that they have been exposed to a process. The processed meat products comprise cold cuts, sausages, canned products etc.

Raw materials. The raw materials for the processed products come from all parts of the carcass. For the expensive products, whole meat pieces are normally used; this is for example the case for bacon, cooked ham, cured pork loin and smoked loin. The processing is often curing and possibly smoking and heat treatment. Comminuted meat products are made from chopped/minced raw materials. The raw materials are often smaller meat and fat pieces, which are cut off during trimming and boning of the cuts. During the comminution of the meat, various ingredients are added; for example salt, phosphates, proteins, starch and spices. The meat mixture is used for making sausages and canned meat products, for example luncheon meat (a typical export product).

Curing. During curing, sodium chloride (NaCl) is added, often together with water, nitrite salt (i.e. salt with 0.6% sodium nitrite), phosphates, ascorbate etc. The curing has several purposes: To provide flavour and juiciness and to improve the shelf-life. The salty flavour is important for the correct taste of the products. Investigations have shown that approximately 2% salt is suitable for the majority of modern consumers. Many products were more salty earlier, but the focus in recent years on the unfortunate effect of salt on the blood pressure has contributed to a reduction of the salt content. Curing is an old method for food preservation. The salt inhibits the growth of many bacteria and stops some of the enzymes in the meat that contribute to its breakdown.

Smoking. Smoking is an old traditional preservation method. Smoking will preserve the surface of the product by inhibiting the growth of the bacteria. In addition a drying can occur; this will also contribute to a longer shelf-life. Finally the smoke provides colour and flavour - this is today the main reason for the smoking of meat products.

Smoking can be done in three ways depending on the temperature and time for the smoking:

- Cold smoking, where the temperature is 20-30oC, i.e. where the smoke is cooled. Cold smoking is for example used for salami sausages. Cold smoking is often done over an extended time period from some days to several weeks.

- Semi-warm smoking, where the smoke temperature is ca. 40oC. This smoking method is used for bacon, cured pork loin and various cold cuts.
- Hot smoking, where the products are heated to 70-90oC; the products are therefore cooked and can be eaten without further heat treatment. The process typically consists of drying, smoking and cooking. Hot smoking is for example used for Vienna sausages.

Heat treatment. Many processed meat products are heat treated (cooked) as part of the process. Most cold cuts receive a mild heat treatment equal to pasteurisation, i.e. a heating to a core temperature of at least 75oC. Depending on the packaging method, on whether the products are sliced or sold as a piece, on the storage temperature (maximum 5oC) etc., the typical shelf-life ranges from some weeks to a couple of months.

Perishable canned meats are products that are cooked in an impermeable pack and have a shelf-life of at least six months when refrigerated. When the pack is opened, the shelf-life is only a few days or weeks under refrigeration. Fully stable canned meats are products that are heat treated to have a shelf-life of at least one year at room temperature - in practice often considerably more. Heat treatment is done in an autoclave (an industrial 'pressure cooker'), where the core temperature in the products reaches 120-122oC. Canned meats are nearly always packed in metal cans.

Additives. Various additives are used for processed meat products. Statutory regulations determine the permitted types and quantities of additives for each product. Preservatives are used to increase the shelf-life. For meat it is mainly nitrite, which inhibits the growth of bacteria. Nitrite is used as nitrite salt; a mixture of salt and 0.6% sodium nitrite.

Emulsifiers, stabilisers and thickening agents. Emulsifiers are compounds that make it possible to produce a stabile mixture of fat and water that does nor separate. Some proteins, e.g. soy and milk proteins, are used in comminuted products to prevent fat separation during cooking. Polyphosphates also have an emulsifying effect. Stabilisers and thickening agents bind water and contribute to a firm texture of the products.

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