

Driving Innovation in Humane Fish Slaughter: Developing an electrical stunning system for European sea bass and gilthead sea bream



Introduction

Making a commitment to fish welfare

As part of their commitment to higher welfare standards, in 2013 Tesco UK published aquaculture standards which required all sea bass and sea bream to be pre-slaughter stunned by 2016. Tesco wanted to bring the slaughter of sea bass and sea bream in line with slaughter methods in salmonids, ultimately delivering high welfare standards that their customers expect. However there was no commercial alternative to the ice slurry method available for these fish species. Tesco took the initiative to change this and worked collaboratively with their supply chain to develop and adopt humane stunning technology for their sea bass and sea bream.

79% of European

citizens said that **fish welfare** should be **better protected** than it is currently and that the welfare of **fish should be protected to the same extent as other animals** eaten by humans, according to a survey of 9,000 people by ComRes, 2018.

After almost 5 years of planning, implementation and continual improvement of the slaughter process, all sea bass and sea bream sold in Tesco UK supermarkets are now electrically stunned before chilling in ice slurry. For their leading contribution to the development of a more humane alternative to slaughter seabass and seabream, Tesco was presented with Compassion's [Best Retailer Innovation Award in 2017](#).

Background

With increasing public awareness of fish sentience and aquaculture, there is a growing demand for more ethical fish products – not only sustainably produced but also with good animal welfare. A humane slaughter is essential when farming to higher animal welfare standards, however fish welfare at slaughter varies substantially across the world and in different sectors.

The key principles of humane slaughter are that death should either be instantaneous or, if insensibility is induced gradually, it should be without fear or pain (Farm Animal Welfare Council, 1996).

For gilthead sea bream and European sea bass, chilling in ice slurry without pre-stunning is the traditional and widely used slaughter method. However this method is inhumane; for more detail see our information sheet¹.

The World Organisation for Animal Health (OIE)² and the European Food Safety Authority (EFSA)³ agree that chilling in ice slurry without prior stunning results in poor welfare and should not be used. In 2009 the EFSA stated that alternative systems should be urgently developed and that electrical stunning seemed to be the most promising method for sea bass and sea bream.

Driving innovation through collaboration

In 2013, Tesco set a 2016 deadline for their policy requiring humane slaughter of sea bass and bream, despite the fact that there was no readymade alternative and producers viewed compliance to be challenging.

To address this challenging problem, Tesco led a working group on stunning technology which included processors and sea bass and bream producers. The working group used innovations from another aquaculture sector - taking lessons on best practice and adopting existing technology from the salmon farming industry.

The next step involved trialling systems for sea bass and sea bream, opting for a dry electrical stunning system by Optimar, which was predominantly used by their Salmon suppliers. This was trialled in collaboration with their three Turkish suppliers, More, Sursan Ilknak and Falfish in conjunction with Seachill.

Initially, to test the stunning process, a stunner only was added to the process and the fish were still being brailed out of the sea cage. However in practise the producers identified this as a key point of concern and installed equipment to instead pump the fish directly from the sea cage to the stunner. Producers found that the pumping system allowed the same level of efficiency in moving fish but with reduced crowding. It also meant that fish could be kept in water until

¹ <https://www.compassioninfoodbusiness.com/resources/fish/humane-slaughter-european-sea-bass-and-gilthead-sea-bream/>

² OIE. (2010). Welfare Aspects of Stunning and Killing of Fish for Human Consumption. Health (San Francisco), 1–5. Retrieved from https://www.woah.org/fileadmin/Home/eng/Health_standards/aahc/2010/chapitre_welfare_stunning_killing.pdf

³ EFSA. (2009j). Scientific Opinion of the Panel on Animal Health and Welfare on a request from the European Commission on welfare aspect of the main systems of stunning and killing of farmed seabass and seabream. Health (San Francisco), 1010, 1–52. <https://doi.org/10.2903/j.efsa.2009.1010>

reaching the stunning stage where they are de-watered prior to stunning, and therefore did not struggle as much as with brailing.

Far-reaching impact

The innovation led by Tesco has already led to welfare improvement for millions of fish per year. The stunning technology is not only used to slaughter Tesco fish, but also 100% of fish that the three suppliers produce annually.



"We are proud to be the first company to have established humane slaughter on seabass and seabream in Turkey. We hope this will set an example to the fish farming industry in Turkey that it's possible to humanely slaughter seabass and seabream. Electrical stunning has improved the fish welfare but also improved product quality and shelf life. It has also facilitated the slaughter operation, especially during rough sea conditions." **Karem GÖksel, Sales Director**

However, this development has a far wider potential impact. As the protection offered to farmed fish in the EU Slaughter Regulation is currently limited to the general EU directive that protects the welfare of all animals⁴. Therefore the emergence of the electrical stunning system adapted for sea bass and bream, with commercial viability, demonstrates that the pain and suffering caused by chilling in ice slurry without pre-stunning is avoidable and should not be used according. The development of this project therefore has the potential to improve the welfare at slaughter for sea bass and sea bream across the entire EU industry and more widely, as producers are encouraged to adopt this more humane alternative system.

Electrical stunning system

Key benefits compared with killing in ice-slurry without pre-stunning

- Improved animal welfare at slaughter
- Better product quality due to lower pre-slaughter stress and pumping method
- Faster processing speed due to pumping; the output of the new slaughter system can be 10 tonnes per hour. With the average fish slaughter weight at approx. 380g, this equates to over 26 thousand fish slaughtered per hour.
- Easier to operate and especially advantageous during bad weather when harvesting otherwise would need to pause due to increased movement of the vessel.
- Lower labour requirement to operate, with one less staff member needed
- Improved organisation and human safety on board harvest vessels.



"Animal welfare is a key priority in our supply chains and the investment and time spent improving the slaughter conditions by the producers in Turkey is warmly welcomed by Seachill. We are seeing improved product quality as a result of better handling and slaughter which is a win win for the industry. William Davies, Seachill, Fisheries, Aquaculture and CSR Manager.

⁴ European Union, 1993. (2009). COUNCIL REGULATION (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing. Official Journal of the European Union, 1–30

The slaughter process

The slaughter equipment, installed on a boat, is moored to the cage side for harvest. The slaughter process consists of crowding the fish using nets, then pumping them from the rearing pen onto a dewatering unit and then to an electrical stunning machine, before depositing the stunned fish into ice slurry totes to be chilled. From there they are transported by sea (and a short drive) to SÜRSAN's processing plant. For a short video demonstration of the process please visit <https://vimeo.com/394211327>.

There are around 150 thousand fish in each cage, so it takes a few days (with 3 harvests per day) to slaughter all the fish in a cage. They split the cage using a net with weights to section off a proportion of the fish for each harvest. A significant difference between the previous slaughter process (without pre-stunning) and the current system, is that fish are removed from the cage by pumping them in water, and therefore braille nets (see figure 1), which are detrimental for fish welfare, are no longer used. When carefully designed and well-managed, a pumping system can be used to move fish more gently. The farmers at SÜRSAN report that the pumping process has led to quality improvements as there is a reduction in damage to the scales of the fish.

Crowding

To begin the slaughter process, a subset of fish are crowded on one side of the cage using a sweep net (figure 2), so they can more easily enter the pipe and be moved to the stunning machine. Crowding in subsets (in order to minimise time in the crowd) and in a calmly manner avoids sea bream and sea bass displaying vigorous escape behaviour, including rapid swimming and struggling, which results in significant muscle use pre-slaughter.



Figure 1. Transporting fish out of water in braille nets is bad for their welfare because it is stressful and causes physical damage as they are compressed together. Fish at the bottom of the net experience significant pressure from the weight of those above and are at risk of damage from fish to fish contact and contact with the net.



Figure 2. A group of fish to be slaughtered are crowded to one side with a net so they can be pumped on board the boat.

If this happens it will lead to an increase in lactic acid production, a lower muscle pH and faster onset of rigor mortis, associated with lower product quality and changes in texture. For more detail see our information sheet.⁵

Tesco have a detailed protocol in place to monitor fish welfare during crowding which defines good, acceptable and unacceptable standards of welfare. The fish are crowded for no longer than two hours and oxygen levels in the water are monitored every 15 minutes during the crowding process; they check that oxygen saturation stays above 80%. If fish show behavioural signs of stress or oxygen levels fall below 80% then fish are given more space by releasing the nets.

Pumping

The fish are pumped in water through a pipe to the stunner (figure 3). This set-up has replaced braille nets in the system. The pump is approx. 2 meters long and 1 meter wide. The pipe is flushed at the end of every harvest, and during any processing breaks, to ensure no fish remain inside.



Figure 3. The pipe (left) and pump (right) moves fish in water from the sea cage to the stunner.

⁵ <https://www.compassioninfoodbusiness.com/resources/fish/humane-slaughter-european-sea-bass-and-gilthead-sea-bream/>

Just before fish reach the stunning machine there is a dewatering-unit (approx. 2m x 1m). The components do not have to be in a straight line, so could be adapted to fit the size and shape of the boat. In any set-up, pumping systems should be carefully designed and managed to ensure gentle movement of fish through pipes.

The stunner

Stunning the fish before placing them in ice slurry is fundamental in ensuring a more humane slaughter. The equipment used by SÜRSAN is the dry electrical stunning machine made by Optimar. This machine can be used to stun a variety of fish species, with adjustment of the electrical parameters. The stunning machine is 1.5 metres long and 0.8 metres wide, weighing around 250 kilos. Additionally there is an el-cabinet, weighing around 60 kilos, required on the boat. The farm manager reports that they do not have any concerns for human safety using this equipment.



Figure 3. The stunning machine used by SÜRSAN to stun sea bass and sea bream. On the right of the photo is the dewatering unit.

The following operating parameters are being used for sea bass and sea bream, and, in the current set-up, the parameters result in a high percentage of fish coming out of the stunner showing no signs of consciousness.

- Current: 0-15 amps. The current is regulated depending on the number of fish etc. There is an automatic feedback in the machine which measures the electrical resistance and changes accordingly, quite quickly. They use a combination of Direct Current (DC) and Alternating Current (AC), mainly DC and require a supply from a 32 amp fuse, single phase.
- Voltage: 130-150V.
- Time fish are exposed to the electrical current: 8/10 seconds.

Table 1 - Parameters for the different plate electrodes - from the First (start) to the last (End)

	Start	Mid 1	Mid 2	Mid 3	End
Voltage :	110 V	90 V	50 V	40 V	20 V
Amper :	15 A	15 A	15 A	25 A	15 A
Hertz :	50	50	50	50	50

After dewatering, the fish land on a conveyor belt which acts as one of the electrodes, with a chain of plate electrodes (steel flaps) made up of six rows of ten plates hanging above acting as the other to complete the circuit when both sides touch the fish. Although fish should be rendered unconscious in <1 second due to the aforementioned parameters, they are exposed to the current for 10 seconds to increase the length of the unconsciousness. This is done to the extent that fish do not recover and die from asphyxiation.

The stunner is checked daily for any material stuck on the stunner which would cause it to not work properly and is cleaned regularly to ensure that the electricity can be effectively delivered.

The stunned fish slide directly down a chute from the stunning machine into ice slurry containers (figure 4). At the start of every harvest, staff check the first 100 fish for any signs that they have not been effectively stunned. This means that any issues with the system could be discovered and rectified. Staff handle the fish one by one, looking for any opercular movement and testing for the presence of a normal eye roll (when rotated dorso-ventrally, the eyes of a conscious fish will move to accommodate the movement whereas the eyes of an unconscious fish remain fixed in position) – both signs that fish are conscious. SÜRSAN report that 97% of fish show no signs of consciousness. The emergency killing protocol states that fish that appear to be conscious should be killed by a percussive blow.



Figure 4. After electrical stunning fish are immediately directed into totes of ice slurry for chilling.

Chilling in ice slurry

The fish:ice:water ratio in an ice slurry tote is approximately 2:1:1 (figure 5). The farmers mix ice with water that has been cooled (to 0°C) rather than ambient water as this means the ice slurry mixture has a lower overall temperature. Slurry totes are not overfilled to ensure that all fish are submerged in the ice slurry.



Figure 5. Fish in ice slurry for chilling.



The use of a pumping system to move fish is advantageous, not only because it minimises time fish experience being out of water, but also because no water is added to the ice slurry totes along with the fish in this system and therefore the temperature of the ice slurry can be kept lower. In contrast, using braille nets to transfer will involve some ambient water being added to the totes along with the fish, which may cause the overall temperature of the ice slurry to rise.

Achieving an effective stun kill system

Further research

Tesco is continuing to work with the producers to ensure the system is achieving higher welfare standards. Observations of behaviour can be consistent with fish being stunned but further research which tests these stun parameters in relation to brain activity of the fish would be ideal. To fully demonstrate the validity of the method, it will be beneficial to publish peer-reviewed research showing absence of brain activity by carrying out electroencephalogram (EEG) measurements.

TAKE HOME MESSAGE

The electrical stunning system made by Optimar can be used as part of a commercially viable slaughter system. The system allows for a more humane slaughter than the traditional method of chilling in ice slurry without pre-stunning and also has product quality benefits. The system can also be operated with less staff and is easier to use in bad weather conditions.

The work driven by Tesco is an excellent example of the significant improvements to animal welfare that can be made due to market demand. Huge progress has been made despite the challenges in present commercial contexts, which demonstrate that solutions can be found when there is motivation and collaboration between stakeholders.

This project also demonstrates how technologies developed in one species and country can be innovated and adapted to new species and used in new countries, whilst maintaining product quality and production efficiency.