Tesco and Hilton Seafood – Improving the welfare of whiteleg shrimp (*Pennaus vannamei*) at harvest.

A case study of a large-scale industrial trial of electrical stunning for P.vannamei.

This stunning system, now approved for use in the Tesco and Hilton Seafood supply chain, is the first large scale electrical stunning system used for prawns.

Background

Crustacean sentience and welfare

Historically, the sentience of crustaceans has not been recognised within the food industry and therefore overlooked with respects to humane slaughter methods. There is a significant and growing body of evidence in the scientific literature, that crustaceans are sentient animals that can experience pain. For example, prawns exposed to painful stimuli were observed to rub at the affected area, and this behaviour was reduced when an anesthetic was applied (Barr et al., 2008). Hermit crabs have also been shown to remember painful stimuli and try to avoid them (Appel and Elwood, 2009). The European Food and Safety Authority (EFSA) have acknowledged that the evidence indicates that decapod crustaceans can indeed feel pain (EFSA, 2005) which means that their welfare needs to be protected.

Crustacean welfare is currently not covered under UK animal welfare law (Animal Welfare Act 2006) or EU regulation (EC 1099/2009) which stipulates requirements at time of slaughter for terrestrial vertebrate species. Inhumane slaughter techniques are one of the greatest concerns for crustacean welfare, where individuals are subjected to slow and painful deaths without stunning. Crustacean welfare studies and recommendations have only been broadly researched in recent years and there is only a handful of research being carried out regarding humane slaughter. Since crustaceans have no legal protection in terms of appropriate welfare standards in many countries, it remains the responsibility of food businesses to ensure that their welfare is protected within supply chains.

Whiteleg shrimp (*P.vannamei*)

P.vannamei, also known as whiteleg shrimp or King prawn, are the most widely cultured shrimp in the world. In 2017, total production of *P. vannamei* was 4,456,603 tonnes (FAO, 2019) amounting to approximately 171.4 – 405.1 billion individuals (Moode and Brooke, 2019). Slow suffocation without stunning is still a common slaughter method for this species, however immersion in ice water or ice slurry is becoming more prominent. When prawns are cooled below 4°C, they enter a state of torpor, but the effects are not instantaneous, and it is not clear if the animals are sufficiently anaesthetised during cold immersion to limit discomfort.

Electric stunning has been validated for use in some decapod species, such as crab and lobster, and there has been some research which suggests that electroshock induces effective stunning in shrimp (Weineck et al., 2018). International guidelines, such as RSPCA Australia, recommend electrical stunning/slaughter as the most humane method of slaughter for decapods. Currently, however, this method is rarely used due to a lack of research and commercial trials and because of the specialist equipment required.

Tesco, Hilton Seafood and Amanda Seafood

Hilton Seafood (HSF) and Tesco have been working together for over 15 years and as part of this long-term relationship are always seeking opportunities to drive continuous improvement on animal welfare standards. Tesco and HSF both have public animal welfare policies (see respective websites), which state that all animals should be effectively stunned prior to slaughter. Their suppliers are specifically selected for their commitment to work with them on further developments in animal welfare innovation, sustainability and any other advances in aquaculture. Following the successful roll out of humane stunning and slaughter of fish, including undertaking electric stunning trials for bass and bream (link to case study), both Tesco and HSF felt it was important to understand the feasibility of humane stunning for *P.vannamei*.

Currently, over 100 million *P.vannamei* are supplied to Tesco through HSF annually. HSF have long-term close relationships with key vertically integrated prawn suppliers in Vietnam. Over the last 2 years, HSF and Tesco have been collaboratively working with Amanda Seafood to undertake commercial trials of electrical stunning of *P.vannamei* to assess potential welfare benefits at slaughter. Following a successful trial in June 2020 and review of the outcomes by external animal welfare experts, Tesco approved the use of electrical stunning of *P.vannamei* in July 2020. Since then, approximately 80% of the *P. vannamei* supplied to Tesco through HSF have been electrically stunned. The ambition is to achieve 100% electric stun for *P.vannamei* in the HSF supply chain.

This stunning system is the first large scale electrical stunning system used for prawns globally.

Electrical stunning trials

Overview

In June 2020, trials were conducted to (i) establish the efficacy of using existing dry electrical stunning technology for immediate stunning of *P.vannamei* in a commercial setting, and (ii) optimise parameters to balance effectiveness of stun with product quality.

Dry electrical stunning technology, originally designed for salmonids, has been successfully adapted for use across a range of aquaculture species, including for bass/bream in the Tesco/HSF supply base. The *P.vannamei* trial was undertaken using an Optimar stunner. This Optimar system is standard to the aquaculture sector and the electrode arrangement was slightly modified from a finfish system to match the size of the prawns. Operating parameters under test were consistent with those reported as demonstrably effective in independent research (Weineck et al., 2018).

The trial was undertaken during harvest at a commercial *P.vannamei* farm in Vietnam in collaboration with Amanda Seafood, utilising 6 ponds all uniform in size, with each pond containing a maximum density of 90 prawns per m^3. The pump was positioned to transfer animals directly between the pond and the stunner. The Optimar stunning machine is 2 metres long and 0.85 metres wide. The prawns are 25-30 g when they are harvested, and their size ensures that they will always touch both the paddle and the conveyor electrode during stunning.

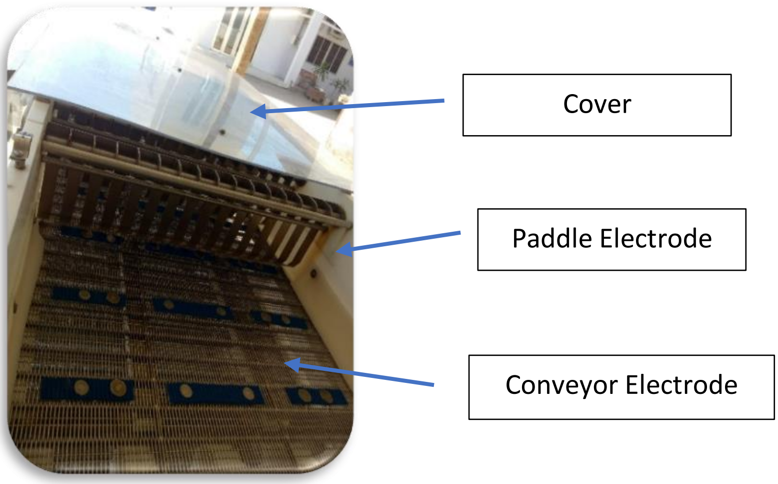

Figure 1: Optimar Dry Electrical Stunner

The harvesting process

Prawns were crowded for a maximum time of 1 hour using a seine net towed by hand around the pond and then pumped directly from the pond and discharged onto the conveyor belt of the electric stunner at a throughput rate of 10 tonnes per hour. The welfare assessment of the trial indicated that using a single chute to discharge prawns onto the stunner resulted in some 'bunching' of animals on the conveyor belt, which can result in pre-stun shock. The single chute was therefore replaced with a dual entry feed (Figure 2).

This has replaced the previous method of harvest where the water level in the ponds was reduced to around 80cm before the prawns were crowded into a pond corner by the means

of a sweep net. Prawns were manually lifted out of the ponds with baskets (max. 10kg to avoid physical damage) and emptied within 15 seconds into a well-managed ice slurry (<4 degrees Celsius) where they were fully immersed and thereby slaughtered.

Figure 2: Dual entry feed to discharge prawns onto the stunner conveyor.

Prawns were stunned when simultaneously establishing contact between both conveyor and paddle electrode, or because of prawn-to-prawn contact across paddle and conveyor electrode surfaces (Figure 3). Although the prawns should be rendered unconscious in <1 second, they were exposed to the current for 10 seconds to increase the length of unconsciousness. The stunned prawns were then immediately transferred into totes to be layered with crushed ice and transported to the processing plant, with 100 prawns checked for stunning effectiveness at start up. The ice slurry controls included temperature, time, coverage and inspection.

Figure 3: Prawn-Electrode Contact.

Stunning trials

A fixed frequency of 45hz was used for every batch processed but voltage was varied between 40-125 volts.

Table 1: Equipment and Test Parameters

	Equipment Parameters	Test Parameter
Frequency (Hertz)	40-60	45
Conveyor Speed (s)	12.53-10.4	11.75
Voltage	20-150	40 -125

For each tested voltage, prawns were collected immediately post stun into baskets and 50kg samples were assessed for:

- Effectiveness of stun (as indicated by co-ordinated leg movement)
- Stun damage (as indicated by surface discolouration and burning)

Following initial review, a sub sample were then assessed for:

- Persistence of heart beat post-stun.
- Persistance of gill bailer movement activity post stun
- Duration of insensibility/sign of recovery post stun

These indicators of stun effectiveness are in line with research which recommends that 'interpretation of behavioural signs should be supported by further research into related physiological processes' (Weineck et al., 2018).

Voltage effects on stunning efficiency could be plotted on an exponential trend line illustrating the greatest relative improvement occurred when increasing voltage from 40-60. Further improvements were observed at voltages above 75 but these are accompanied by a (similarly exponential) increase in the percentage of prawns that had sustained burns during the stunning process (Figure 4).

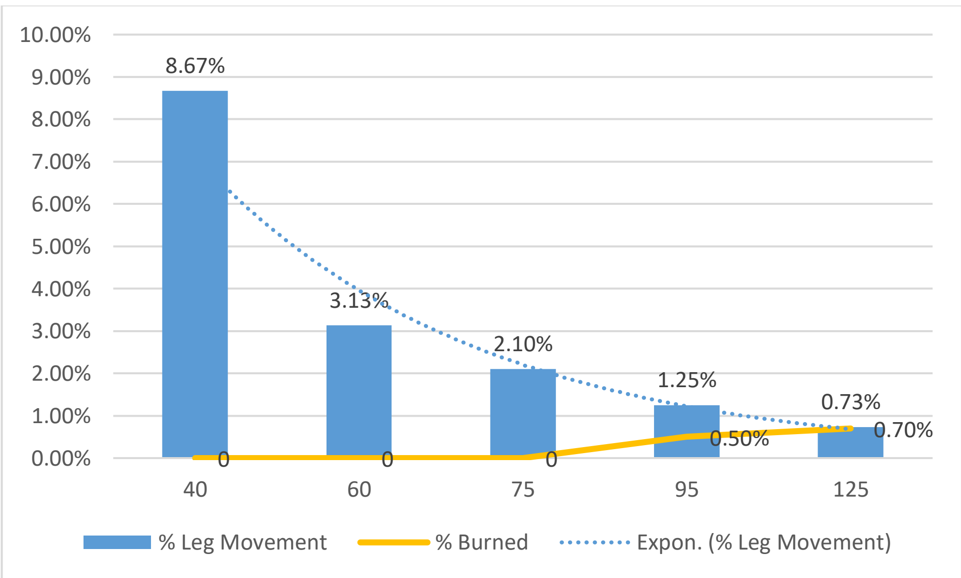

Figure 4: Best fit trends for Stunning Efficiency (indicated by leg movement) and Incidence of Burns at Increasing Voltage (operational amperage = 0-0.015 mA).

Examination of a sub-sample of prawns indicated <2% continued to demonstrate heart and gill bailer activity (indicative of neuronal and respiratory function) in the absence of co-ordinated leg movement, however as electrical stunning was followed by transfer to ice slurry the subsequent immersion in ice slurry ensured no full return to consciousness. A significant proportion of prawns were in irrecoverable stun (stun-kill) on exit of the stunner as evidenced by transfer back to a controlled aqueous environment where none showed signs of recovery within the monitoring period (10 minutes plus handling time of 32 seconds). This monitoring period was chosen as a worst-case scenario to account for any handling delays post stun.

Based on considerations of percentage stunned verses percentage damaged/burned the proposed operating parameters would be between 60-75 volts at 45 Hertz (operational amperage = 0-0.015 mA). While stunning efficacy is (marginally increased) at higher voltages, the impact on product quality (Figure 5) would make this commercially unviable. Primary electric stun using these parameters achieves > 97% stunning efficacy with the immediate immersion in ice slurry achieving 100%.

Figure 5: Image showing discoloured shells and flesh of *P. vannamei* as a result of High Voltage Damage Effects

Further considerations

Since a small proportion of animals continued to demonstrate heart and gill bailer activity in the absence of co-ordinated leg movement, overt behavioural responses could be included as a main element of assessment going forwards.

Additional research will also be needed in due course to correlate behavioural measures with neuronal activity once a crustacean equivalent of electroencephalogram (EEG) can be developed.

Take-home messages

This case study is an excellent example of the positive impact that food businesses can have on a significant number of animals, by going above and beyond the requirements of legislation and certification. Tesco and HSF have worked collaboratively, along with their suppliers in Vietnam, to improve the slaughter process of *P.vannamei* by adapting the parameters of existing Optimar stunning technology used in their salmon, seabass/seabream, and pangasius supply chain. The technology is also in commercial use by Hilton Seafoods UK suppliers for wild caught lobsters as well as edible crab in Norway (Roth and GrimsbØ, 2013).

Key benefits of the electrical stunning system compared to immersion in ice slurry for *P. Vannamei*:

- Less handling of the animals
- Reduction in crowding times (in pond)
- Easier access to measure effectiveness
- Consistency on stun delivery
- Faster method to render animals unconscious and insensible to pain
- Greater efficiency and reduction in labour during the harvest process, although initial investments required to implement the technology are high

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