Meat Processing

SUPPLEMENT

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From muscle to meat

At slaughter, the blood and the oxygen it carries are drained from the muscles, and this changes the muscles’ energy production system from mainly aerobic, based on oxygen, to anaerobic, without oxygen. Also, the muscle protein turnover system is active for some time after slaughter. So even though the animal as a whole is dead, the biochemical processes in the muscles continue to function several hours and days after slaughter. The rates of two specific biochemical processes have a major impact on the final meat quality, namely glycolysis and protein degradation. The glycolysis results in a decreased muscle pH from above seven in the living animal to below six the day after slaughter in the majority of muscles in the pig carcass. Protein degradation is a part of the muscle growth and repairing system in the living animal, and the process is thought to be accelerated after slaughter which eventually leads to what is known as meat tenderisation.

Both processes (glycolysis and protein degradation) are driven by enzymes, and since the activity of enzymes is dependent on muscle temperature – high temperature, high activity – chilling rates of carcasses have a major impact on these biochemical processes and thereby the final meat quality.

Effects on meat quality

Chilling can have an effect on nearly all meat quality parameters through the effect on the rate of glycolysis and the rate of protein degradation. Thus, drip loss, purge loss, PSE, tenderness and meat colour are known to be affected by chilling.

Table 1 Effect of chilling rate on eating quality, colour, drip from loin and chill loss from whole carcasses

<table>
<thead>
<tr>
<th></th>
<th>Slow chilling</th>
<th>Fast chilling</th>
<th>Sign.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Batch process</td>
<td>Quick chilling tunnel</td>
<td></td>
</tr>
<tr>
<td>Tenderness*</td>
<td>9.4</td>
<td>6.0</td>
<td>***</td>
</tr>
<tr>
<td>Juiciness*</td>
<td>8.4</td>
<td>8.5</td>
<td>n.s.</td>
</tr>
<tr>
<td>Meat colour, paleness*</td>
<td>57</td>
<td>49</td>
<td>***</td>
</tr>
<tr>
<td>Drip loss, %</td>
<td>1.7</td>
<td>2.6</td>
<td>*</td>
</tr>
<tr>
<td>Chill loss, %</td>
<td>2.7</td>
<td>1.1</td>
<td>***</td>
</tr>
</tbody>
</table>

a: Sensory scale from 1 to 15 where 15 is ‘very tender/juicy’
b: Colour L* value
n.s.: non-significant (p > 0.1); *: p < 0.05; **: p < 0.01; ***: p < 0.001

Chilling of hot carcasses is an important process in the meat production chain, and the rate of chilling especially has a major impact on meat quality, chill loss, shelf-life and microbial safety. The carcass temperature just before chilling is normally in the range of 39 – 40°C, and the goal is to reach approximately 5°C 20 to 24 hours after slaughter when the carcasses usually are cut and boned. Air is generally used to remove heat from the surface of the carcasses, and the rate of chilling is controlled by both air speed and air temperature, the latter going from below -20°C in quick chilling tunnels to above 0°C in conventional, slow, batch chilling systems. In spray chilling systems, the evaporation of water sprayed onto the surface of the carcasses helps to remove heat from the carcass. This article will focus on the effect of pig carcass chilling on meat quality.

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to be affected by chilling and especially the rate of chilling.

The results presented in Table 1 (page 3) are from an internal DMRI trial set up to compare very slow chilling with fast chilling. Slow chilling was obtained by using a traditional batch process and fast chilling by using a quick chill tunnel process followed by equalisation in a chill room. One major advance of using fast chilling is the low chill loss that is obtained by a part freezing of the carcass surface during the tunnel process. This reduces the evaporative loss dramatically and is the main reason for the difference observed in chill loss between the slow and fast process.

The eating quality parameters were determined in the loin, and tenderness was also highly affected by the chilling rate with less hard and tenderer meat using the slow process. The positive effect on tenderness can be explained by an increased rate of protein degradation in the loin due to a slower drop in muscle temperature in the slowly chilled carcasses.

The meat colour expressed as paleness of chops from the loin was also highly affected as meat from slowly chilled carcasses had higher values. The higher paleness value of slowly chilled meat is explained by an increased protein denaturation caused by a faster pH decline after slaughter. The faster pH decline is a result of the enzyme driven glycolysis that is kept at a higher rate due to a higher muscle temperature for a longer period after slaughter. Protein denaturation leads to increased gaps between neighbouring myofibrils in the meat which gives rise to more light being reflected from the meat surface, and this results in a paler appearance of the meat. In extreme cases, the combination of high muscle temperature and low pH can give rise to the quality defect known as PSE (Pale, Soft, Exudative) that sometimes can be found in the inner part of the ham and loin from slowly chilled carcasses.

In the literature, drip loss is also reported to be affected by chilling rate – the slower the chilling, the higher the drip loss; however, drip loss has also been reported not to be affected by chilling rate and as presented in Table 1 (page 3), very slow chilling can even give rise to lower drip loss compared with fast chilling. These apparently inconsistent results on the effect of chilling rate on drip loss from the loin are explained by the very complex nature of drip loss formation. At least three factors are known to influence the amount of drip loss from meat:

- Final pH of the meat. High final pH gives rise to low drip loss and is the main reason why DFD (Dark, Firm, Dry) has a very low drip loss and a dry surface
- Protein denaturation, which is increased when the pH drop is fast and the chilling is slow and gives rise to high drip loss and a paler colour
- Protein degradation increases the meat’s ability to hold water. High temperature increases protein degradation so the slower drop in muscle temperature in the slowly chilled carcasses decreases the drip loss formation.

Thus, as the final pH of the meat used to determine drip loss in Table 1 (page 3) was almost identical (pH 5.5) using the two chilling rates, the lower drip loss from the slowly chilled carcasses in Table 1 (page 3) is explained

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**Figure 1** The principle of stepwise chilling (QCT = Quick Chill Tunnel)

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**Table 2** Effect of stepwise chilling on eating quality, colour, drip and chill loss

<table>
<thead>
<tr>
<th></th>
<th>Stepwise chilling</th>
<th>Control Quick chill tunnel</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenderness a</td>
<td>9.5</td>
<td>6.9</td>
<td>***</td>
</tr>
<tr>
<td>Juiciness b</td>
<td>10.3</td>
<td>9.8</td>
<td>**</td>
</tr>
<tr>
<td>Meat colour, paleness b</td>
<td>57</td>
<td>54</td>
<td>n.s.</td>
</tr>
<tr>
<td>Drip loss, %</td>
<td>3.0</td>
<td>4.1</td>
<td>♠</td>
</tr>
<tr>
<td>Chill loss, %</td>
<td>1.7</td>
<td>1.1</td>
<td>**</td>
</tr>
</tbody>
</table>

*a: Sensory scale from 1 to 15 where 15 is ‘very tender/juicy’

b: Colour L* value

n.s: non-significant (p > 0.1); ♠ p < 0.1; * p < 0.05, ** p < 0.01, *** p < 0.001
by increased protein degradation, which is consistent with the high
tenderness obtained when using very slow chilling. The higher paleness
score of the meat indicates a higher protein denaturation in the slowly
chilled carcasses; however, in this case the protein degradation ‘overrules’
the protein denaturation effect on drip loss.

**Stepwise chilling – a new concept**

From the results presented above it seems that slaughterhouses have to
construct or adapt their chilling procedure based on the parameters that
are of the highest importance to them. If a low chill loss and no PSE is of
major importance, a high chilling rate is to be used, however, if high eating
quality is of major importance a slower process has to be used. Since all
parameters are often preferred by most slaughterhouses, a compromise in
the chilling process is chosen that gives a rather low chill loss, low risk of PSE
and without major negative effects on eating quality and drip loss.

In recent years, a new concept of chilling called stepwise chilling has
been presented\(^{11,12}\). This new concept combines the positive effects known
from quick chill tunnels with the positive effect found using the traditional
slow batch chilling process.

The principle of stepwise chilling is illustrated in Figure 1 on
page 4. The first part of the chilling process should be as fast as possible.
Besides reducing the chill loss, fast chilling also reduces the rate of
glycolysis and thereby the rate of pH decline, which results in low drip loss
and low risk of PSE in the fully equalised meat. When the core temperature
of the loin reach 10 – 15°C, the chilling process is halted, and the carcass is
tempered in a chill room at a constant temperature for six hours. During
this period, the relatively high muscle temperature gives rise to an increased
rate of protein degradation which accelerates the tenderisation process and
decreases drip loss formation. After the tempering period, the carcasses are
exposed to fast chilling again to reach equalisation temperature.

The results shown in Table 2 (page 4) are from an internal DMRI trial
in which stepwise chilling was implemented at a commercial
slaughterhouse with a tempering period of six hours at 10°C. The
eating quality parameters tenderness and juiciness were both positively
affected by stepwise chilling. The results on especially tenderness are
confirmed by similar studies\(^{11,12}\). In a test on tenderness, comparing the
effect of traditional ageing in a chill room with the effect of stepwise
chilling, it was found that stepwise chilling produces tenderness
improvements in the meat equal to two to four days of ageing in a chill
room\(^{11}\). The paleness of the meat was not affected which also was shown by
Therkildsen et al.\(^{11}\). However, Rosenwold et al.\(^{11}\) observed more paleness in
meat from stepwise chilled carcasses. Thus, dependent on the setup of the

![Figure 2: Bacterial number before chilling and two days after slaughter. Different superscripts differ significantly.](image)
fast chilling part, stepwise chilling might have an effect on meat colour.

Most surprisingly, the drip loss seems to be positively affected by stepwise chilling with lower values and thereby a better water holding capacity of the meat. The effect on drip loss is supported by other studies\(^{12,13}\) and is expected to lead to lower purge loss in retail packed meat and lower thaw loss from frozen meat.

The higher temperature in the tempering period of stepwise chilling may raise some concerns about product safety and shelf-life. An alternative principle of removing heat from the carcass is by direct contact with a cold surface where the heat is removed by conduction. An example of this is dipping a hot carcass into cold water. The heat will then be removed by conduction and not by evaporation. This direct contact is much more efficient compared with evaporation and is the principle behind the idea of PAD chilling that DMRI has proposed\(^6\).

The idea (Figure 3) is to substitute the tunnel chilling process with the pad chilling process where the refrigerant gets into close contact with the carcass through a pad incorporated in a PAD chilling unit. The chilling pad is subdivided in channels in which the refrigerant circulates. After chilling, the carcass has to equalise. It is anticipated that chilling in accordance with this principle will have considerable advantages compared with other chilling methods in that the process will be up to 30 per cent faster. Chilling of cuts and whole carcasses can be differentiated which provide an extra possibility for optimisation of the fast chilling procedure and the tempering conditions\(^6\). A future perspective – PAD chilling

The currently used technology for pig carcass chilling is based on evaporation of moisture from the carcass surface, which is removed by the use of an air flow around the carcass. The energy consumption using this technology increases exponentially with the chilling rate; thus, faster chilling rates – higher energy consumption, cost and environmental impact. A future perspective – PAD chilling

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Due to possible increased microbial growth during tempering, this issue has been tested, and as shown in Figure 2 on page 5, the effect on microbial growth is actually negative compared with a standard quick chill tunnel process. Thus, no negative effects on shelf-life and food safety using stepwise chilling are to be expected. The lower plate count using stepwise chilling is caused by a reduced moisture level on the carcass surface in the tempering period, and this is also the explanation for the higher chill loss using stepwise chilling.

As presented above and compared to a standard quick chill tunnel process, the new concept of stepwise chilling offers the possibility of a dramatic increase in eating quality, less problems with purge and thaw loss and the same low risk of PSE. A disadvantage of the stepwise process is the minor increase in chill loss; however, this can be minimised with an at-site optimisation of the fast chilling procedure and the tempering conditions\(^6\).

\*The new concept of stepwise chilling offers the possibility of a dramatic increase in eating quality, less problems with purge and thaw loss and the same low risk of PSE\*

References


Biography

Lars Kristensen is the Manager of the Meat Technology Section at the Danish Meat Research Institute (DMRI) which is a part of Danish Technological Institute. The section’s competences cover the effect of various factors in the ‘Farm to Fork’ chain on raw and processed meat quality. Lars Kristensen started his professional career with an apprenticeship as a butcher, and for that reason he has an extensive practical and applied knowledge concerning meat and meat products. Regarding his academic career, he has a PhD in Meat Science and Technology and is a former Associated Professor at that field at University of Copenhagen.
Food fraud on an international scale is a reality – current preventive measures are not working and new techniques and tools are needed to address the problem, say experts. The recent revelation of large-scale and criminal food fraud involving the adulteration of processed meat products with horsemeat has cost the market, directly and indirectly, millions of Euros in costly product withdrawals, loss of sales and brand reputation, source and supply issues, consumer nervousness and lack of trust – all-in-all, potentially several years of costly misery and rebuilding of market positions for a number of global manufacturing, catering and retail brands.

Is this a one off major criminal conspiracy that has been broken? Are measures already in place by and large sufficient and proportionate to the risk? Apparently not – as the horsemeat scandal is still unfolding in Europe, we simultaneously see high profile measures to combat seafood fraud in the US.

Seafood products are also under heavy scrutiny following the discovery of contamination in supply chains and products being fraudulently mislabelled. Oceana, a large international advocacy group, recently released a study which found that 33 per cent of the 1,215 fish samples it collected from 674 retail outlets in 21 states were mislabelled according to US Food and Drug Administration (FDA) guidelines. Oceana reported that they found seafood fraud everywhere they tested. Of the most commonly collected types of fish, snapper and tuna had the highest mislabelling rates across the country at 87 and 59 per cent, respectively. While 44 per cent of all the retail outlets visited sold mislabelled fish, sushi venues had the worst level of mislabelling at 74 per cent, followed by other restaurants at 38 per cent and then grocery stores at 18 per cent.

A new Act has been introduced, the Safety and Fraud Enforcement for Seafood (SAFE Seafood) Act with further companion legislation announced to fight the growing problem of fraud by ensuring that seafood sold in the US is tracked from boat to plate, while providing more information to consumers at the point of purchase.

Fraud is high value with relatively low penalties for criminals and favoured by the inherent weaknesses that lie within the food industry’s complex supply networks.

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that food fraud is increasingly endemic, routine and happening all the time – driven by the huge financial incentives for criminals and favoured by the complexity and non-transparency of the supply and distribution networks.

A tonne of beef mince has a value of about EUR 2500 whereas a tonne of horse meat is worth about EUR 800, so a 200 per cent profit is available. Taking the example of the Swedish company Findus, it used Comigel, a French company, to make its processed meals in Luxembourg. Comigel sourced the meat from Spanghero in the south of France who employed an agent in Cyprus. The Cyprus agent used another agent in the Netherlands which sourced its meat from an abattoir in Romania. Why has this happened? At least in part because buyers seek to drive down the cost of ingredients ... and maybe not asking enough questions about how it’s obtained. The scope for criminal adulteration or contamination at any step of the distribution network can easily be seen.

An added pressure is the moves that individual countries are making to safeguard the health of their own citizens. Italy, Romania’s largest buyer of fresh horsemeat, banned imports because of bovine tuberculosis. In 2007, the US banned horse slaughter, resulting in horses being shipped to Mexico for slaughter – with the result that imports of horsemeat to the EU increased from EUR 1.3 million in 2006 to EUR 11.8 million in 2007 and EUR 21.4 million in 2010. It doesn’t take much to imagine where it all went.

Hindsight is a wonderful thing. In retrospect, the issues are clear but how can this knowledge be used to prevent future recurrences? The history of financial fraud illustrates that criminals will always find new doors to open when one slams behind them.

Malcolm Kane, consultant and expert in criminal food fraud, former Head of Food Safety at Sainsbury’s and currently part of the NSF Consulting Group Fraud team says, “A good starting point for any ‘food issue’ is to research the available RASFF (Rapid Alert System for Food and Feed) database.” RASFF was set up by the European Commission to provide food and feed control authorities with an effective tool to exchange information about measures taken responding to serious risks detected in relation to food or feed. The aim is that this exchange of information helps Member States to act more rapidly and in a coordinated manner in response to a health threat caused by food or feed. “It is quite clear from this RASFF list that over the past year, there have been sufficient examples of dubious practices in the meat trade to alert any diligent technical manager in that trade. This points to regular monitoring of RASFF as being an essential tool in every technical manager’s job description.”

However, while mislabelling is clearly a potential threat to human health – opening the door for potentially harmful adulterants and contaminants to be consumed by the public, the reality is inevitably more complex. Misrepresentation is not always a public health issue, but it is a high value criminal issue and does have a big effect on consumer confidence and is therefore a significant brand protection issue for the industry.

On 28 February, the European Serious & Organised Crime Conference was held in Brussels. The conference was hosted by the British Chamber of Commerce in Belgium, supported by the EU Commission and with commercial partners BAT and IBM and sponsored by European Crop Protection. Ned Kingcott, a Government Administration expert, attended and reported the evidence presented there about the scale and sophistication of criminal fraud. International gangsters are making huge amounts of money in all fields where they can make big money quickly (including from drugs, cyber crime and child exploitation). This gives them the power to pay for highly sophisticated means of evading law enforcement. “Apparently they have even created a ‘black space’ on the internet allowing communications that cannot be accessed by law enforcement,” says Mr Kingcott.

A key message at the conference was the importance of industry input into anti-crime activity. The current budgetary restrictions of
EU and national law enforcement agencies are impacting significantly on the regulatory abilities to combat crime and the role of industry in supporting their activity was stressed. The EU bodies concerned with serious organised crime, INTERPOL and OLAF (European Anti-Fraud Office) are all of this opinion.

David Edwards, Managing Director of the NSF Consulting Group, firmly believes that industry is better placed to combat fraud than the enforcement agencies are and yet the current industry safety systems and practices are outdated and inadequate to deal with a rapidly changing brief and new due diligence demands that increase almost daily.

Why is it that the industry’s current traceability and inspection systems appear to be failing?

According to Malcolm Kane, there has been a systemic failure of the management systems, risk assessment and controls to an extent that surprises even those who have worked within the industry or have been closely involved in it.

Part of the issue is the EU law on traceability. Every company must show due diligence by being able to trace their product back to the previous step in the supply ‘chain’ and that previous firms in the ‘chain’ have done the same. Whilst retailers would like to claim complete transparency along their whole supply chain, in reality this is often not the case because there is too much reliance on a paper documentation trail whilst there is relatively little physical product inspection or process verification during the audit process. The immediate response to the horsemeat scandal has been on the one hand to introduce more inspections and on the other hand to tighten up procedures for auditing processes and for the detailed compilation and verification of product specifications to ensure that products are safe.
The number of regulatory and industry product inspections has increased dramatically since the scandal broke, and in the words of David Edwards, “The more inspection, the more discovery.” This has happened before, as the history of the 2003 – 2007 Sudan 1 carcinogenic red dye contamination scandal illustrates. However, as Edwards says, inspection is costly – you cannot inspect everything all the time. Ultimately, only the big players would be able to bear the cost of more burdensome inspection regimes, potentially leading to market contraction and loading more costs onto consumers.

Indeed, EC legislation does not necessarily support an intensive inspection regime in the present circumstances. The available information to date shows that there are authenticity issues and there may be a health risk, but the most likely health impact would be as a result of Bute contamination, so this would not necessarily justify the wholesale testing and withdrawal of beef and beef derivative products.

Jenny Morris, a food safety expert who managed food safety at the London 2012 Olympic and Paralympic Games, comments that the horsemeat fraud has raised concerns about the adequacy of food legislation to deter criminals. “In particular,” she says, “there are questions about traceability requirements and whether or not they are fit for purpose in the global food supply network that operates today. A review and rethink is necessary which among other things should consider any barriers to proactive information sharing between industry and regulators. It is only by strengthening our systems that we will be better placed to defend ourselves against criminals seeking easy ways to make money.”

Some believe that the systems for regulatory implementation and enforcement in the developed countries are outdated and no longer fit for purpose. A source says “There is a real need to update the way controls are planned, coordinated and followed through. We have non-consolidated information systems, fragmented databases and insufficient risk analysis. The developing countries have better systems than us in some instances.”

How can the industry work smarter?
In the opinion of the expert food fraud working group put together legal and accurately describe the nature and origin of all raw materials and ingredients used.

The established standards available for the auditing of food businesses both nationally and internationally, such as the BRC Global Standard for Food Safety, the International Food Standard (IFS) and FSSC 22000, have become an accepted entry level requirement for suppliers of own label food products to the major retailers but many large retailers have now introduced much higher standards of audit, such as the NSF IAT (Integrity and Traceability) audit standard, which monitors manufacturer’s traceability and integrity controls much more rigorously and to provide assurance and confidence that such controls are being suitably managed.

Nevertheless, such measures can never totally deal with the criminal intent to defraud. Investigations and enquiries can help identify the causes and the culprits after the fact but they do not necessarily equip the industry to proactively identify and mitigate future risks. These simple and linear responses are unlikely to provide adequate protection.

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In the field of data analysis, the requirement is for better faster accurate information. The RASFF database contains huge amounts of information, but the difficulty has been to mine it and analyse it in a meaningful and timely way to identify trends and patterns. Professor Declan Naughton at Kingston University in the UK is helping to develop new network analysis tools that can digest enormous amounts of data such as these global food alerts, to rapidly identify a global picture of potential pressure points and where the point of transgression and control are to be found globally. In this way, patterns of transgression can be traced as they emerge. Similar systems could be used to analyse supply and distribution networks in product recalls.

Development work is continuing apace and new techniques are coming on stream all the time. This has undoubtedly been given a sharp impetus by recent events. What is clear is that nothing will be the same again. The face of food safety has changed and everyone in the industry has to sit up and revise their approach as traditional food safety mechanisms are no longer fit for purpose.

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Also at Kingston University, Professor Andrea Petroczi is working on new and versatile research tools that can be used to estimate the prevalence of fraudulent or transgressive behaviour such as rule breaking or illegal activities. These could for example be applied in a food safety situation around labelling or food handling.

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Juiciness enhances the perceived saltiness of meat products

Fred van de Velde and Marijke Adamse
Ti Food & Nutrition & NIZO food research

Meat products, including sausages and processed meats, are among the top three product categories that contribute to the high salt intake in the modern Western diet. Within the framework of the Top Institute Food and Nutrition (TIFN), researchers at NIZO food research have developed a strategy for reducing salt by enhancing the salt perception in processed meat products (cooked sausage) by increasing their juiciness. Specially developed sausages with increased moisture release were perceived as juicier and saltier. The associated reduction in salt ranges from 15 per cent to 40 per cent, depending on the salt content of the sausage.

Excessive consumption of salt contributes to today’s high rates of cardiovascular disease and various other chronic conditions. The current salt intake in the West is well above the recommended daily intake in food of six grams. Bread, processed meat products and cheese are the three most important food categories in terms of salt consumption. A sodium reduction target of 50 per cent has been proposed for meat and processed meat products. Because sodium plays several roles in meat, simply reducing the sodium content is accompanied by a loss of firmness, less intense saltiness, reduction in the flavour profile and a shorter shelf-life. Because these factors ultimately influence consumer acceptance, there is a need for strategies that minimise the side-effects of reduced sodium content.

Three main approaches are proposed in order to compensate for the reduction of sodium in meat products: (1) The use of salt replacers / alternatives; (2) the use of flavour enhancers which enhance the saltiness of products and natural flavourings which reinforce the association with salt; and (3) optimising the physical form of salt to give a stronger salty taste (inhomogeneous distribution of salt in the product). Combinations of the first and second approaches have been successfully used by NIZO in cheese and meat products. The strategy developed by the Top Institute Food and Nutrition and NIZO food research focuses on enhancing saltiness by changing the structure of processed meat products. Recent research has shown that moisture release from a model gel system enhances the sweetness of the product.

The authors used whey protein gels in which moisture release was varied independently of fructose content. Moisture release was defined as the amount of fluid that can be pressed from the product – a phenomenon that occurs when the gels are chewed. Sensory evaluation of the gels showed that increasing the amount of serum from three to 12 per cent increased the perceived sweetness of the gel by 20 per cent; as a result, the fructose content could be reduced considerably without changing the taste. Moisture release is related to the perception of wateriness and juiciness of model gel systems. Again mixed whey protein polysaccharide gels served as the model system to establish relationships between the microstructure of food products and their perception. Because juiciness is an important characteristic of (processed) meat products, we focused on reducing salt content in sausages by increasing the moisture release, and hence the juiciness of these products.

Sausage preparation

The aim of the experimental set-up was to develop a series of sausages that varied in salt content and moisture release but not in texture. Moisture release was controlled by adding different types of polysaccharide to the sausage mixture (i.e. 0.3 per cent methyl cellulose or 0.3 per cent gellan gum). Figure 1 shows that, independent of salt content (between 0.8 and 1.8 per cent), the variants containing methyl cellulose showed low moisture release (average

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Figure 1 Moisture release of the cooked sausage variants with low moisture release (green) and high moisture release (blue).
with high and low moisture release. Analysis of the salt content of the various sausages revealed only slight differences between samples with high and low moisture release.

Salt perception

A trained QDA (Quantitative Descriptive Analysis) panel analysed the sensory properties of the sausages. The panel members agreed on the use of three sensory characteristics to describe the sausages: saltiness, firmness and juiciness. As with the texture assessments, sensory firmness was slightly higher for the sausages with low moisture release than for the variants with high moisture release. In accordance with the moisture release assessments and independent of salt concentration, the sensory juiciness of the sausages with high moisture release was higher than that of their counterparts with low moisture release (Figure 2). The difference in sensory juiciness was not as marked as for the moisture release determined instrumentally. In addition, the sensory juiciness of the variants with low moisture release depended on the salt content. Juiciness increases with increasing salt content. The relationship between moisture release and sensory perception in cooked sausage is more complex than in the model system of whey protein gels containing polysaccharides.

The sensory scores for saltiness showed that the sausages with high moisture release were perceived as significantly saltier than the variants with low moisture release (Figure 2). The degree of increase in salt perception, as a result of moisture release, increased as the salt content decreased. This is consistent with the fact that enhancing effects are generally more marked at low concentrations of tasters. However, it may also be a result of the fact that the juiciness of processed meat products depends on the salt content. In the samples with high moisture release, juiciness is determined by moisture release. In the samples with low moisture release, juiciness is determined by the ability of the meat to bind water, which is influenced by the salt content. The perception of juiciness for the low-serum variant (at 1.8 per cent added NaCl) is only slightly lower than for the corresponding high-serum variants, while the difference in perceived juiciness at 0.8 per cent added NaCl is greater (Figure 2).

Sausage variants displaying high moisture release in instrumental analysis are perceived as juicier and saltier than the corresponding variants with low moisture release. The saltiness of sausage is therefore enhanced by the release of moisture during chewing and the accompanying juiciness. This enhancing effect is greater at low salt levels than at higher salt levels. Figure 3 shows the saltiness of the sausage variants as a function of the measured salt content of the sausages. At all levels, saltiness is greater in the high-moisture variants than in the low-moisture variants.

Significant salt reduction in meat products is possible

The saltiness of sausage is enhanced by moisture release and the accompanying juiciness. The perceived enhancing effect is greater at low salt levels than at higher salt levels. The perception of juiciness in processed meat products is a combined result of the amount of serum extracted from the meat during chewing (unbound water) and the ability of the muscle tissue to retain water (bound water). This study has shown that a relative salt reduction of 15 per cent to 40 per cent is possible with this technology developed by TIFN and NIZO food research.

References


Biographies

Fred van de Velde is Group Leader of the NIZO Protein Centre and Project Manager Protein and Ingredient Functionality. NIZO food research is an independent research company. The Protein and Ingredient Technology group is responsible for innovation in ingredient functionality. The core expertise is tailoring the functionality of proteins. Fred studied organic chemistry at the Delft University of Technology. He joined NIZO food research in 2002 after a post-doc position within the Wageningen Centre for Food Sciences. He is expert on food microstructure and its relationship with mechanical properties and sensory perception.

Marijke Adamse is a scientific assistant at the department Flavour and Texture at NIZO food research. She handles projects from lab-scale to pilot plant productions.
IFFA 2013 on course for expansion – more exhibition space and a new hall concept

Around 950 exhibitors from 47 countries will present their innovations at IFFA – The number one event for the meat industry – in Frankfurt am Main from 4 to 9 May 2013. With new products covering the entire process chain, they will occupy 110,000 square metres of exhibition space, an increase of six per cent compared to the previous event. Organiser Messe Frankfurt expects around 58,000 trade visitors from all around the world.

New hall concept
IFFA 2013 will be distinguished by a new, optimised hall concept. For the first time, the fair will occupy both levels (11.0 and 11.1) of the new Hall 11. There, key international players from the packaging, supply facilities, measuring and weighing technology will present their innovations. Additionally, exhibitors from the processing and cutting segment will be located in Hall 11.1. As in the past, companies from the slaughtering, dismembering and processing segment will be positioned in Halls 9.0 and 9.1. The focus in Hall 8.0 will be on processing. Thanks to this new structure, visitors will find the complete range of machines and equipment concentrated in the western part of the Frankfurt Fair and Exhibition Centre.

IFFA focuses on the trends in the meat-processing sector
Safety, hygiene, traceability, automation and sustainability are important subjects for the meat-processing and supplier industries. In particular, ever greater significance is accruing to the question of sustainability. Many ideas and solutions for the efficient use of energy and resources have already been implemented in many parts of the meat-processing and packaging technology sector, and IFFA offers an up-to-the-minute overview of them. The machines and equipment to be seen in Halls 8, 9 and 11 cover the entire spectrum – from slaughtering, via processing, to packaging.

Suppliers of ingredients, spices, additives, casings and packing materials (Hall 4.0) are important partners for butchers and industrial meat-processing companies. Besides product safety, a good feeling for consumer trends is vital in this field. One of the main subjects in the sector is clean labelling, i.e., the reduction or exchange of declarable additives, allergens and artificial aromas. Additionally, the trend to ‘Walking Food’ describes the lifestyle and eating habits of younger target groups, for which the spice industry offers suitable concepts – not just for characteristic spicy sauces but also for appealing take-away packaging.

The range of exhibits to be seen in Hall 4.1 offers an overview of the latest products and trends for the butcher’s shop with innovations from the fields of measuring and weighing technology and packaging, not to mention new solutions for purchasing foodstuffs, furnishings and protective clothing, as well as quality, service, catering and party-service concepts. Important subjects for butchers include regionalism, energy efficiency, hygiene, convenience and away-from-home sales. Regionalism has developed into a major trend with numerous consumers rediscovering their region in this age of increasing globalism, and giving preference to regional products and economic activity.

Food safety scandals, recalls of foodstuffs, the outbreak of an epizootic disease – are topics that are frequently in the media spotlight and have a high priority in the public conscience. Questions of food safety, quality assurance and traceability play an ever more important role in the meat industry. Traceability is more than just an important tool for risk management. It also plays a part in consumer protection and supply chain improvement including the equipment used for this.

All events that are associated with the production of fresh and cooked meat products must be recorded in detail. This is the only way to guarantee seamless traceability. This process begins with the animals’ birth and continues through their rearing and fattening, slaughter and processing and all stages of transport and storage to the presentation of the products in the shelves and refrigerated display cases. It requires modern information technology, intelligent sensors and vision systems, chemical quick tests, continuous recording of process data including software capable of the complete documentation of all processes.

At IFFA leading manufacturers will show products and solutions of the future for every stage of the traceability process.

Measure, regulate, control
The ‘Quality & Safety Tested’ mark is the focus for innovation in the product segment of ‘Measure,
Berndorf Band GmbH – one of the leading suppliers of steel belts

Each steel belt from Berndorf Band is tailor-made to meet customer’s requirements exactly. An endless production method is used to ensure perfect tracking, uniform flatness and belt straightness. A further important criterion of steel belts is the corrosion resistance. Therefore, Berndorf Band pays special attention to the selection of material. Berndorf Band steel belts are made to match extreme mechanical and thermal stress which makes them the ideal solution for processes like baking, cooling, deep-freezing, steaming or drying.

Both process and conveyor belts can be provided with vee-ropes and/or product retaining strips. A special bonding method ensures perfect adhesion of vee-ropes and product retaining strips within operating temperatures ranging from -60°C to +100°C. As a standard material for vee-ropes, nitril rubber is used. For low temperature applications and meat products using MAP (modified atmosphere packaging) is very popular. Above all, it requires that the packaging is impermeable to leakages and so to aroma and flavour loss or even to premature deterioration of the produce. Consequently, in the case of MAP gas measurement devices for quality control are essential.

Regulate, and Control. This ranges from X-ray control systems and checkweighers, to metal detectors including data capture and quality control equipment, and NIR (near infrared) spectroscopy for quick analysis of the fat, protein and water content in meat so as to eliminate the time taken to prepare test samples.

Presently the packaging of fresh and cooked meat products using MAP (modified atmosphere packaging) is very popular. Above all, it requires that the packaging is impermeable to leakages and so to aroma and flavour loss or even to premature deterioration of the produce. Consequently, in the case of MAP gas measurement devices for quality control are essential.

Suppliers will showcase equipment for random sample measurement in the laboratory in addition to systems for offline measurement and for in-line process control in production.

Tagging and identifying
Animal breeders must mark cattle, pigs, sheep and goats with ear tags which are printed with details of the member country of the EU, federal state, administrative region, county, municipality and business from where the animal originates. Before slaughter it is necessary to also include the traceability code of the abattoir. Ear tags (barcode tags) and animal passports are sufficient for living animals. However post-slaughter these markings can no longer be used for identification.

In this case, efficient labelling systems make it possible to clearly identify every cut of meat or complete batches. The systems comprise printers and barcode scanners in addition to electronic identification using RFID (Radio Frequency Identification). The latter in particular are becoming increasingly important due to their versatility in terms of process automation and process control. It will be some time before all the possibilities of RFID technology are fully

NDC adds collagen to its range of meat measurements

At IFFA 2013, NDC will be exhibiting the latest version of its popular InfraLab Benchtop Meat Analyzer.

In addition to fat, moisture and protein measurements, the latest InfraLab adds collagen to its measurement capabilities. A four-component InfraLab takes just 10 seconds to measure a single sample for all parameters, which gives significant time and resource cost savings.

Developed from the outset for the process, as well as for the QC lab, the InfraLab requires minimal operator skills in routine use. Its robust, easy-to-clean hygienic design makes it ideal for the meat further processing industry, where batch release, quality assurance and process profitability rely on accurate repeatable measurement data.

InfraLab is secure too, requiring user log in via its intuitive colour touch screen before use. For each sample, a user name, customer reference, time and date values, measurement results and standard deviations are recorded. Data can be exported conveniently via the USB port to a spreadsheet or other program. Ethernet connectivity enables network and LIMS integration.

Berndorf Band is a reliable partner for a huge number of steel belt users, no matter if small and independent or multinational. Some of the most important OEM producers of steel belt machinery also count on Berndorf Band.

www.berndorf-band.com

Find InfraLab on NDC’s stand F34 in hall 9.1, or visit www.ndc.com/meat for further details

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exploited, but the expectation is that it will offer advanced future solutions in the areas of stock management and intralogistics with respect to the identification and traceability of pallets, E2 crates or products packed in trays.

Food safety, quality assurance and traceability are the topics trending at IFFA 2013. New product development is targeted to coincide with the IFFA, it being the first time new products are presented to an international trade audience.

**Hygiene and hygienic design: the key to improved food safety**

More than ever before, safety, quality and hygiene are top priorities in the meat-processing sector. Consumers expect and demand safe products made using perfectly hygienic methods. At IFFA trade visitors can obtain a complete overview of the latest innovations in the field of hygiene technology and future developments.

Hygiene begins with the personal cleanliness of employees and their protective clothing, gloves and equipment, as well as the clear separation of personnel and production areas. The broad spectrum of hygiene equipment to be seen at IFFA includes disinfectant basins, hand wash basins for contact-free washing and disinfecting, sole and boot cleaning machines, knife sterilisation basins, soap dispensers, wastepaper baskets and towel dispensers. Parts of machines, conveyors and other plant components that come into contact with products must be cleaned of any product residuals sticking to them and disinfected at

**Steel belt conveyors for enhanced hygiene and reduced cleaning costs**

Sandvik Process Systems, the world’s largest producer of stainless steel belts, will showcase the hygienic and economic benefits that this technology can bring to meat processors and others further along the supply chain.

Visitors to Sandvik’s stand (Hall 9.1, Stand F63) will be able to see a fully operational food conveyor that showcases the design features required for food-quality conveying, including endless belt and ease of cleaning.

Research carried out by Finnish food laboratory VTT Expert Services Ltd has shown that bacterial build-up on meat conveyors can be reduced by upgrading to a stainless steel conveyor. And with hygiene, safety, quality and compliance high up on everyone’s agenda, the inherent cleanability of a stainless steel belt is convincing many processors to take a fresh look at Sandvik’s systems.

As a flat, smooth, hard and inert conveying medium, steel belts can be cleaned and sanitised using heat, pressure, brushes, detergents or chemicals. Quick and easy cleaning enables the highest standards of hygiene to be maintained and offers a number of other benefits too. Low water consumption and reduced use of cleaning chemicals or detergents means lower costs and less impact on the environment, while faster cleaning results in less downtime.

The inherent strength of the material also means it is more resistant to knife or bone damage, and therefore less likely to suffer cuts where microbes can develop.

While meat conveying will be the main focus of the stand, Sandvik will also highlight applications for its belts in other areas of meat processing – including freezing – and across the broader food industry where its versatile products are used for everything from baking and cooking to steaming and drying.

Senior management and specialist engineers will be on the stand throughout the fair to provide full details of Sandvik’s design, engineering and installation services.

**uni ECB Belts for Reducing your Cleaning Costs**

uni ECB takes cleanability one step further in optimising hygiene on meat processing lines.

With the patented uni Snap Link design – a pinless belt. The pinhole and the pin inside are unaddressed hygiene issues on all modular belts available on the market today.

By removing the pin and pinhole, a major bacteria trap is eliminated. The dummy hinges absorb impact and drive the belt using the markets most cleanable sprocket engagement system.
regular intervals. Most of this work is still done manually, which is time consuming, expensive and not always completely reliable. Therefore, more and more users are turning to automatic CIP (Cleaning-in-Place) and SIP (Sterilisation-in-Place) systems. In common with many other fields, the trend is towards robot-based processes. However, with or without robots, the automatic cleaning systems can be adjusted to meet individual requirements and thus achieve optimum and, above all, reproducible results.

In this connection, extremely precise automatic dosing systems guarantee a more efficient use of cleaning agents, which in turn helps reduce the burden on the environment, conserve resources and cut costs on the procurement and waste-disposal sides.

The cleanliness and ease with which meat-processing machines and plant can be cleaned is also a question of design. Thus, simplicity is the key principle of hygienic design (HD) and the aim is to avoid undercuts of all kinds and open seams, in which product residuals can catch and form ideal breeding grounds for microorganisms. For the same reason, open screw holes, Allen or Torx screws, etc. are not permitted. Corners and transitions must be smooth, free of joints and cleanly rounded off. The surfaces of covers or sensor housings in spraying or wet areas should be inclined at an angle of at least three degrees to avoid any traces of water remaining on them. Steeper gradients ensure a faster run-off and should, therefore, be used whenever possible. Additionally, it should be possible to clean all parts that come into contact with the product without having to remove them from the CIP or SIP systems.

**Investments in hygienic design pay off**

Food processing and packing lines not based on hygienic-design principles have no future in the market because the risks and costs in terms of potential production losses, recall campaigns, recourse claims and image loss are too great. Therefore, to invest in HD represents excellent insurance and is worthwhile in terms of both production and economic efficiency. Hygienically designed machines and plant offer none or significantly fewer opportunities for product residuals or contamination to take hold. Fewer deposits means less cleaning effort, which in turn saves cleaning agents, water, steam and energy. In a nutshell, hygienic demand increases the productivity of machines and plant and, against the background of growing demand for convenience food and small or individual packs generated by the increasing number of single and two-person households, this aspect is growing continuously in significance. The changed pattern of demand has resulted in smaller batch sizes and increased product variety for food retailers and packaging companies. In turn, this means more frequent changes of product and cleaning for the production companies. Thus, to be able to operate profitably under these circumstances, companies must minimise the change-over and cleaning times – in other words, HD is a must.

Trade visitors can see the latest innovations and trends in the field of hygiene technology at IFFA 2013. Around 950 exhibitors, including all market leaders, will present new products for all stages of the meat-processing chain. Thanks to the new layout of the fair, the complete range of machines and plant is now concentrated in Halls 8, 9 and 11, in the western section of Frankfurt Fair and Exhibition Centre. There, visitors can see the latest high-tech solutions for firms of all sizes – from artisan operations to the meat-processing industry.

**Automation for greater productivity and food safety**

Automation in the meat-processing industry is an important issue. It ensures greater energy efficiency as well as productivity and quality. In addition, it improves hygiene conditions and relieves staff of the heavy physical work. Industrial robots are increasingly proving to be the key to effective solutions as opposed to costly specialised mechanical approaches.

**Sortation conveyors and sorting robots**

Sortation conveyors work by presorting the goods and temporarily storing the weighed fillets in buffer compartments or interim diverts. Since each buffer compartment requires individual checking for number and weight, this means, as well as complex and costly mechanical systems, the use of a lot of measuring and control technology. Once the target weight and number have been reached in the buffer storage boxes, the latter drop the products via a trap onto the conveyors beneath.

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**Ammeraal Beltech – One Stop Belt Shop in the meat industry**

Ammeraal Beltech is a global belting company and a true ‘One Stop Belt Shop’ that is able to provide components, services and solutions for processing and conveying products. Our success is the control of the full value chain (development, manufacturing, fabrication, sales, distribution and service) and the close co-operation with our customers and other partners in the wide area of meat applications.

The company has extensive know-how and expertise, particularly in the meat industry, and provides a wide product range for any application e.g.:

**uni ECB – easy clean modular belt**
uni ECB is developed in close co-operation with slaughterhouses and has the unique design to meet the demands regarding hygiene and food safety.
- Reduces cleaning costs

**Soliflex PRO – homogenous positive drive belt**
This well-balanced concept allows for easy cleaning, reducing total cleaning costs in perspective of time, water and cleaning agents.
- Avoids fibre contamination
- Easy and fast cleaning
- Self-tracking
- Scraper friendly

**Self-tracking belts**
The Ammeraal Beltech self-tracking belts reduce costs, offer conveying benefits and can improve the overall reliability.
- Quick installation/replacement time
- User friendly
- Increased lifespan

For more information, please visit us at IFFA 2013 – Hall 9.1, no. C89

www.ammeraalbeltech.com
which then take them to the packing line, where there is always a relatively large amount of manual work to be done.

Sorting robots make it possible to build compact robotic units for weighing, sorting and packaging according to pre-determined weights. In addition, they allow rapid changes of format and mixed mode operation. ‘Mixed mode’ here refers to the parallel packing of e.g. chicken fillets in trays according to a fixed weight and the simultaneous packaging of ‘bulk ware’ in larger boxes for bulk packs. The result is that ‘cells’ of sorting robots with three delta robots can fill trays or boxes in any ratio required. The first two robots pick out the best-fit fillets and fill the trays for the fixed weights with them; the third puts the rest into boxes for the ‘bulk packs’.

To summarise the technology: at the entrance to the ‘robot cell’, one or more belt scales weighs the fillets on their way from the cutting room. Then the conveyors pass the fillets under a detector which determines their weight, exact location and orientation. From these data, depending on the weight in each case, a sorting algorithm calculates the instruction set for both conveyor belt and robots.

The entire gamut of new automated solutions relating to the processing and packaging of meat and sausage products will be showcased by the exhibitors at IFFA.

For further information on IFFA 2013, please visit: www.iffa.com