

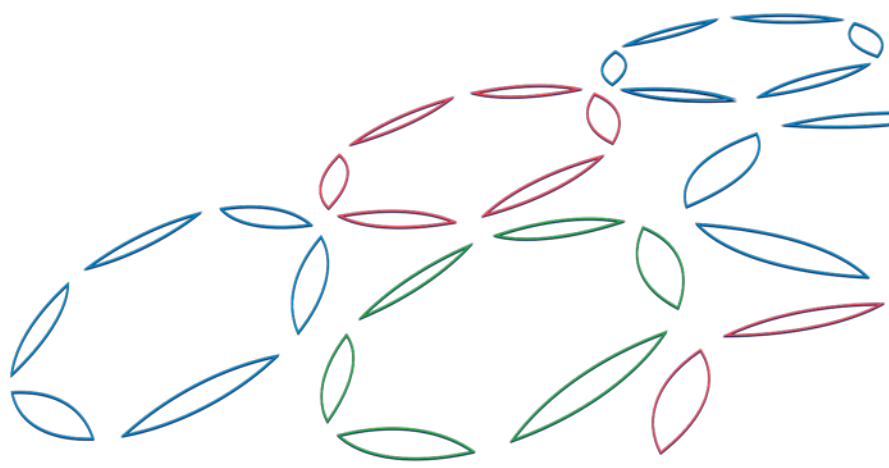


Comparison of shipping rainbow trout in Cool Seal and EPS boxes from Iceland to Poland

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Titill / Title	Comparison of shipping rainbow trout in Cool Seal and EPS boxes from Iceland to Poland Samanburður á flutning regnbogasilungs í Cool Seal og EPS kössum frá Íslandi til Póllands		
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Ágríp á íslensku:	<p>Verkefnið var unnið af Matís ohf. og Skaginn3X fyrir Samhenta umbúðarlausnir til að gera samanburð á Cool Seal kassa og EPS kassa við flutning á regnbogasilungi frá Flateyri á norðanverðum Vestfjörðum og Slupsk í Póllandi. Fjórir rannsóknarhópar voru til samanburðar; ofurkældur fiskur í EPS og Cool Seal kössum, og hefðbundinn (0 °C) í EPS og Cool Seal kössum.</p> <p>Flutningurinn var í hitastýrðum flutningabílum og skipagám. Skráning var gerð á hitastigi í umhverfi og silungi við flutninginn. Einnig var gert gæðamat á flökum við komuna til Slupsk.</p> <p>Niðurstaðan var að ekki væri munur á milli umbúða miðað við flutningsaðstæður. Hitastig hélst mjög jafnt í öllum hópum. Cool Seal kassar reyndust mjög vel og stóðust þyndarálag vel, þrátt fyrir meira magn á bretti en EPS kassar. Gæðaúttekt eftir átta daga flutning sýndu mjög góð flakagæði.</p>		
Lykilorð á íslensku:	Ofurkæling, hefðbundin kæling, EPS kassi, Cool Seal kassi.		
Summary in English:	<p>This report contains a description and main results of a project that the company “Samhentir packaging solutions” contracted Matís ohf. and Skaginn3X to carry out. The objective of the project was to compare the Cool Seal boxes and EPS boxes when transporting rainbow trout from Flateyri (NW Iceland) to Slupsk in Poland. Four experimental groups were compared; Sub Chilled fish in EPS and Cool Seal boxes, and traditional (0 °C) in EPS and Cool Seal boxes.</p> <p>The trout was transported in temperature controlled trucks and sea-container. Ambient and product temperature was logged during transportation. A fillet quality test was conducted at arrival at Slupsk.</p> <p>The results showed that there was no difference between packaging based on transport conditions. Temperature in all groups remained steady at the set temp. The Cool Seal boxes withstood the weight pressure well, despite 30 boxes on a pallet. Quality assessment after eight days of transport showed a very good fillet quality for all experimental groups.</p>		
English keywords:	Sub Chilling (S.C.), traditional chilling, EPS box, Cool Seal box.		

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1 INTRODUCTION

This report contains a description and main results of a project that the company “Samhentir packaging solutions” contracted Matís ohf. and Skaginn3X to carry out, to investigate if Cool Seal packaging can be used in long transportation, from production to secondary processor of whole gutted salmonids (aquaculture) species, instead of traditional expanded polystyrene (EPS) boxes. It is known that EPS has better insulation properties than Cool Seal, but the theory tested in this project is that such insulation properties are not needed during transportation in temperature controlled environment. The added benefit is then that Cool Seal has lower environmental impact and saves packaging- and transportation cost.



Figure 1 Temperature after Sub Chilling

The research questions addressed in the project are:

1. Do the Cool Seal boxes qualify for long way/time transport in temperature controlled containers and trucks; with the normal stimuli (thermal loads) that occur during transshipments?
2. Is there a quality difference between products shipped in EPS and Cool Seal boxes?
3. Is there a quality difference between Sub chilled (S.C.) and traditional products?

There is much to gain by using Cool Seal packaging instead of EPS boxes, lower packaging cost, lower transportation cost and more environmental friendly packaging and less carbon footprint. The Cool Seal packaging takes less space on a pallet and 30 boxes can be stacked on a pallet instead of 27 EPS boxes, as shown in Figure 2.



Figure 2 EPS packaging on left with 27 boxes (540 kg) and Cool Seal packaging on right with 30 boxes (566 kg)

Cool Seal is also less expensive to buy and much easier to transport empty to the production side, un-foiled.

2 RESEARCH DESIGN

The research was carried out during the period of October 1st to November 9th 2017. The fish used for the experiment was 3-4 kg rainbow trout that was slaughtered at the facilities of Arctic fish in Dyrafjordur on October 31st. The trout was then transported to Flateyri, around 30 km, where it was chilled and packaged the following day. It was then trucked to Reykjavík, around 460 km distance, in a temperature controlled truck. It was then rearranged to a sea-container in Reykjavik and transported to Rotterdam. In Rotterdam, the trout was put into a refrigerated truck and driven to Slupsk in Poland, which is about 30 hours' drive. The fish arrived in Slupsk on October 9th, nine days after slaughtering.

2.1 Packaging and Transportation

Fresh farmed fish is traditionally packed whole, gutted and placed fresh in ice in EPS boxes before being stacked on pallets and placed in temperature controlled containers for sea transport from Iceland. Normally around 20-22 kg of whole fish is packed in around 4-5 kg of ice in each box with volume capacity of around 40-48 L. The EPS boxes used for sea transport are usually equipped with drain holes, which allow both melting water and drip from the fish to leak out of the boxes and prevent fish from lying in water or blood. The transporter, Samskip, demands that the pallets are wrapped with a plastic film during transport to ease handling between trucks and sea-containers. Due to thermal load during processing and packing of the fish, the temperature in the flesh can easily rise to 1–6 °C when packed. As noted by Anyadiegwu and Archer (2002) and Margeirsson (2011), EPS boxes are very good thermal insulators and have, in conjunction with ice, been recommended for years to preserve fish quality under challenging temperature conditions (Seafish, 1996).



Figure 3 S.C. trout in Cool Seal box in Slupsk

The main disadvantages of using EPS boxes are that they take a lot of space during transportation, both when they are transported empty from the manufacturers to the fish processor, and in transportation of fish to the market. Around 800 empty EPS boxes can be stacked in a 40" container, but around 4000 of Cool Seal boxes. There are also environmental disadvantages of using EPS, from the manufacturing all the way to waste disposal.

Cool Seal boxes have many advantages in comparison; they are easy to transport to processing sites, they take less space in transportation and are easily recycled after use. The disadvantage is on the other hand that they do not have the same insulation properties as EPS. The Cool Seal box can be shredded after use and be 100% recycled and re-extruded for non-food applications. The EPS box can also be recycled, but with higher cost and fewer opportunities for end-use and lower value for recycling.

The circumference of the Cool Seal boxes is the same as the EPS boxes, but they are lower, 165 mm in height compared to 230 mm of the EPS box. The carrying capacity of both boxes is around 40 litres and the both weigh about the same, around 960 grams.

2.2 Experimental groups:

1. S.C. - Cool Seal: 484 kg of trout Sub-Chilled to -1.0°C core temperature. Fish packed in Cool Seal boxes (25 boxes) with no drain holes.

2. S.C. – EPS: 500 kg of trout Sub-Chilled to -1.0 °C core temperature. Fish packed in EPS boxes (25 boxes) with no drain holes.
3. Traditional – Cool Seal: 566 kg of trout iced traditionally (0 °C core temperature). Fish packed in Cool Seal boxes (27 on pallet) with drain holes.
4. Traditional EPS: 540 kg of trout iced traditionally (0 °C core temperature). Fish packed in EPS boxes (27 on pallet) with drain holes.

Ibutton loggers were placed on the top of the two pallets for monitoring ambient temperature. Ibutton loggers were also placed within fish belly's, in selected boxes on four pallets; at the bottom, middle and on top of them.

To fill the Cool Seal pallet up to 30 boxes, five S.C. boxes were stacked on top of the traditional Cool Seal boxes. This was done to test the structural integrity of the boxes i.e. to see if the bottom boxes would withhold the pressure during such a long transportation period from Flateyri to Slupsk.

The set point temperature in the container and the trucks during transport was -1,5 °C.

2.3 Quality evaluation

The quality of 25 fillets from all four trout experimental groups were evaluated; regarding inelasticity, softness and gaping. An expert in salmon quality tested the fillets using the FHF (appendix I) method to compare quality differences between the four groups.

3 PROGRESS

Rainbow trout was slaughtered, bled, gutted and transported in slurry ice between -1 °C and 0 °C on October 31st 2017 to a fish processing plant in Flateyri “Fiskvinnslan Flateyri”. The fish was packed the following day. The fish were either traditionally packed (Trad) in around 3-4 kg of ice in EPS boxes and Cool Seal boxes (Figure 1), or S.C. to around -1.5 to -1.0 °C before being packed without any ice being added into either the EPS or Cool Seal boxes. EPS boxes were stacked with 27 boxes on a pallet, seven in row and nine stacked up. Cool Seal boxes were stacked with 30 boxes, seven in row and stacked 10 up.

The fish was trucked in Iceland, transported by sea in refrigerated containers to Rotterdam and trucked from Rotterdam to Slupsk, Poland. The set point temperature of the refrigerated container and the truck used for transport was -1.5 °C, but the ambient temperature readings are shown in Figure 4.

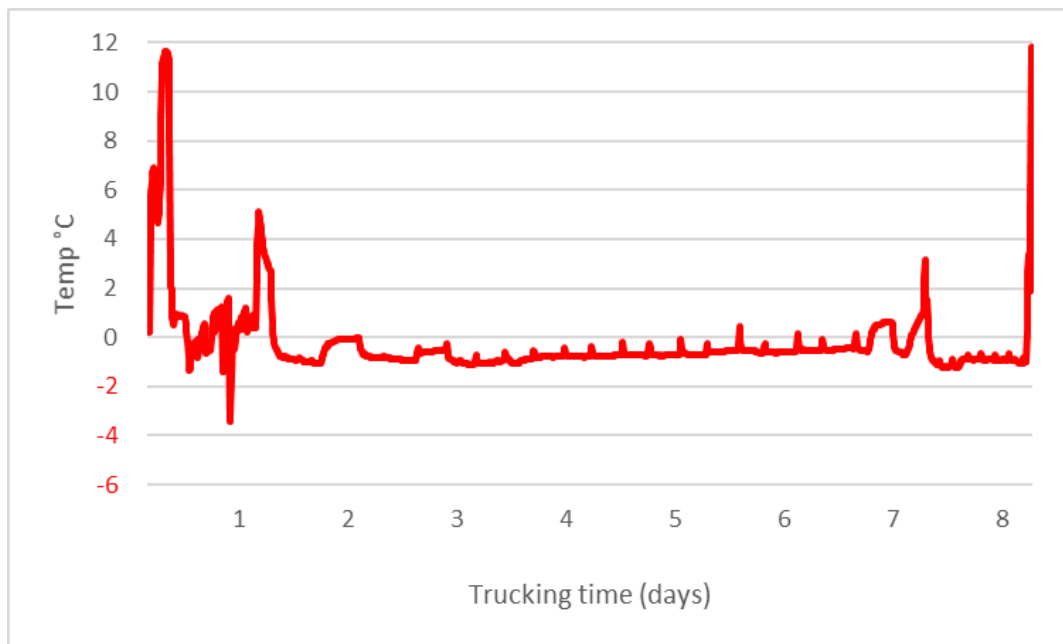


Figure 4 Ambient temp during transportation from Flateyri, via Reykjavik and Rotterdam, to Slupsk

The shipment was delivered in Poland eight days post-packaging, i.e. on November 9th 2017. At the time of arrival, fish temperature was around -0.2 °C in the Trad fish packed in EPS with ice left in all the boxes. Temperature of the SC fish packed in both EPS and the Cool Seal were around -1.2 to -1.5 °C. The fish, which was nine days from slaughtering, was removed from the packaging, filleted and quality inspected and the temperature loggers retrieved.

The sub-chilling process at Flateyri was a bit excessive, with the surface temperature going down to -3 °C, but the core temperature measured at the time was -1 °C, but in less than a day the surface- and core temperature stabilized at around -1.5 °C, as shown in Figure 5.

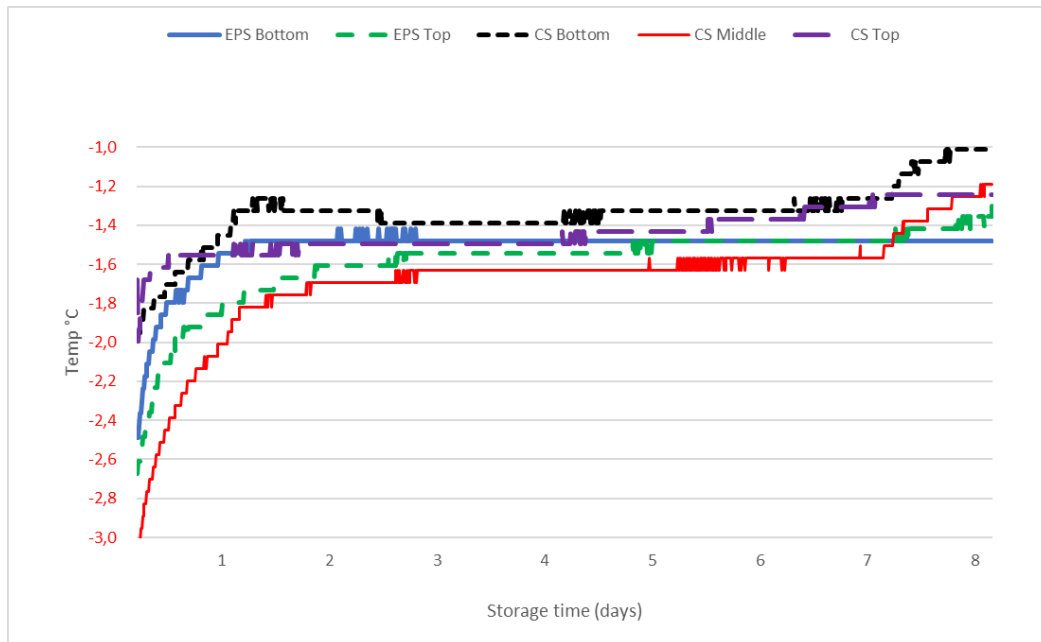


Figure 5 Temp logging of S.C. product in EPS and Cool Seal (CS) boxes, measured at bottom, middle and top of pallet

The difference between box types and the location of the boxes on the pallets does not seem to be of significant relevance, except that the Cool Seal boxes at bottom and top are slowly following the ambient temperature.

The traditional product was iced with around three kg of ice-cubes. With most of the ice left in both types of boxes the temperature was close to 0 °C. The difference between loggers are not significant, as shown in Figure 6.

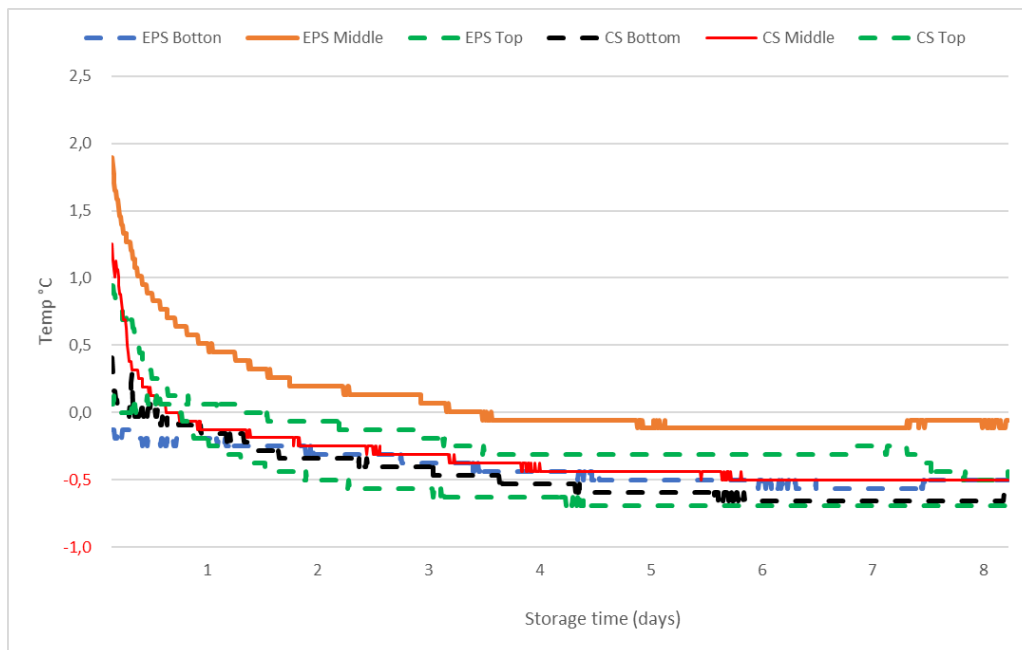


Figure 6 Temp logging of traditional product iced and packed in EPS and Cool Seal (CS) boxes

Quality assessment included evaluation of elasticity, softness and gaping of fillets according to FHF (2010). Zero is the best quality for all scales, but two is the least for elasticity and softness, but four for gaping. All groups had best score for softness and gaping but there was some difference between groups in inelasticity, as shown in Figure 7.

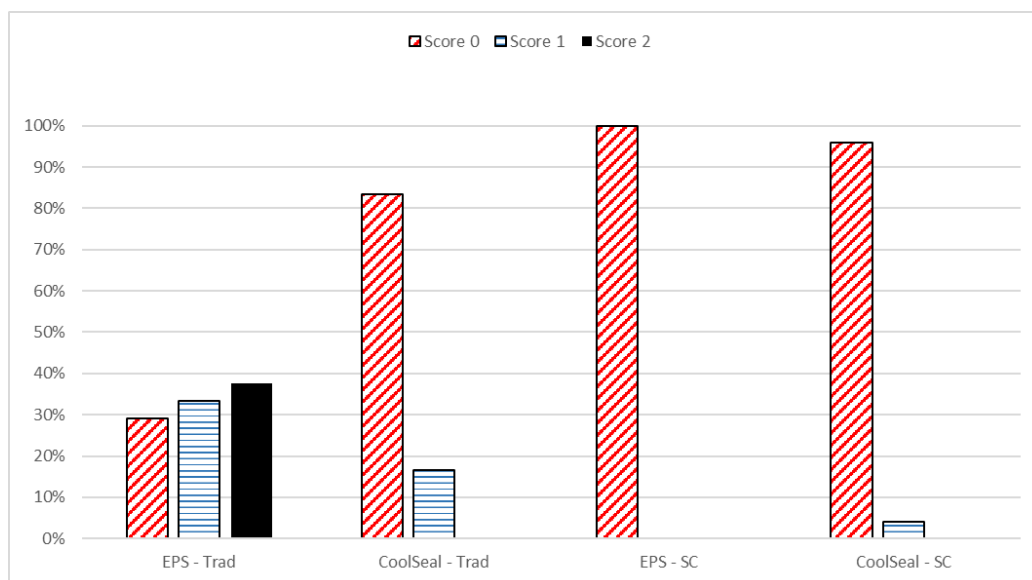


Figure 7 Inelasticity score in Quality evaluation on all four groups, S.C. and traditional, in EPS and CS boxes

The results show that the quality of all groups was excellent, except for the traditionally packed products in EPS boxes, which were showing signs of reduced quality i.e. giving low outcome in inelasticity, but same outcome in softness and gaping.

4 RESULTS AND DISCUSSION

The evolution of the ambient air temperature during storage and transport of the fish is shown in Figure 4. In general, the temperature control in the refrigerated container and trucks is good; ambient temperature stayed around 0 °C in the first truck, close to -1.5 °C in the container and around -1.6 °C in the second truck during the last day of transport. The short thermal load periods seen in the figure should not have a big effect on the fish temperature inside the insulated packaging, on the first day it went up to 12 °C but only for a short time. The fish temperature results presented in Figure 5 and 6 confirm this. The S.C. product in Cool Seal boxes at the bottom and top were giving a little bit in with the ambient temp. The Cool Seal boxes have an Achilles heel at the bottom and top with only a thin insulation. This could be met with extra insulation cover at bottom and top of the pallet, but the sides have a double wall.

The Cool Seal boxes were steady and firm during the transportation. Even with 10 boxes in height, 30 on pallet, there were no signs of it giving in because of weight pressure (Figure 8).



Figure 8 Cool Seal boxes on a pallet after transportation, in Slupsk, 30 boxes

The elasticity, softness and gaping of the trout fillets in the four experimental groups are presented in Figure 6. The results for the softness and gaping are excellent for all groups with 0 in grade. But the traditional storage in in EPS boxes got a significantly lower score for inelasticity, with over 30% in score 1 and 38% in score 2. There is no practical explanation for this difference. But in general, the quality of the fillets was excellent and would have withstood more temperature load in ambient temperature fluctuation and longer transportation time, if needed.

Temperature after filleting the S.C. trout was around -1.1 °C, as shown in Figure 9, and the colour of the fillets was also excellent, between 33 and 34.



Figure 9 Temp in S.C. trout after the filleting

5 ACKNOWLEDGEMENTS

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Figure 10 Researcher from Skaginn3X and Samhentir Packaging Solutions standing by pallets of EPS (right) and Cool Seal boxes (left), with 27 boxes on

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7 APPENDIX

7.1 Salmon quality evaluation

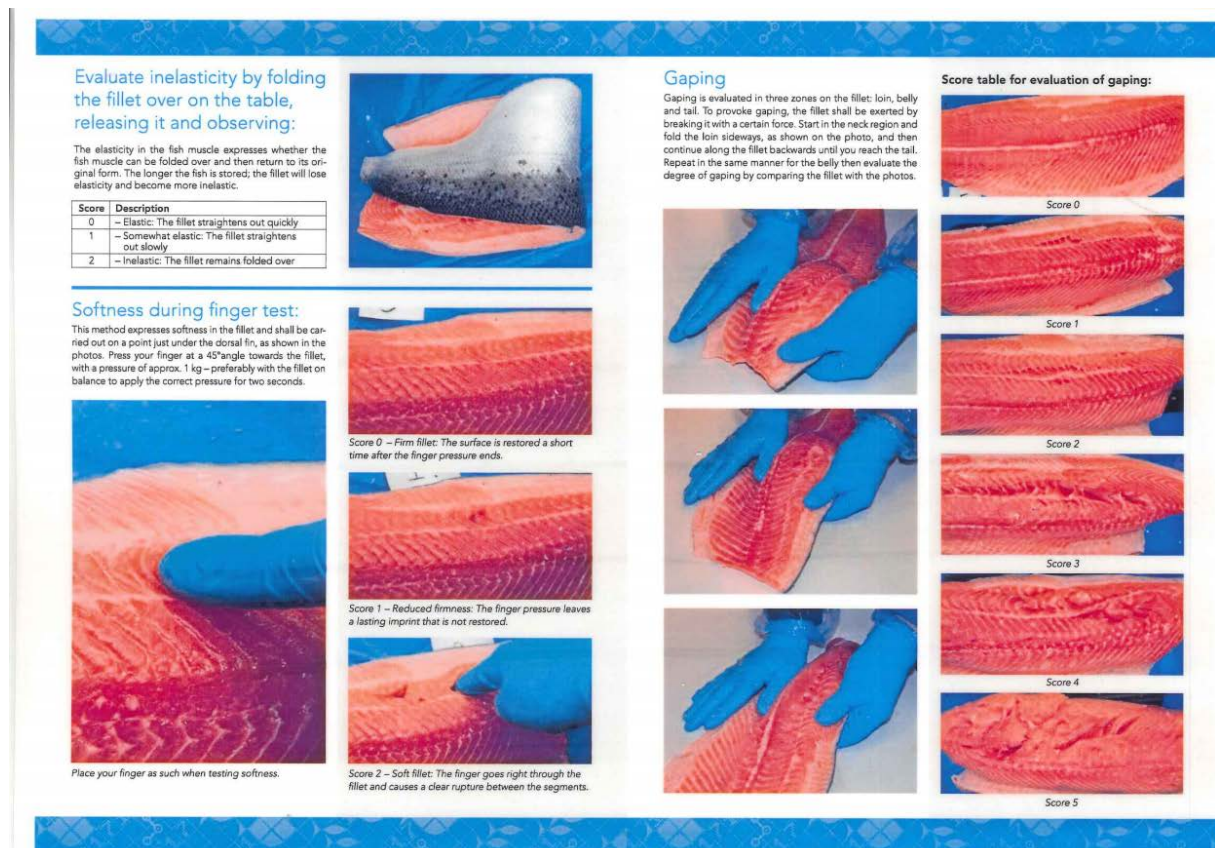


Figure 11 Quality evaluation for fish (trout)