Speaker Abstracts

Future challenges of the new European regulation on the protection of animals at the time of killing and its relevance to international

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On 1st January 2013, a new European regulation on the protection of animals at the time of killing — Regulation (EC) No 1099/2009 — will apply within the European Union. It will replace a directive adopted 20 years ago. The contexts for trade in meat in the European Union and internationally has changed with the increased interest by the public in the ways animals are treated. Science and technology on stunning and handling animals has evolved too. The meat industry has become highly industrialised. The EU legislation on food safety assumes that business operators are responsible. The Regulation of 2009 will affect both slaughterhouse operators and competent authorities. The first one will have to fully integrate animal welfare in their process and ensure its implementation. Studies have shown that some operators in the EU have already moved this way due to pressure in particular from the retailing system. One important challenge will be to educate workers to understand animal welfare in slaughterhouses because of the innovative aspects of the issue and the need to convince them of the cost/benefits derived from the proper handling of the animals. A further challenge for slaughterhouse operators will be to ensure the monitoring of the 'level' of animal welfare on the basis of systematic procedures. To deal successfully with all those challenges, the close collaboration between authorities and operators will be essential. This is why the new regulation requires Member States, for the first time in the area of animal welfare, to set up a 'scientific support' which will provide technical and scientific assistance to inspectors and stakeholders. Facilitating access to technical information is a key element for improving the enforcement of welfare standards. A system of certification of competence should provide to operators and competent authorities a new tool to further compete on 'quality' and animal welfare ensuring transparency and reassuring the consumers. This will be even more relevant in relation to imported products. The new regulation maintains the same requirement of the Directive of 1993 requiring that imported meat from third countries to be accompanied with a certificate that guarantees equivalent welfare standards to EU ones. Based on the international standards the EU reaffirmed in this way its commitment to improve the welfare of animals at international level. The proper enforcement of these requirements has been developed together with the partnership agreements with third countries in animal welfare and offering training and capacity building opportunities in order to promote mutual understanding on the issue.

Methods for whole-house gassing of poultry

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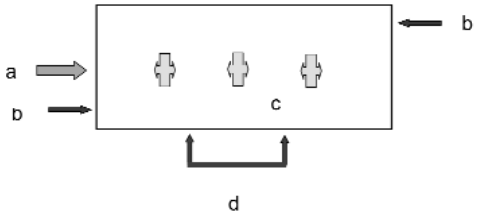
Whole-house gassing of poultry using liquid carbon dioxide (CO_2) is one method of culling that can be implemented in the case of a disease outbreak. Although birds find CO_2 aversive, the method is relatively quick and reduces human exposure to zoonotic disease. However, it is important that lethal gas levels are achieved quickly and uniformly, to prevent protracted suffering of the birds being culled. In this study, various methods of gas injection were tested for evenness of CO_2 distribution. They were (see Figure 1): a) a single lance injecting into one end of the shed; b) two lances injecting into each end of the shed; c) upstands placed down the middle of the shed; and d) twin lances injecting into the side of the shed (see Figure 1). For all methods except method (b), a single tanker of liquid carbon dioxide could be used, but with method (b) two tankers were required. Gas concentration of oxygen and CO_2 were measured using Combi Check analysers (PBI Dansensor, Denmark). All methods were effective in filling poultry houses with lethal concentrations of gas (ie 45% in ~8 min) apart from upstands which took >14 min to reach 45%. Method ii) is required to fill larger poultry houses. Method i) was used to cull a flock of ~12,000 5-week old pullets suffering from Marek's in a shed 30 × 12 m. Carbon dioxide levels reached 45% at the rear of the building in 5'20", at which point gas ingress was stopped. Carbon dioxide at bird level was 50% (max) and 46% at the end of a 1 h soak period. On inspection, all birds were dead and there was no evidence of smothering or panic judging by position and distribution of carcases. Post mortem examination of 20 birds found no evidence of fatal hypothermia, a concern when injecting liquid CO_2. Liquid CO_2 can be used to cull poultry quickly and relatively humanely.

Figure 1 Overhead view of a poultry shed, showing gas entry points: (a) single lance; (b) two lances; (c) upstands; and (d) twin lances.



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Electrical stunning of farmed fish

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Quality-oriented food animal production has become more important during the last few years. All animals, including fish, should be protected from anthropogenic excitement, pain or suffering during transport, lairaging, restraint, stunning, slaughter or killing. An applied method of electro-anaesthesia is widely used for the stunning of slaughter animals based on the induction of a general epileptiform insult ('grand mal' or seizure-like state). Provided that sufficient electrical current is passed through the head a general epileptiform insult, which is indicative for unconsciousness, will occur. Ineffective stunning can be very painful and paralysis may occur. Therefore, the use of EEG recordings and responses to stimuli are recommended. The so-called eye roll appeared insufficient to assess loss of consciousness. Fish can be rendered unconscious in water by applying a voltage across two plate electrodes for 1 s. When the voltage is applied top-to-bottom, perpendicular or head-to-tail, the minimum current density depends on the orientation of fish relative to the electric field. The minimum current needed for an immediate stun depends on the fish species, conductivity of the water and waveform of the current. A combination of electrical stunning for 5–20 s followed by chilling in ice water resulted in death of the stunned fishes. Analysis of the flesh quality showed product quality is comparable to that obtained by, for instance, live chilling. Using chilling as killing method for electrically stunned fish is a recommended method for application in a commercial setting. An alternative for stunning in water is dry electro-stunning head-to-body. For this approach, a stunner that consists of rows of steel flaps with a conveyor belt as positive and negative electrodes, respectively, is used. The conveyer belt transports the fish during exposure to electricity through the stunner. The waveform of the current consists of an ac (100 Hz sinusoidal) and dc component. For head-to-body stunning of Atlantic salmon (*Salmo salar*) a minimum current of 0.67 Arms (≈107 Vrms) is needed. Methods to prolong the unconscious conditions until death ensues should be sought. Dry electro-stunning followed by decapitation is a useful method for the slaughter of African catfish (*Clarias gariepinus*) and hybrids. The method is easy for industrial fish processors to apply if their current procedure includes decapitation and evisceration. When using a minimum current of 0.57 A head-to-body for an individual catfish for 5 s, decapitation should be applied within 60 s post stun to prevent recovery.

Assessment of the relative welfare impacts of three gas treatments for the euthanasia of suckling piglets

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When euthanasia of sick or injured animals is required on animal welfare grounds, a method that induces minimal welfare compromise should be chosen. Blunt force trauma to the head is currently the most commonly employed means for on-farm euthanasia of pre-weaned piglets. When performed correctly, loss of consciousness is immediate, but the potential for delivery of sub-lethal blows, along with aesthetic unacceptability to many operators, has lead to the need for alternative methods to be developed. The present study investigated the relative welfare impacts of the use of three different hypoxic gases or mixtures for euthanising suckling piglets. The gases were 100% carbon dioxide (CO_2), 100% argon (Ar) and a mixture of 40% CO_2: 60% argon (Ar/CO_2). Each gas was tested using male piglets, aged between 14 and 21 days (n = 5). On each occasion, a chamber was filled with the test gas and a piglet was placed inside. Throughout the experimental period, behavioural (escape attempts, vocalisation, loss of co-ordination, respiratory effort, convulsions) and physiological (electroencephalogram [EEG], electrocardiogram [ECG], respiratory rate) data were continuously recorded until death. In addition, plasma cortisol and adrenaline levels were determined before treatment and immediately following death. A welfare index was established to assess the relative welfare compromise induced by each gas treatment. The index included five behavioural measures observed in the period prior to apparent loss of consciousness, beyond which there was no further potential for welfare compromise. These measures were: latency to onset of convulsions, duration of escape behaviour, duration of increased respiratory effort, respiratory effort grade and duration of squealing. The sum of ranks for each animal across the 5 measures yielded a single score indicative of welfare compromise, with a lower score equating to less compromise. According to this index, CO_2 induced significantly greater welfare compromise (49.8 [± 2.77], mean [± SEM]) than either Ar (35.2 [± 3.56]), or Ar/CO_2 (37.0 [± 0.89]). These results suggest that 100% CO_2 is not an acceptable method for on-farm euthanasia of young pigs. Although argon and the mixture did not significantly differ in terms of welfare impact, times to loss of consciousness, isoelectric EEG and respiratory arrest were significantly shorter with Ar/CO_2 than Ar ($P < 0.05$), making this potentially more useful from a practical standpoint. However, the degree of welfare compromise observed in all treatments suggests that other alternatives to manually applied blunt trauma should be investigated.

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Electrical stunning of captured fish

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Electrical stunning to protect welfare of food animals at slaughter is established for a range of farm animals. For fish, it is reported that when sufficient current is passed through the head, a general epileptiform insult will occur, which is recorded on an EEG. The epileptiform insult is indicative for loss of consciousness. Fish species' specific specifications to achieve an instantaneous stun without recovery, should be based on EEG recordings. It is known that electrical stunning of fish may lead to carcase damage. For Atlantic Salmon (*Salmo salar*) it is reported that so called 'dry stunning' results in a very low incidence of damages. With 'dry stunning', a current is administered to a fish, after de-watering, via rows of positive plate electrodes and a conveyor belt as negative electrode. Preliminary experiments performed by SINTEF with captured fish indicate that electrical stunning could allow for more rapid gutting and rinsing of fish onboard. Stunning of captured fish prior to killing could, therefore, increase the fish quality and at the same time protect welfare of fish at slaughter. The issue of electrical stunning of captured cod (*Gadus morhua)* and haddock (*Melanogrammus aeglefinus*) onboard is one of the sub-objectives of a Norwegian project, led by SINTEF. This project started in 2010 and focuses on development and assessment of novel technologies onboard. In this project we assessed 'dry stunning' of captured cod and haddock onboard the *Jan Mayen*. For the 'dry stunning', experimental equipment developed by the Norwegian manufacturer SeaSide was used. EEG recordings revealed that when on average 52 Vrms (100 Hz alternating current component, coupled with a direct current component) was applied across the electrodes for 1 s, sufficient current was passed through cod and haddock to provoke immediate loss of consciousness. In 2009 a group of fishermen in The Netherlands decided to initiate a project on stunning of captured sole (*Solea solea*), turbot (*Psetta maxima*), plaice (*Pleuronectes platessa*), dab (*Limanda limanda)* and cod onboard. It is the view of these fishermen that sustainability of fisheries should also include welfare of captured fish. The Dutch project, which started in 2010, is managed by the company Scienta Nova. The first step is to establish conditions for 'dry stunning' to achieve instantaneous loss of consciousness in plaice and dab.

Welfare of animals and employees in connection with slaughter or euthanasia of animals

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Human awareness and skills constitute the one most important factor for the welfare of the animals in their care. We aim to study human-animal interaction and relationships between investments in human resources and animal care, assessed levels of employee subjective well-being (SWB) and animal welfare (AW), and the organisational efficiency at different workplaces where animals are handled and killed routinely. A three-year innovative collaboration between natural sciences, medicine, social sciences and humanities was initiated in 2009. SWB refers to a person's evaluation of his/her life. It includes both a cognitive and an affective component. Different factors influence SWB, work place and job satisfaction being highly important. AW has been defined in various ways; the most general one states that AW occurs when the animal is in harmony with its environment. Research shows that AW is affected by the way animals are handled by humans, whose knowledge, attitudes and personalities are important factors. There are also studies showing positive effects of human-animal interaction on human well-being and animals can be used in rehabilitation or treatment of physically and psychologically ill people. In this study, staff and animals at abattoirs and animal laboratories in Sweden are studied. In both these types of workplaces there is frequent human-animal interaction of a particular kind. There are also many differences regarding, eg gender distribution among employees, level of education, social standing, physical and mental work conditions and animal species. We hypothesise that there is a mutual dependency between employee SWB and AW at these workplaces, resulting in a virtuous or vicious circle. A healthy, satisfied and happy abattoir or laboratory employee is more likely to interact with his or her environment in a friendly way, and to treat fellow workers and animals well. A healthy, non-stressed and well-treated animal is easier to handle, and less likely to cause irritation and stress among the staff. Data are collected through

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questionnaires, interviews, observations of humans and animals in interaction and a review of strategic company documents. Results from the study will be presented. These are expected to illustrate the importance and the impact of simultaneous focus on human well-being and animal welfare to reach a higher level of both in a production setting.

Journey duration and welfare of pigs transported to slaughter in the UK

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Ongoing 'Review of Council Regulation (EC) No 1/2005' on protection of animals during transport has reopened the debate on permissible journey durations for pigs. A Defra-funded study was carried out at two UK-based commercial pig abattoirs to assess the possible influence of journey time on welfare of pigs transported to slaughter. A total of 195 loads (deliveries) of pigs were observed between October 2009 and August 2010 covering winter and summer conditions, delivering 32,334 pigs from a variety of husbandry systems. Selection of loads to include in the study was semi-random. Journey durations of transports observed ranged between 59 min and 18.45 h, with the majority being less than four hours. Pigs were observed being unloaded in order to assess incidence and severity of injuries and lameness. Where possible, behaviour of up to 61 pigs per load was then observed in a lairage pen for up to one hour. In addition, pH values were measured in the *Musculus glutaeus medius* 45 min and 24 h post slaughter from a representative sample of carcases from most loads. Salivary cortisol was measured in sub-sets of pigs in one abattoir. In total, six pigs were dead on arrival (0.02%). Eighty-nine pigs were lame to the degree that they walked with difficulty or avoided putting weight on the affected limb. This was not related to journey duration. Eighty pigs were killed immediately upon arrival as casualty slaughters, though this included slaughter for declared injuries. Other main reasons for casualty slaughter included traumatic injury, lameness, ulcerated tail-bites, heart attack, or rectal prolapse. Behavioural analysis revealed that the first pig in each group observed started drinking within ten minutes of arrival, regardless of journey duration. Neither did duration affect incidences of aggressive behaviour in lairage. Pigs that had travelled more than eight hours did have a longer latency to rest than those that had travelled four hours or less. Although both pH_{45} and pH_{24} were influenced by differences in journey duration, this explained little of the variation in these measures. Levels of salivary cortisol increased linearly with journey duration. Uniquely, this study combines behavioural and physical indicators of welfare in slaughter pigs to assess effects of journey duration under commercial conditions. From these data there is currently no indication that travel durations of up to 18.5 h have an obviously negative effect on welfare of pigs transported to slaughter in the UK, although the implication of salivary cortisol levels at longer journeys needs further investigation.

High expansion gas foam: a humane agent for emergency killing of poultry?

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Disease control measures require poultry to be killed on farms to minimise the risk of transmission to other poultry, and in some cases to protect public health. We assessed the welfare implications for poultry of application of high expansion foam, intended as a gas delivery mechanism (ie not occluding the airway). Individual bird trials investigated the physiological and behavioural responses of broilers and hens to nitrogen-filled foam. A novel small-scale foam generator was used which was capable of producing foam with an expansion ratio of approximately 300:1. The birds were equipped with sensors and a logger to record cardiac and brain activity (electroencephalogram, EEG) and were exposed to foam in a 1 m^3 Perspex box. Behavioural responses to foam included head-shakes and brief bouts of wing flapping, followed by ataxia/loss of posture and vigorous wing flapping characteristic of anoxic death. Loss of posture was seen on average 15.5 s after submersion in hens but significantly earlier in broilers (9.2 s). The average onset of vigorous wing flapping was 17.8 s in hens and 15.3 s in broilers. Mean time to motionlessness was significantly shorter in broilers (51.4 s) compared to hens (65.2 s). Based on EEG characteristics not compatible with consciousness, mean time to onset of unconsciousness was 30.1 s in hens 17.6 s in broilers. Post mortem examinations showed that the foam did not occlude the airway. The euthanasia achieved with anoxic foam was particularly rapid, due to the very low oxygen concentrations achieved in the foam (below 1%). Trials with ducks and turkeys produced similar results. Identical trials with carbon dioxide-filled foam showed that its mode of action was anoxia. These trials provided proof of the principle that submersion in anoxic foam is a highly effective and humane method of euthanasia. Further trials to scale up nitrogen-filled foam application were carried out, focusing on foam delivery rate and the height of foam achieved over submerged birds before flapping onset. These

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trials showed that initial stocking density (40–50 kg m^{-2}) did not greatly affect the rate of foam destruction. Physiological data showed no significant differences compared to the results of laboratory studies on single birds. Thus, foam as deployed in these larger trials, delivered a reliable and humane anoxic kill which was robust even at maximal stocking densities. Based on the results of these studies, an operating protocol (including design standard, application protocol, operating routine, monitoring points, foam depletion and bird removal instructions) have been produced.

Reduction of stress reactions of lambs at slaughter by improving their reactivity to human beings

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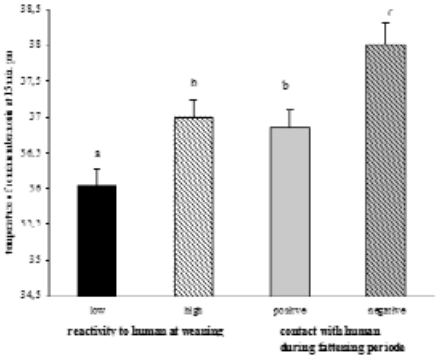
The slaughter period starts at the farm when animals are prepared for transport and ends when death is induced with the stunning and/or bleeding procedure. This period is associated with various potentially stress-inducing factors including physical constraints (eg transport, food deprivation) and psychological challenges, (eg human presence, unfamiliar environments). Stress reactions at slaughter can be reduced by diminishing the stressful aspects of the slaughter procedures. Other approaches may also be used. Stress reactions depend partly on the individual's propensity to interpret negatively environmental events. While it is well known that early emotional experiences may modulate later emotional reactivity of the individual, less is known of the effects of negative or positive emotional experiences occurring later in life. Such knowledge may help adapting farming practices to produce animals that are less reactive to the slaughter procedures. The present study investigated in lambs (Romane breed) whether early positive experiences may reduce stress reactions at slaughter. Therefore, it assessed (i) whether reactivity to a human after weaning predicts reactivity at slaughter, and (ii) whether positive contacts with humans during fattening reduce reactions to slaughter procedures. Reactivity to a human was evaluated after weaning in 121 lambs using a standardised test. The 40 most and 40 least reactive lambs were selected and reared in 4 groups balanced for reactivity scores. Two groups received negative contacts (automatic food distribution, abrupt and sudden handling) while the other two groups received positive contacts (manual food distribution, calm handling). In addition, 5 days a week an experimenter spent 1 h quietly in each of the latter 2 groups, stroking those lambs that accepted. Two months later, reactivity to the human was again evaluated. Reactivity to the human at weaning was positively correlated with reactivity at the end of fattening ($F = 20.54$, $P < 0.0001$), indicating that lambs showed consistent differences. In addition, positive contacts during the fattening period reduced the reactivity to the human ($F = 3.69$, $P = 0.04$). Following slaughter, muscles of lambs that after weaning were less reactive to the human were cooler (Figure 1). Muscles of lambs of the positive contact groups were cooler ($F = 5.45$, $P = 0.02$) and had a slower pH decline ($F = 7.45$, $P = 0.008$). These characteristics are indicative of slower post mortem muscle metabolism suggesting lower pre-slaughter stress levels. Thus, reactivity of lambs to human presence after weaning can predict stress reactivity, including to the slaughter procedure. Positive experiences with humans during the fattening period may reduce stress reactions at slaughter.

Figure 1 Effect of reactivity and treatment on muscle metabolism.



The welfare of horses at slaughter: the development of recommended handling guidelines and animal welfare assessment tool for horses

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The horse meat industry is a vibrant part of Canadian agriculture including its export markets. Horses processed for human consumption generate at least $50 million per year with annual exports of live horses to Japan at approximately $16.9 million. According to the 2008 Alberta Horse Welfare Report, Alberta exported a total of $44.1 million worth of horse meat: $25.8 m to Europe, $15.8 m to Japan and $2.3 m to other countries. As part of their mandate, the Horse Welfare Alliance of Canada recognised the need to develop animal handling and welfare assessing tools for the horse industry. They understood that as the horse processing industry continues to evolve, all must be done to ensure optimal care and show due diligence in regards to the welfare of horses at slaughter. This could only be achieved through the development of industry-recognised guidelines, animal welfare assessments and education of all those involved in the process; this has been successfully accomplished in the other livestock industries. *The Recommended Handling Guidelines and Animal Welfare Assessment Tool for Horses* was developed in consultation with leading animal welfare scientists, equine behaviourists and horse slaughter experts from across North America. The guidelines include behaviour and handling of

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horses, facility design for optimal animal welfare at loading, unloading, lairage and within-plant handling areas, transportation, and proper stunning, along with animal welfare assessment standards and forms. The standards utilise objective numerical scoring of the percentage of horses stunned correctly with one shot and the percentage of horses falling during handling. The benefits of this guideline include consistent industry guidelines for the transport and processing of horses for meat, an animal welfare management tool for both the industry and third party assessors, a standardised tool to assess the welfare of horses during processing, concise standards for what is acceptable, positive messaging to the public and customers that this industry is responsible and cares about the animals, and document factual information on the processing of horses in North America.

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