# Does the meat industry get the research it deserves?

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There are many organizations, centers, agencies, universities, and laboratories public and private funding and conducting research on meats globally. In the broadest context, this research spans considerations of quality, safety, processing, packaging, techniques, and consumer issues. But are the needs being researched really the needs and priorities of the users whether they be the consuming public, the packing industry, equipment manufacturers, producers, etc.? This is a very difficult question to answer categorically.

The best way to answer this question is to look at some specific examples of research efforts around the world and to investigate whether the meat industry and society benefitted from the work. Time will not allow a thorough investigation outlining all the efforts underway with all meat species in even one of the most active countries let alone all of them. Therefore, only an example or two from several different regions of the world will be highlighted and discussed briefly.

Before these examples are exposed, it might be appropriate to mention the listing of research and outreach needs identified by the industry. It is important for the meat industry in any country to expend the effort in a visioning exercise to forecast what those priority projects should be for the common good. The American Meat Science Association has a standing committee that reviews these needs and periodically updates a published list of meat research and extension priorities. This exhaustive list provides direction to all those funding and conducting research upon what their primary focus should be in the years ahead. This document can be accessed at http://wiki.meatscience.org/wiki/index.php?title=Research_Needs_in_Meat_Science. I am sure that most other countries' meat research groups have similar documents.

Some of the projects selected to demonstrate that researchers are indeed satisfying the industry's needs are very simple while others are huge, very complex and very expensive. One of the very simple straightforward approaches was conducted by Dr. Steven Lonergan at Iowa State University several years ago. At the time, this author was at the company which funded the work and took note of the extremely rapid uptake of the results by the US pork industry. The industry had been recommending bleed times for pigs of at least ten minutes to assure thorough bleed out of the carcasses. This length of time was in direct opposition to the motivation to move carcasses through the slaughter floor as rapidly as possible in order to remove all the sources of heat (blood and viscera) and to move the carcass into the chill with great haste. The project discussed here investigated the actual percentage of bleed out at different time intervals after sticking of the carcass post stunning. It was found that over 99% of the blood was obtained within three minutes after sticking. (Gardner et al., 2006) As these project results were reported to abattoirs in an industry newsletter, it became known to this author that at least three companies used the downtime during that next weekend to modify their slaughter lines to reduce the bleed time to three minutes or less. This involved a particularly rapid uptake of research findings by companies which solved a problem that they had not even realized they had.

Another pork project by this same primary investigator finally brought some resolution to that age-old question about the contribution of marbling in pork to sensory texture traits such as sensory tenderness, sensory chewiness, and star probe values, a quantitative measure of tenderness. There has always been a high level of controversy over this point with many reports saying there was no relationship while others showed that a very significant relationship existed. The study by Lonergan et al. (2007) demonstrated that pH of the product must be considered before assessing the contribution of lipid. In summary, if pH was very low in the pork product, marbling had no impact on sensory traits. The product was essentially of poor quality and marbling would not help. If the pH was high, the product was very good in sensory traits so the amount of marbling appeared to be irrelevant. However, when the pH was intermediate, then lipid content of the muscle had a significant impact on most of the sensory traits identified as chewiness and tenderness both quantitative and qualitative. This research answers a very important question for the industry as they develop consumer preferred products.

Another example comes from Dr. Theo Verkleij, meat scientist, TNO Food & Nutrition Research, The Netherlands. He stated that in the early days, a lot of questions were raised from industry to get information about the shelf life of meat products. At the same time, (mid '80) they were curious about all the issues which were involved in determining the shelf life of a product. But testing all this issues was quite a job. Subsequently, Theo and his colleagues developed an idea to predict the shelf life of a product based on intrinsic and extrinsic properties. Subsequently they looked for a sponsor, the Dutch Product Board of Livestock, Meat and Eggs, and together they developed a predictive modeling system to estimate the shelf life of meat products. Nowadays, this model is still used by microbiologists and the industry to economize on shelf life determination. (Borch *et al*., 1996)

An alternative to challenge tests for the assessment of the shelf-life of food products is predictive microbiology, a development of mathematical models that describe the influence of predominant, controlling factors (such as temperature, water activity and pH) on the lag phase and the growth rate of microorganisms. During their research in the Netherlands, modifications of the square root model were tested to predict the relationship between growth rate and temperature, between the lag phase and the temperature of spoilage organisms growing in vacuum-packed meat products, on MAP and aerobically packed fresh meat. Predictions of the models have been validated in practical situations, predictive microbiology has been shown a promising technique for the estimation of a product shelf life and its impact of any modification of a products formulation on both its safety and its shelf life. This predictive model is adapted by industry to help them get insight their shelf life. (Muermans *et al*., 1993)

Another example of meat research responding to industry needs also comes from the Dutch. Some years ago, Dr. G. Wijngaards, working as a biochemist at TNO Nutrition and Food Research (Netherlands) wondered how an injury (wound) could heal. It was determined how in detail the thrombin and fibrinogen function to stitch the material in this wound and him and his colleagues at TNO did some experiments with thrombin and fibrinogen derived from pig blood. The idea came up to extend also experiments with pork and beef meat. This resulted in a method to bind different meat pieces to each other and a company (with core business in pork blood sampling, processing, drying etc.) was found to implement this idea.

In the end, together with Harimex, nowadays Sonac, the Dutch wrote a patent and they brought the system of meat binding (Fibrimex) to the market. Even the European Food Safety Authority commented on the safety of this system of meat binding. The system is used in several countries around the world. Even the fish industry is also working with this binding system. For a nice example of the binding of salmon before slicing and packaging, see figure 1.

*[Figure 1 Photo of a slice of Salmon]*

From this figure it is obvious, the fish structure is ruptured. Fish meat consists of a typical pattern, in which several red filaments are separated through a white collagen. When observing figure 1, one can see the different pattern. And the binding between the two pieces was performed with Fibrimex.

Another example comes from Denmark. The Danish Meat Research Institute has several divisions with experts particularly focused on industry issues primarily in Denmark and other Scandinavian countries although they do work throughout the world. They operate from departments focusing on automation, meat quality, food safety, and consulting services. DMRI Consult recently developed a concept for intelligent pad chilling of carcasses and cuts, a method that will lower costs and improve meat quality.

The department develops machines and IT systems to automate and improve the efficiency of the slaughter, cutting and boning processes and maintains the data systems on the slaughter line. The department's main objectives are to increase productivity and improve the working environment. The department has received much recognition for its efforts. In 2005, His Royal Highness Crown Prince Frederik presented the department with the Danish Industrial Robot Association's "Automation Prize" for the construction of a machine that removes the surface bones of fore ends. Many of the machines running at Danish Crown in Horsens (the world's most modern slaughterhouse) have been developed by DMRI's Automation Department. The projects are carried out in cooperation with machinery suppliers, who are experienced in the marketing, servicing and production of machines for slaughterhouses.

According to Carsten Jensen, Sr. Project Manager, the working environment has been improved on the boning line, where surface and inner bones are removed. Tedious, manual work has been eliminated, and the number of cutting accidents has been reduced. The machines are so efficient that the boning of fore ends in Denmark has become economical in spite of the high wages. Since no two fore ends are the same, developing the machines has been a big technological challenge. (DMRI, 2008)

Another idea from Denmark involves pad chilling. Most Danish abattoirs today use a so-called blast chilling process in which the warm carcasses are transported through a chill tunnel with high air velocity and with temperatures around -20$^{o}$C. The blast chilling process causes the surface temperature to quickly get beyond the freezing point. This results in shell freezing of the carcasses whereas the core temperature of the muscles only drops a few degrees. The carcasses are subsequently placed in a chill room at a temperature of 2-4$^{o}$C for equalization of the carcasses to a temperature in the entire carcass of 5$^{o}$C after 16 to 20 hours.

The DMRI has previously carried out an immersion chilling project where the carcasses were wrapped in a bag and subsequently placed in a chill tub at a temperature of -4 to -16$^{o}$C. The results documented that immersion chilling has distinct advantages to traditional batch chilling in relation to food safety, meat quality, chill loss, differentiated chilling and energy consumption. The disadvantage of immersion chilling was, however, that the costs for wrapping the hot carcass before lowering it into the chill tub were unreasonably high.

The Danish meat industry has initiated a development project to be performed by the DMRI. The idea is to substitute the tunnel chilling process with the pad chilling process where the refrigerant, e.g. water gets in close contact with the carcass through a pad. The chilling pad is subdivided in channels in which the refrigerant circulates. After chilling the carcass has to equalize. It is anticipated that chilling in accordance with this principle will have considerable advantages compared to other chilling methods in that the process time is 30% faster, chilling of cuts and whole carcasses will be differentiated and provide a possibility for optimisation of the meat quality, lower chill loss, low energy consumption and maybe up to 30% shorter time for equalizing because of missing need for interchanging of energy between the thick and thin parts of a carcass and the subsequent less space requirement for equalization when working in shifts. (Kristensen, 2008)

Beef bone-in retail cuts packaged in High Oxygen Modified Atmosphere packages can have a serious bone discoloration problem, sometimes called "black bone" in the industry. This is a serious industry problem when it occurs. Dr. Jeannine Grobbell of Kansas State University conducted a quality research project in which she looked at different packaging atmospheres with or without misting with a 2.5% ascorbic acid solution. She found that ultra-low oxygen modified atmosphere packaging virtually eliminated this problem and dramatically reduced the problem compared with PVC and HiOx MAP. She also found that there were large differences in the iron and hemoglobin content of marrow in different bones. (Grobbel et al., 2006a; Grobbel et al., 2006b)

A final example comes from New Zealand. In the early 1990’s, a New Zealand entrepreneur bought the patent for the Swiss Tendertainer container for the storage of meat. This concept has since been evolved into the FoodCap system for preparing retail-ready meat for a major New Zealand supermarket.

The FoodCap is the heart of the FoodCap system, and its unique properties as a meat storage and handling container has created new opportunities for central retail preparation. At the outset, the Meat Industry Research Institute of New Zealand (MIRINZ) demonstrated that the FoodCap, which stores meat in a gassed, anaerobic atmosphere and under mechanical compression, provides effective microbiological control at least the equivalent to vacuum packs. Subsequent research by Carne Technologies demonstrated improved meat quality attributes through moisture reabsorption into the meat during storage.

However, it is as a materials handling vehicle that the FoodCap offers enormous benefits. Not only does it dispense with disposable packaging, the FoodCap allows automation of product handling: in the Auckland Central Retail Manufacturing (CRM) plant, the FoodCaps are conveyed on automated conveyors, stored in chillers using automated crane systems and finally delivered, after the appropriate maturation period, to the production lines without any human involvement.

The underpinning research for the FoodCap system has also identified opportunities to provide retail ready meat without the need for expensive Modified Atmosphere packaging (MAP). After preparing and overwarapping the retail packs, an automated conveying system accumulates the packs individually in a buffer chiller before sorting for retail delivery. Automation in the accumulator system again allows strict temperature control in the buffer chiller, which is maintained at -1ºC.

After sorting the packs for retail delivery, the FoodCaps are again used as the delivery system. The FoodCaps are a sealed container that permits the whole atmosphere of the container to be modified during the retail delivery period.

The combination of the FoodCap container, underpinning meat science research and innovative engineering solutions has created a unique retail meat preparation system. The existing plant processes around 400 tonnes of meat per week and produces around 100 000 packs per day for 120 supermarkets. It does this without the need for MAP packaging (poorly regarded by the New Zealand shopper) and dispenses with the disposable packaging normally associated with meat handling and storage. (Simmons, 2008).

From all these examples from several countries, it is obvious that meat science researchers have been very responsive to their respective industry needs. Those needs may be in the area of meat quality, processing innovations, food safety, or new product development but many new, cutting edge ideas have been generated in these meat science laboratories. Moreover, the examples provided are but a very tiny slice of the entire picture over the past half century since meat science became a respected discipline. One must conclude with a resounding “yes” that meat scientists have responded to the needs of industry in many cases before industry even knew they had the need.

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