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TRACEABILITY AND QUALITY IN A FRESH FISH EXPORT CHAIN: AN ICELANDIC AND CAPVERDIAN STUDY

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ABSTRACT

The aim of this study was to improve Icelandic and Capverdian fresh fish exports, by means of traceability and quality related information. For that purpose, EU and US regulations regarding traceability were reviewed. Traceability is now a clear legal requirement and companies have to implement appropriate systems to stay competitive. An Icelandic fresh fish export chain was used to verify the implementation of traceability systems and to find the correlation between traceability and quality management systems. The TraceFish standard for captured fish was also used as a tool to evaluate the traceability system implemented by each member in the chain. The quality related information kept by each member, especially the temperature records, was also studied. The results show that the TraceFish standard is practical and can be used by companies as a tool to implement/improve the traceability systems; they also showed that traceability and quality related information is already combined to some extent. In a fresh fish export chain, the key factor is to maintain freshness. Although the chosen chain was short, relatively large fluctuations in the surrounding temperature were experienced. A temperature difference between the product and the surroundings of 4°C, for more than 1.5 hours, leads to a change in the product temperature which could influence the product quality. Finally, a traceability scheme was suggested to improve the traceability system in a Capverdian fresh fish export chain by using the Icelandic study; a storage house located in S. Vicent Island was used as an example. The suggested traceability system was also compared to the TraceFish standard, which proved to be very practical even for small scale export as in Cape Vert.

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1 BACKGROUND

The Republic of Cape Verde is an archipelago which consists of 10 small volcanic islands. It is located about 300 miles off the west coast of Africa, with a total area of 4033 km^2. The EEZ is around 734 265 km^2.

Cape Verde has a subsistence economy and the fisheries sector contributed with the following values (Ministry of Environment, Agriculture and Fisheries of Cap Verde 2002).

- It represented 2.1% of the Gross Domestic Product (GDP)
- It employed 6% of the labour force
- The Per Capita Consumption was 26.0 kg/yr

The fishery resources are estimated at 33 000 – 44 000 MT (Ministry of Environment, Agriculture and Fisheries of Cap Vert 2002) and fresh fish represents the most valuable source of protein.

In 1999 an EU inspection mission was carried out in Cape Vert in order to evaluate sanitary conditions and the fisheries Competent Authority (CA) surveillance. Critical defaults were found to be:

- Insufficient and incompatible laws (with regards to the EU laws)
- Absence of a legislative framework for quality and sanitary control by the CA
- Absence of official and accredited laboratories for fish and fish products
- Lack of human resources/capacity (trained inspectors)

In February 2000, the EU imposed an embargo on the import of fish and fish products from Cape Vert. The embargo reflected on the exports as shown in Figure 1 as the EU is the main market for Capverdian fish and fish products.

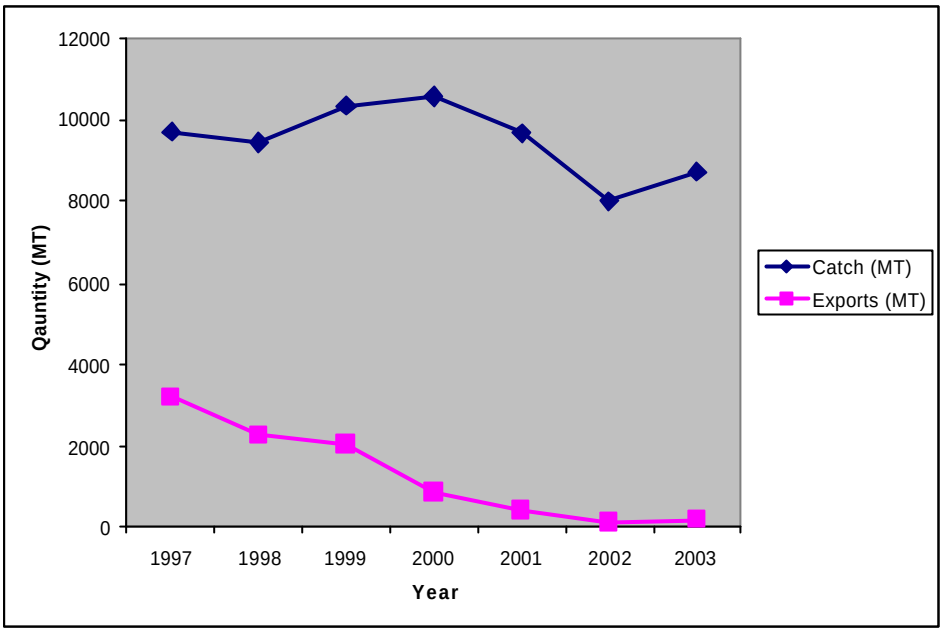


Figure 1: Cape Verde annual catch and exports from 1997 to 2003, showing the impact of the EU ban (2000 to 2003) on catch and exports (FAO b 2001).

From 2000 to 2003, the government adjusted the Capverdian laws to the EU regulations, implemented sanitary conditions and quality control surveillance in Cape Vert. After the implementation of the above mentioned measures, the embargo was officially lifted (October 2003) and exports of Capverdian fish and fisheries products to the EU re-commenced.

Cap Vert now has seven processing plants, but only three have implemented the HACCP system and are certified to export to the EU and US markets; frozen whole fish (frozen at sea and land frozen), canned fish, live lobster and fresh fish are the main exported products.

Fresh fish exports began in 2005 and until December 2005, 4.3 tonnes were exported. The most processed species is *Thunnus albacares* and the main markets are Portugal and The Netherlands.

Currently, the Capverdian Competent Authority and the fish industries are working to maintain and/or implement all the necessary requirements to increase the exports of fish and fish products. This means that both the CA and companies have to fulfil the demand of the markets regarding quality, safety and in the near future, the implementation of traceability systems throughout the export chains.

1.1 Objectives

The overall objective of this study is to contribute to the improvement of the quality of Icelandic and Capverdian air freighted fresh fish by means of the combination of traceability and quality related information.

The following aims were established for this project:

- To study traceability linked to HACCP (Hazard Analysis and Critical Control Points), and Pre Requisite Programmes such as GMP (Good Manufacturing Practices) and GHP (Good Hygiene Practices) using an Icelandic chain as a test chain.
- To study traceability in accordance with legislation and the TraceFish standard.
- To observe the time - temperature profile during transportation of fresh fish from a processor in Iceland to secondary processing in Belgium.
- To give an overview of the traceability aspects in the fresh fish exported from Cape Verde, the weaknesses and strengths.
- To suggest a suitable traceability system that could be implemented with the increase of export from Cape Vert.

1.2 Rationale

The project is relevant for the development of the fisheries sector in Cap Vert, as it will focus on traceability, the newest requirement regarding exports to the EU and US markets linked to quality management systems, already implemented in fish industries authorised to export. It will be used to:

- Suggest to the Capverdian Competent Authority revisions of the country's legislation to enable the implementation of traceability systems;
- Recommend and assist the implementation of a traceability scheme for Capverdian fish exports based on EU regulations and the TraceFish standard.
- To recommend and assist the correlation between traceability and quality management systems.

An Icelandic cod export chain was studied in this project.

Iceland is a fish producer and exporter; fisheries are one of the most relevant sectors and in 2004, the fisheries sector contributed the following (Ministry of Fisheries 2004).

- It created 8.1% of GDP (Gross Domestic Product)
- It employed 6.7 % of the labour force – about 10,000 people
- It generated 60% of the export value (121.7 billion ISK)

Cod is one of the most important resources as it represented 40.3% of the export value in 2004 (Ministry of Fisheries 2005). Iceland's main export markets are the EU (77%) and the US (10%). Almost 100% of the catch is exported.

The Icelandic fish industry has been implementing traceability systems in the exporting chains to comply with Icelandic laws (Nguyen Thi Quynh Van 2004) such as: Law n° 55/1998, Regulation n° 233/1999 and Regulation n° 588/1993. Since January 2005, the food and fisheries industries in the EU, and third countries wanting to export to the EU, must have implemented systems to comply with the requirements of Regulatio n (EU) N° 178/2002, where traceability is a current requirement. Capverdian fish industries, as exporters to EU markets, must also implement traceability systems to comply with the above mentioned regulation.

2 WHAT IS TRACEABILITY?

In the past decade, various food crises severely affected many countries, especially in Europe. Examples are the mad cow disease (BSE) in the UK in 1996 and the dioxin contamination in Belgium in 1999 (Beulens *et al.* 2005). After that, authorities and scientists have focused on the utilisation of a standardised system to ensure consumers safety, the re-call of defective/hazardous products and to identify the source of the problem. This system is called traceability**.**

Interest in traceability systems in food processing has been increasing in recent years, although it has been used for many years in several other sectors such as the aviation, automobile and pharmaceutical industries (FAO 2004). As the supply chain has lengthened from local production, processing and consumption to more global commercial opportunities, the transfer of information related to production and safety became more complex. With the increase in complexity, the consumer wishes to know the origin (species, country, catching area, etc), the transformation and the distribution of their food products (FAO 2003).

Food businesses are increasingly demanding traceability to assure their standards and to protect their businesses. The facilitation of full-chain traceability for food products will aid the consumer by guaranteeing safe and healthy products with well-documented characteristics.

2.1 Defining traceability

The term "Traceability" has been introduced to describe systems in which information about a particular attribute of a food product is systematically recorded from creation through marketing (CIES 2005).

Traceability is defined by several food organisations and agencies as described bellow:

- *"Ability to trace the history, application or location of an entity by means of recorded identification."*- ISO 8402:1994
  Regarding ISO 9000:2000, when considering a product, traceability can relate to the origin of materials and parts, the processing history, the distribution and location of the product after delivery.
- *"The ability to trace and follow a food, feed, food-producing animal or substance intended to be or expected to be incorporated into a food or feed through all stages of production, processing or distribution''*- EU regulation n° 178/2002 (European Union (EU),2002).
- *''The creation and maintenance of records needed to determine the immediate previous sources and the immediate subsequent recipients of food, (i.e., one up, one down)''* - U.S. Law. Bioterrorism Act 2002 (FDA 2002)
- *''The ability to follow the movement of a food through specified stage(s) of production, processing and distribution''*-Codex Alimentarius Committee, 27th Session Report 2004 (FAO 2004)

Tracing is the retrieval of information to reconstruct the history of products. A flow of information has to be systematically associated with the physical flow of goods.

Tracking is the retrieval of the actual status of a shipment, a package, etc. It is the capability to follow the path of a specified unit or batch of a trade item downstream through the supply chain as it moves between trading partners. This does not mean that the information must at all times be *visible* by being labelled on the food or being with it.
By analysing all the definitions shown above, and relating it to fisheries trade, the relevance of traceability and the information flow to ensure food safety and quality is clear. All members on a food chain should be able to trace (and track) their products, by keeping and exchanging data within the chain.

The globalisation of the food/fish industry in terms of sourcing raw materials, processing and marketing has resulted in demands for increased exchange of information through the whole chain. This will provide more opportunities for fisheries product, ensure both quality and safety through the whole chain, and fulfil consumers' expectations.

2.2 Traceability in standards and laws

In recent years, traceability requirements are being enforced to enable greater transparency and guarantee food safety. This has been achieved by the development of internatio nal standards, industry guidelines and legislation.

2.2.1 Standards

2.2.1.1 Codex Alimentarius Committee

The Codex Alimentarius Committee produces guidelines to be incorporated into regulations of individual countries, rather than specific legislative requirements. Some standards related to traceability have been developed, such as:

General Standard for Pre-packaged Food (FAO 2001a)

Relevant information regarding the origin of the product is the main point. Section 4.5.1 states: *"The country of origin of the food shall be declared if its omission would mislead or deceive the consumer"*

Section 4.5.2 states: *"When a food undergoes processing in a second country which changes its nature, the country in which the processing is performed shall be considered to be the country of origin for the purpose of labelling"*

Guidelines for Generic Official Certificates Formats, the Production Formats and Issuance of Certificates (FAO 2001b).

Although not designed for food, this standard constitutes requirements to be used in trade between two countries.

In point 16, it is explained that the details of the product being certified should be clearly documented on the certificate which should at least contain the following information:

- Nature of the food
- Name of the product
- Quantity in appropriate units
- Lot identifier or date coding
- Identify and, as appropriate the location of production establishment
- Name and contact details of the importer or consignee
- Country of dispatch
- Country of destination"

Currently, debates are still running within the CAC to decide if traceability should be made a mandatory requirement in the food industry.

2.2.1.2 TraceFish standard (TraceFish 2002 a and b).

TraceFish is the short title for the concerted action project "Traceability of Fish Products", funded by the European Commission. It is also an electronic system of chain traceability. Here, voluntary standards were agreed for specific sectors. It was coordinated by the Norwegian Institute of Fisheries and Aquaculture and it ran from December 2000 to November 2002.

The TraceFish standards are divided in two different standards including the related technical aspects:

- TraceFish standard for captured fish (TraceFish 2002a)
- TraceFish standard for farmed fish(TraceFish 2002b)

The above mentioned standards relate to the information that should be recorded at each stage of the supply chain in order to maintain traceability, such as:

- Information on captured fish and/or farmed fish distribution chain
- Technical specification for the electronic encoding of data, based on the EAN.UCC numbering system, which is referred to in point 2.4

For the purpose of this project, the TraceFish Standard for captured fish was studied. It specifies which data should be created, recorded, and transferred through the captured fish chain. Full supply chain traceability is one of the significant requirements.

According to the TraceFish standard for captured fish, the key to the operation of traceability of fish products is the labelling of each unit of goods traded, whether of raw materials or final products, with a unique ID (TraceFish 2002a).

To identify the relevant information that enables traceability, the data collected from each member of the supply chain, should be analysed and categorised in accordance to its importance, as shown below:

- Necessary information to identify and physically trace the products *shall* be recorded.
- Specific information that is required by law related to food safety, quality and labelling *should* be recorded.
- Further specific and commercial information considered to be of sufficient relevance to be included in the specifications *may* be recorded.

Since the information through the chain is standardised (encoded in a specific format), it is easily transferred through the chain.

There is a direct relationship between a traceability system and labelling. Proper labelling of the final product at the end of the chain is aimed at assuring consumers through the

information conveyed on the label or tag (FAO 2004). However, it doesn't mean that all information should be placed on the label. Traceability systems should generally go *beyond* this labelling information in order to be effective.

2.2.1.3 ISO 22000:2005 (ISO 2005)

ISO (the International Organization Standard) is a worldwide federation of national standards bodies, composed by technical committees which are responsible for preparing International Standards.

ISO 22000 was prepared by the Technical Committee ISO/TC 34, Food Products. It specifies the requirements for a food safety management system, by combining the following key elements:

- Interactive communication (where traceability can be found)
- System management
- Pre requisite programmes
- HACCP principles

According to ISO 22000:2005, each and every food organisation, should meet all the requirements and be able to demonstrate, by means of records (electronic or paper based systems), its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.

Food safety is one of the most important issues in the food chain. Considering that the introduction of food hazards can occur at any stage in the chain, adequate control throughout the food chain is essential. Thus, food safety is ensured through the combined efforts of all the members in the food chain.

HACCP system

HACCP is a food management system that identifies, evaluates, prevents and controls known hazards and the risks of them occurring at specific points in the food chain. It is mentioned in chapter 7 where all the steps to create, implement and maintain it are detailed.

Traceability system

It is referred in point 7.9, where it is clear that each member of a food chain, "…*shall establish and apply a traceability system that enables the identification of product lots and their relation to batches of raw material, processing and delivery records*".

Here it is also required that "*the traceability system should be able to identify incoming material from the immediate suppliers and the initial distribution route of the end product";* records shall be maintained for a certain period, in the event of product withdrawal, based on regulatory and customers' requirements.

A recall system is also part of this standard; in point 5.7, each member of the chain "*…shall establish, implement and maintain procedures to manage potential emergency situations and accidents that can impact food safety and which are relevant to the role of the organization in the food chain*".

Interactive communication between members in the food chain is an important aspect. All the members have to be sure to have perfectly identified and controlled all the hazards, at each step in the chain. They also have to be able to communicate to suppliers, customers (upstream and downstream) and relevant interested parties (e.g. Competent Authorities) in order to place safe products on the market.

2.2.2 Laws and regulations

To export fish products to the EU or the US markets, fishery businesses in Cape Vert should comply with the national regulation (based on the EU regulations). Additionally, they shall fulfil the requirements of the importer market, as well as the requirements from the buyers (e.g. traceability system that provides a standard way to identify, track and trace products, services, and locations).

2.2.2.1 EU regulations

Globally, requirements for traceability are being enforced. In the EU, traceability and product recall systems are therefore a current requirement for all food products. Since the beginning of 2005, the new EU regulation requires that all food and feed business operators have to conform to the traceability directives.

Previously, it was sufficient for a processor to be able to identify the source of an ingredient; now the processor is obliged to ensure that the food products meet the requirements of the food law. This implies that the source of all ingredients can be traced and a processor must therefore be able to prove that his supplier can provide full traceability (Schwagele 2005).

The most significant EU legislations relating to traceability are:

EC n° 178/2002 (European Union (EU) 2002. *"laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety"* (O.J. L31 1 Feb 2002). It took effect on 1 January 2005.

The production through the whole chain is seen as a continuous process (from primary production to the consumer). Traceability is seen as a mandatory issue to enable food safety. Generally speaking, the food law emphasises:

- Outlines on the general principles and requirements of food law
- Establishes the European Food Safety Authority

- Provides procedures in matters of food safety, i.e., among other things the implementation of traceability systems in the food and feed supply chains in Europe.

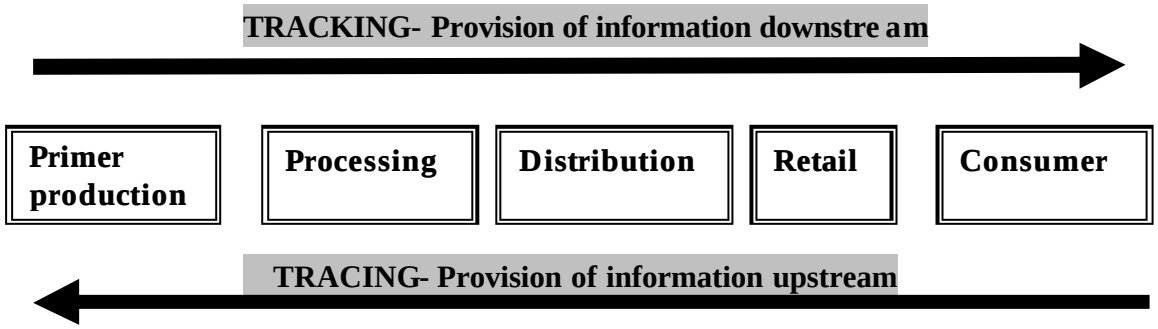
The general food law covers the entire supply chain.

Article 11 is relevant to this project, as it says that *"Food and feed imported into the Community for placing on the market within the community shall comply with the relevant requirements of food law or conditions recognized by the Community to be at least equivalent or, where a specific agreement exists between the Community and the exporting country, with requirements contained therein."*

The most relevant article regarding traceability is Article 18 where the following aspects are considered relevant:

- Traceability should be implemented by each member of the food, feed and food producing chain, regarding each and every ingredient and process used, at all stages of production, processing and distribution.
- Each and every food and feed business operator shall be able to identify all suppliers (of food, feed, ingredients etc), and the food business to whom their product was sold. All the related information shall be recorded and made available to the competent authorities or buyers, upon request.
- The food and feed placed on the market shall be adequately labelled in order to enable traceability. Additional information is required (paper based) to meet specific requirements.
- The food and feed business operators are responsible for withdrawing all the goods that they believe do not comply with food safety regulations and also to inform the competent authorities.

Basically, the traceability system should fulfil the following scheme (Schwagele 2005).



All food and feed business operators should implement a traceability system that enables the tracking of the product at any step in the chain in case of recall and the need for withdrawal; if needed, withdrawals should go to the consumer. This system shall also

provide all the required and related information to identify the non conformity cause and remove it.

Methodologies for the analyses of food and feed materials combined with information technology systems are essential to deliver a working tracking and tracing system (EC n° 178, 2002).

Directive EC /95/2001 (European Union (EU) 2001).

It is related to food safety and requires that all companies have: traceability back to the point of production, systems to recall unsafe products and they have to notify competent authorities in case of unsafe products.

The EU traceability and food safety regulations are strongly linked to other regulations related to health conditions for production and placing on the market of fish products (Directive 91/493/EEC), hygiene in handling (Directive 93/43/EEC), identification of lots (Directive 89/396/EEC), legal requirements for labelling (104/2000/EC), etc.

2.2.2.2 Non – EU regulations

In the United States (US), traceability is not mandatory. It is seen as a tool to ensure food safety. Currently, product recall procedures and mandated documentation are the only form of product traceability in the US (Thompson *et al.* 2005). Some rules were developed by the FDA (Food and Drug Administration), such as the "Procedures for the safe and sanitary processing and importing of fish and fishery products"- Rule 21 CFR 123- (FDA 1995) but there is no specific requirement for traceability. However, as a part of the HACCP system, there must be a linkage between batches of products and processing records that can only be achieved by recording batch identification codes on to processing record.

Recently, due to the terrorist attacks of September 2001, the US introduced the "Public Health Security and Bioterrorism Preparedness and Response act of 2002, PL107-188" (FDA 2002), where some relevant requirements rely on traceability, such as:

- The need for registration with the FDA of buyers, exporters or agents
- Creation and maintenance of records to enable the identification of the immediate previous sources and subsequent recipients of food ("one step up, one step down")
- Description of the product/article
- Country of origin
- Production method
- Country of dispatch
- The anticipated port of entry

This regulation is relevant, since Cape Verde also exports to US markets; in section 306 there is a requirement that all companies wanting to export to US markets should have implemented internal traceability of their product.

Beyond the legal aspect, consumer safety is primarily a question of business ethics and responsibility (ECR 2004).

2.3 Traceability: main objectives

Traceability and systems to link a final product with its ingredients and processing have always formed a key part of any Good Manufacturing Practice (GMP), quality assurance scheme (HACCP) and it helps to improve them.

The main objectives/benefits of the implementation of traceability are described in the book "Traceability within the Fish Industry", published by Sippo in association with the Eurofish International Organization and also in the book "Food authenticity and traceability", edited by Michele Lees. These objectives are to:

- Prevent food incidents: when hazards occur, the process to trace the product back to the source of the hazard (recall) is more efficient and simplified if the partners involved in the chain have organised records and made them available on demand.

This will lead to the identification of all of the potentially harmful products, prevent or minimise any harm to consumers and avoid the negative public opinion about a specific product that usually results in a reduction of sales.

- Minimise the impact of a product recall by limiting the scope of products implicated (as the financial impact of the entire batch recall is enormous, when compared to a group recall).
- Facilitate risk assessment from food exposure by linking information through the chain, it is possible to build the history of the product (harvesting area, processing, ingredients and additives, storage, transportation) and guarantee food safety and quality for the consumers.
- Control food residues**:** it facilitates the implementation of residues monitoring programs as it works with secure data provided from all partners enabling the sampling in target points along the chain.
- Control incorporated ingredients
- Prevent fraud when associated with regular auditing
- Help the industries to improve their quality management and process monitoring
- Incorporate it into laws and standards
- Improve consumers' health and confidence
- Improve mutual trust between members of a chain
- Promote consumers' confidence (as it is linked to consumers' perceptions)
- Facilitate brand protection
- Help to improve the image of the company
- Enable safety

Finally, implementation of traceability systems, although costly, can also be an economic benefit to the producer.

2.4 Overview of the different types of traceability systems

Chain traceability is the key to cooperation and mutual trust between independent companies in a chain. No matter which system is in place, it must be able to provide all the necessary information to ensure food traceability and safety throughout the chain.

The different types of traceability systems are:

- Paper based traceability system: this is the simplest form of traceability; it implies that every relevant piece of information is written on paper that follows the raw material through the processing line to retail.

- Electronic system: with the explosive development in electronic data analysis, traceability systems based on information technology have been developed. The minimum requirement for traceability is that each traceable unit has to be uniquely labelled to allow identification. The following data carriers are being used:

- EAN-13 (European Article Number) and UCC-12 (Uniform Code Council) - Bar code: this is the most common labelling method in used. Other bar codes (EAN/UCC-128) can also be used for the same purpose (EAN 2002).

- RFID (Radio Frequency Identification) tags (Derrik 2004): this is a growing technology; the price is high to justify their use at the consumer end of the chain. However it is used today for some reusable fish tubs and as an internal traceability keeper in the meat industry. The advantage of these tags is that they are fast and easy to read.

- Combination of paper based and electronic systems: If a unit to be traded can't be unequivocally identified, then it should be tied to records and documents (e.g. health certificates) to enable basic conditions for traceability and safety. This is the most commonly used system.

Depending on the degree of implementation and the traceability system in place, product traceability may require significant investments, where the benefits are not immediately obvious.

2.5 Fish industry: traceability and quality management systems in the fresh fish trade

Fish quality, safety and shelf life are highly influenced by non-visible factors such as autolysis, contamination, and growth of microorganisms (Liu Junrong 2002). Biological variations, harvesting conditions and post-harvest handling were considered to be the most relevant aspects (Huss 2001) to enable quality and safety. The effects of these factors can be assessed long after the damage has occurred, proving that proper procedures to prevent it should have been implemented.

From 1970 to 1984, 18% of disease outbreaks were related to fish and fish products in the USA (Huss 2001). In the USA, approximately 50% of outbreaks were caused by shellfish (FAO 2004).

Due to the need for improving quality, food safety and consumer health, the Hazard Analysis Critical Control Point (HACCP) system was created. Since then, it has been implemented in many companies in several countries (Cape Vert included).

The implementation of a HACCP system facilitates national and international trade by demonstrating to customers a commitment to food safety. The need for requisite documentation is defined, and if conducted correctly, will help food business operators to establish traceability at all stages in the chain (FAO 2004).

Despite the great evolution regarding fresh fish quality and consumer safety, it is clear that it is not possible to produce food with zero risk (CIES 2005).

In the fish trade, freshness is one of the most important aspects. It is - for all species - almost exclusively a function of time and temperature. In principle, each fish should be continuously monitored with a time-temperature recording device; however, this is not technically or economically feasible. Therefore, these two aspects are dealt with separately. In a well-functioning distribution chain where each step can be relied upon in terms of temperature control, quality and traceability can be implemented by a time recording. Still, an important aspect of quality and safety assurance is to be able to trace products, ingredients, suppliers etc., through the food production chain (FAO 2004), especially when failures occur.

The implementation of quality assurance systems (HACCP), Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP) and well recorded harvesting, processing, transportation and distribution information (traceability) are the keys to increasing fish products' quality, safety, trade and consumption (Lees 2003).

There is a fundamental difference between HACCP, GMP and GHP systems and traceability systems. Although one of the main goals for all these systems is consumer safety, they differ in their approach. The HACCP, GMP and GHP systems are proactive and process oriented, with the aim of preventing incidents related to products' quality and safety. The traceability system is product oriented and reactive. It monitors the flow of products with the aim of minimising the impact in case any of the other systems (HACCP, GMP and GHP) fail. Therefore, the combination of these systems will benefit both quality and safety and minimise the risk of incidents as well as their impact.

Thus, the whole chain from vessel to retailer can be managed in a more effective way, when the traceable information is actively used along with quality and safety information to enhance mutual trust and cooperation between steps in the chain. Significantly less time (and money) can be spent on quality checks and storage, and when recalls are to be carried out, traceability is an insurance that the company limits loss, and protects its brand on the market (FDA 2002).

3 MATERIAL AND METHODS: THE ICELANDIC AND CAPVERDIAN STUDIES

The project includes two cases:

- Traceability and quality related information in a fresh fish export from Iceland to Belgium.
- Traceability and quality related information in a Capverdian fresh fish exporting chain

Figure 2 shows the fresh fish export chain used to study traceability and quality related information in a fresh fish export to Belgium.

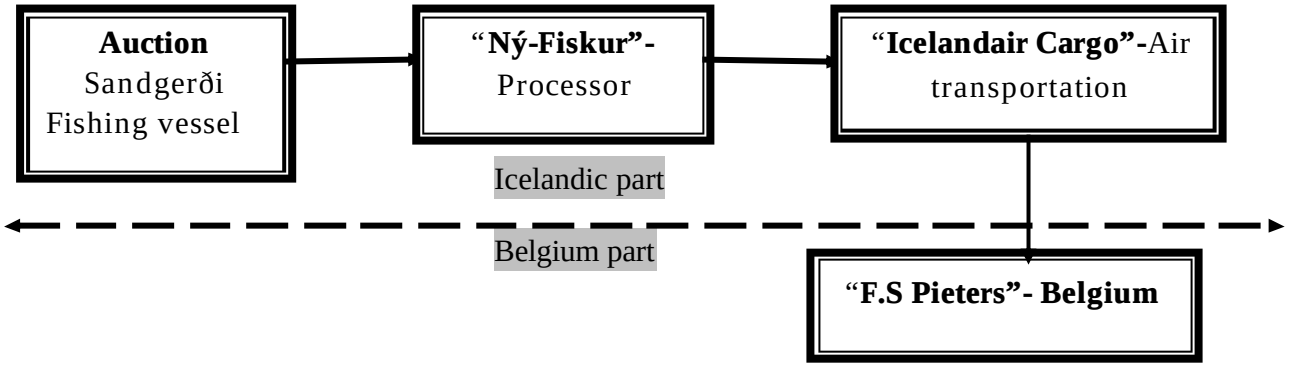


Figure 2: Icelandic fish export chain used to study the traceability and quality related information in a fresh fish export to Belgium.

3.1 Traceability and quality related information in a fresh fish export to Belgium.

The objectives of this study were:

- To verify how traceability related information is created, and how it is kept and transferred through the chain.
- To verify if the traceability systems implemented by each member in the chain are in accordance with EU regulation 178/2002 and with the TraceFish standard.
- To observe the synergy between the quality management and traceability systems.
- To study the time - temperature profile during transportation of fresh fish from a processor in Iceland to secondary processing in Belgium.

To achieve the objectives, visits to the Icelandic members of the chain (Auction, Ný-Fiskur and Icelandair Cargo) took place on the 29 and 30 November and 16 December, as well as interviews with a predefined questionnaire based on the TraceFish standard. To study the time- temperature profile during the export process, temperature measurements of the products took place as well as the placement of temperature loggers.

This study focused on the Icelandic members of the above mentioned chain. To enable better comprehension, the traceability and quality management systems implemented by each Icelandic member were analysed separately as well as the temperature profile study.

3.1.1 Auction

A visit to an auction located in Sandgerði took place on 16 December to understand the traceability and quality management systems in place. Some data were collected but due to the need for additional information, a meeting took place on 22 December at IFL to interview the marketing director of Íslandsmarkaður Auction.

3.1.2 Nýr – Fiskur processing plant

The visits to Nýr- Fiskur took place on 29 and 30 November to:

- Follow the processing of fresh cod loins.
- Collect some preliminary traceability and quality related information.
- Place the temperature loggers to provide the necessary information regarding the temperature profile during transportation.

A third visit was made on 16 December to interview Nýr-Fiskur's manager by using a questionnaire based on the TraceFish standard and to have additional information to link the quality assurance programmes to the traceability system.

For this study, cod was caught on 28 November. The whole cod was bought through the auction in Sandgerði on 29 November 2005 and landed straight at "Nýr- Fiskur" processing plant on the same day. The processing of the lot took place on 30 November and the export was made on the same day to F.S Pieters (located in Belgium) which is Nýr-Fiskur's main buyer.

On 29 November, relevant traceability related information was gathered. Temperature measurement of the whole cod took place (by means of a handset thermometer) as well as its quality assessment (after the weighing step) by sensory evaluation of random samples.

On 30 November, the fresh fish processing line was followed in order to understand the quality management system and the relevance of the temperature records at Nýr- Fiskur. During processing, temperature measurements of the fillets (at the filleting and packaging steps) were made. At the packaging step, the de-skinned loins were placed in 3 kg polystyrene boxes with a false bottom (to drain water); although Nýr-Fiskur also uses 5 kg and 18 kg polystyrene boxes with false bottom.

Then, five polystyrene boxes (with fresh loins) were marked and the temperature of the loins measured and recorded (Figure 3).

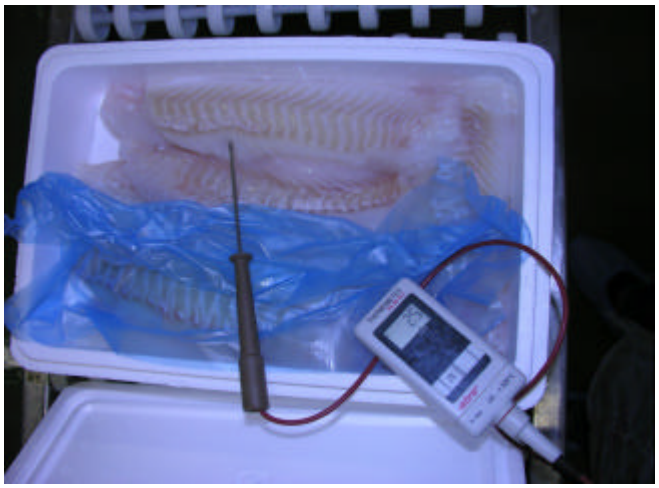


Figure 3: Temperature measurement of final product (fresh loins) by means of a handset thermometer at Nýi Fiskur.

Right after the temperature measurements of the fresh loins in the polystyrene boxes, three "Thermochron iButton" loggers (called "iButton" loggers for the purpose of this study) were placed in each polystyrene box (on top, centre and bottom), in contact with the cod loins air freighted to the Netherlands.

The iButton logger (Figure 4) is a self- sufficient digital thermometer that measures temperatures and records the results in a protected memory section. It logs up to 2048 consecutive temperature measurements with an accuracy of ± 1°C from -30°C to +70°C and 0.5°C increments (Maxim 2006). It starts to measure and record data while affixed to the object. For this study, 21 iButton loggers were used after calibration at 0°C by means of an ice bath for 1 hour.

Figure 4: iButton logger used in the study to record the temperature of the loins placed in the polystyrene boxes.

The boxes were closed (without ice mats or dried ice inside) and labelled in order to clearly indicate that they were samples to a laboratory, RIVO, in the Netherlands (Figure 5).

Figure 5: Samples (fresh loins packed in polystyrene boxes at Ný- Fiskur) labelled to clearly identify the samples for RIVO laboratory.

Then, the five polystyrene boxes were placed in different strategic places in one pallet to enable temperature performance of different locations of the pallet (Figure 6 and Figure 7) and exported (as a part of a batch) to "S.F Pieters" processing plant, located in Belgium.

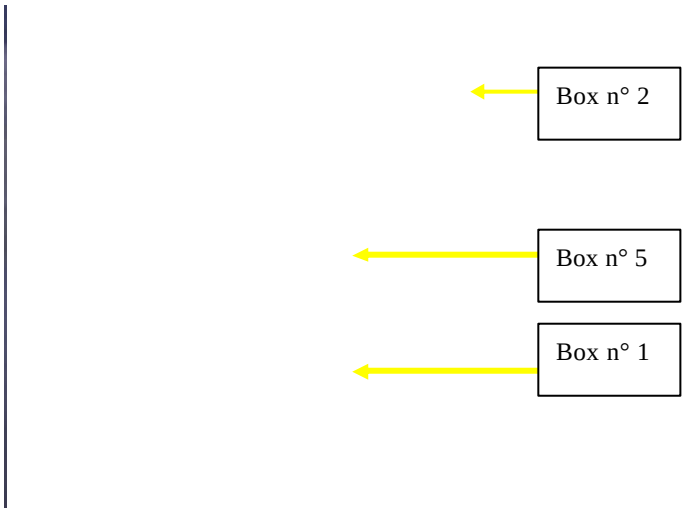


Figure 6: Placement of boxes 1, 2 and 5 (samples) in one pallet ready to export from Ný-Fiskur to F.S Pieters, Belgium.

Figure 7 shows the placement of the samples (boxes with fresh loins) in the pallet.

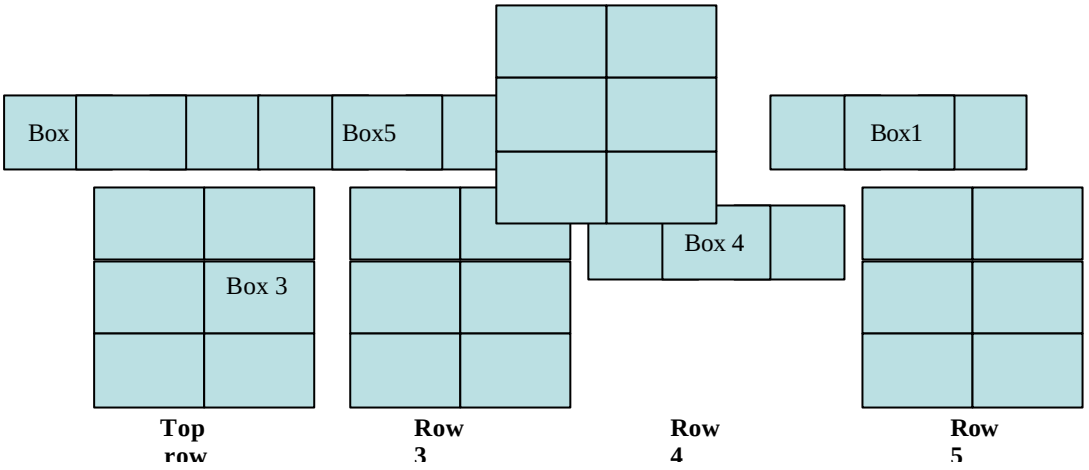


Figure 7: Diagram on the placement of the samples (boxes with fresh loins) in the pallet exported from Ný- Fiskur to F.S Pieters.

To record the surrounding temperature, onset loggers were used after previous identification and calibration by means of an ice bath. The onset logger (Figure 8) is a temperature logger with optic communication able to record more than 32000 measurements in the range of -20°C to +50°C (Onset 2006). Its accuracy is ±0.4°C. The onset logger was previously calibrated to 0°C, by means of an ice bath.

Figure 8: Onset logger used to record the surrounding temperature profile from Ný-Fiskur to F. S Pieters, Belgium.

To record the surrounding temperature during export, one onset logger was placed on top of the pallet, as shown in the Figure 9.

Figure 9: The onset logger placed on top of the pallet ready to be exported from Ný-Fiskur to F.S Pieters, 30/11/05.

The pallet was taken to Keflavik International Airport to be air freighted to Belgium by Icelandair.

3.1.3 Icelandair Cargo, Keflavik International Airport

Icelandair Cargo is one of the Icelandic transport companies in charge of transporting fresh products out of Iceland. To understand the traceability and quality management system at Icelandair Cargo, the lot produced at Ný-Fiskur on 30 November was followed to its placement in the cold storage at the Icelandair Cargo storage house at Keflavík International Airport. In Belgium, Icelandair sub contracts a company to deliver the fresh product to F. S Pieters, by means of a cooling truck.

Additional data was collected by email and also by interviews.

3.2 Simulation of the implementation of traceability in a Capverdian fresh fish export chain

The aim of this study was to show the current status of traceability and quality management systems in Cape Vert and to present a suitable traceability system that could be implemented with the increasing of fresh fish exports. The suggested traceability scheme was compared to the TraceFish standard and the results are presented in Table 13 **Error! Reference source not found.** and Table 14 in Appendix 7.2. Quality related information was used to evaluate how it complements the traceability system, as well as the TraceFish standard to compare and summarise the traceability information. The data was gathered by email. For the purpose of this study, a certified storage house (Complexo de Pesca Cova d´Inglesa, CPCI) located in S. Vicent was used. Fresh tuna from small certified boats was processed and packed in polyethylene boxes with ice bags at CPCI and exported to the Netherlands, one of the most important Capverdian fresh fish markets. The chain used for this study is shown in Figure 10.

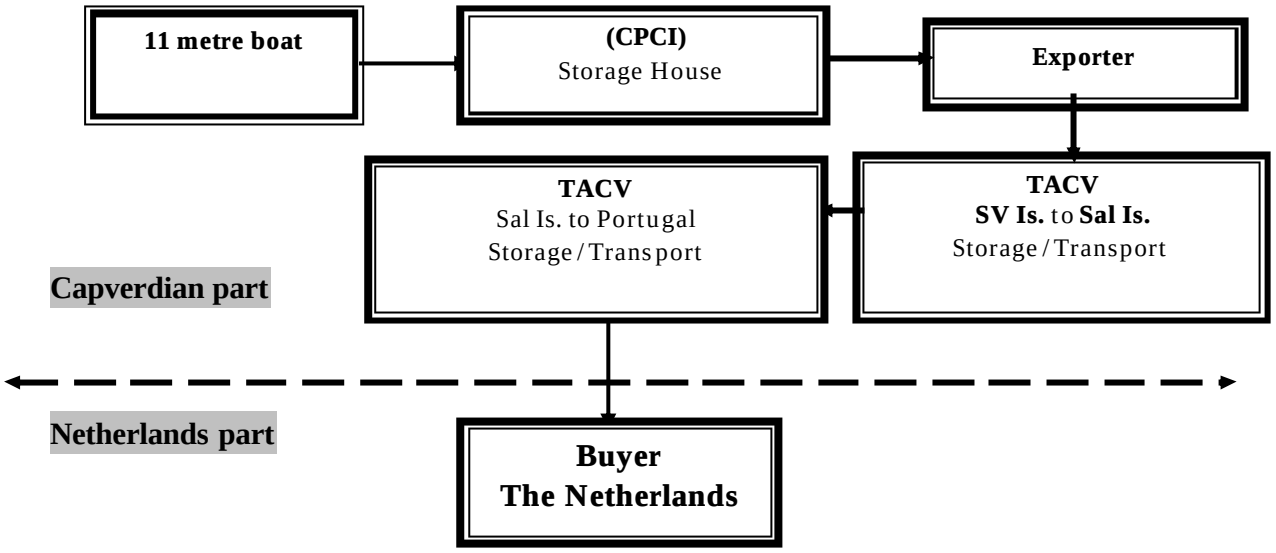


Figure 10: Chain to study a Capeverdian traceability scheme for fresh fish exports from CPCI to the Netherlands.

Main emphasis was given to the Capverdian members in the chain.

CPCI is the only certified plant for live, fresh and frozen fish products in S. Vicente Island. It started to export fresh whole fish in 2005 (although the ban was lifted in 2003) and until December 2005, only 5 tonnes of fresh whole fish were exported, mainly to the Netherlands. The Capverdian fresh products are air freighted by the only air transportation company- TACV, Cap Vert Airlines.

4 RESULTS

The results are organised according to each studied case.

4.1 Traceability and quality related information in the fresh fish exports to Belgium.

The traceability and quality related information created and transferred by each Icelandic member in the chain is explained separately and then compared with the TraceFish standard required information by means of the TraceFish tables, which can be found in the Appendix.

4.1.1 Auction

The auction system is owned by fish buyers and sellers; HACCP and Pre-Requisites Programmes (GMP and GHP) are applied.

4.1.1.1 Receiving lots

The auctions have access to various types of information from the boat's log book. This information is available before landing:

- Catching grounds
- Catching time
- Landing day and time
- Fishing gear
- Processing method on board (fish older than 12 hours should be landed gutted)
- Grading size (depending on the boat)
- Temperature records
- Weight

Usually the lots are landed in tubs (the tubs are identified with a unique number due to an agreement between the tub producers). Small boats use little ice (up to 5%) and big vessels usually take around 15% of ice due to the longer time spent at sea. After landing, the ice percentage is measured and a label is then placed on each tub providing the following information:

- Name of the boat where the lot comes from
- Fish age (from catch day)
- Species
- Tub number
- Weight (of each tub)
- Date
- Grading size (depending on boat)

If the lot is gathered from many boats, the necessary information is kept and made available in the auction's data system whenever needed. However, some traceability information can be lost.

4.1.1.2 Preparing the lots for sale

Quality assessment is made on each landed lot, based on the appearance of the gills, eyes, odour and texture but no particular scheme is used. Although the auction had a course on QIM (Quality Index Method), it is not used.

The auctions do not check the temperature of each landed lot on a regular basis but ice is added after gutting and/or grading steps (the gutting and grading steps are made only by the biggest auction). The temperature checks only take place when problems occur (e.g. lots landed without ice or little ice left).

All the required information is then inserted into the auction database and made available to the buyers by means of the Clock Market.

Each lot has a unique identification (ID) by combining the following data:

- Day of sale
- Auction ID
- Auction number
- Number of the lot
- Bid number (a serial number of five digits, where the three first numbers are the bid serial number and the two last numbers are used if the lot is broken up)
- Buyer ID
- Tub number
- Fish age and type
- Units available to be sold
- Weight (the weight of each lot is taken by weighing one tub, the ice percentage in it and the average is used for the whole lot)

The above-mentioned information is applied in a label, as shown in Figure 11.

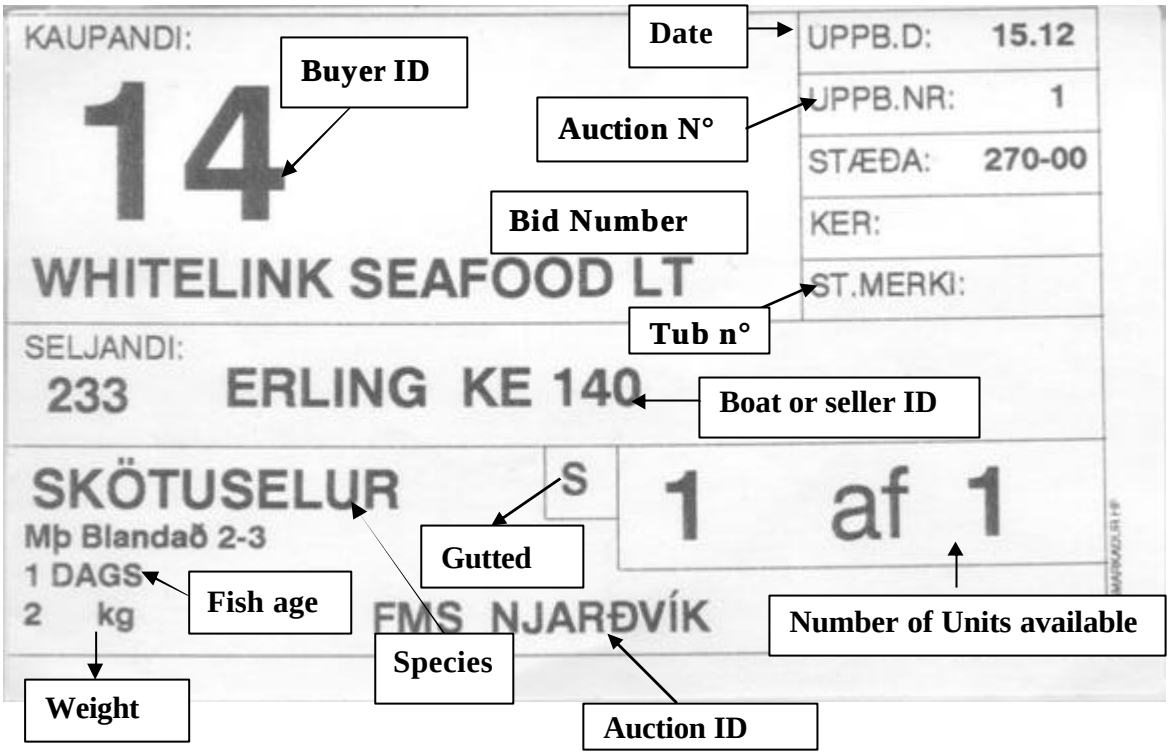


Figure 11: Auction label placed on tubs with graded fish, showing the relevant information related to the lot ready to be sold.

As mentioned before, an electronic system called "The Market Clock" (Figure 12) is used. Here, buyers and sellers can access all the necessary information regarding boats, harbours, lots, price, fishing gear, quality, size grade, average weight, age of the fish, comments on the handling, minimal units to be sold and traceability links, whenever they need to. The auction decides on selling the whole lot or part of it (here, the quality aspects, species quantity and size grade are the main factors). This electronic system is more often used (90%). A paper based system can also be used (10%) and it also provides the necessary information.

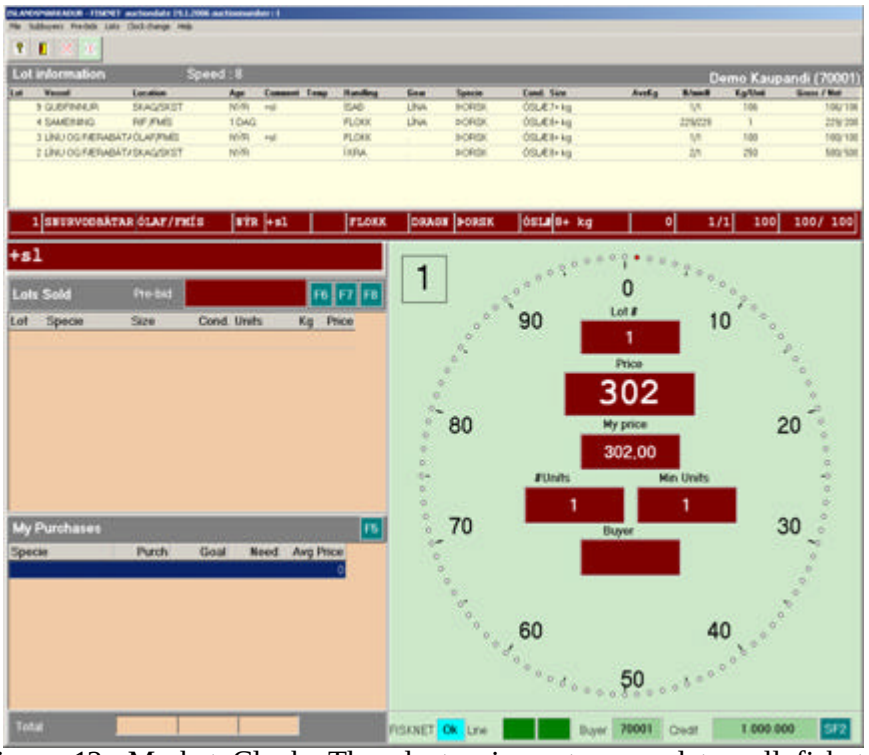


Figure 12: Market Clock. The electronic system used to sell fish trough the auction system. All the necessary information regarding the lots is available in the Market Clock.

The traceability and quality available information is summarised in Table 10**Error! Reference source not found.** in the Appendix.

By comparing the traceability information with the TraceFish standard combined with the quality related information, the following aspects were considered relevant:

- Some information can be lost when mixing lots from different sources (boats or sellers).
- Temperature measurements are made only when the quality grade (based on their own experience) and freshness reveal a problem or in the absence of remaining ice.Although they have the knowledge on the QIM method for quality assessment of the fish, the sensory evaluation is based on their experience.

4.1.2 Ný- Fiskur: fish processing and marketing company

Ný- Fiskur is one of the biggest Icelandic fresh fish marketing and exporting companies, located in Sandgerði, near the international airport in Keflavik. It was founded in 1996 and 25% is owned by FS Pieter (75% is privately owned).

The main processed species are cod, redfish and catfish as fresh (mainly) and frozen products. In 2004, 90% of the products were sold to FS Pieters (a processor located in Belgium, which usually re- packs the fresh fish from Ný- Fiskur).

In 2004, 3500 tonnes of raw material were used to process fresh cod, which represented 70% of the total production.

Although Ný-Fiskur buys fish mainly from small boats, they own one boat and they also have business with three more boats to guarantee the providing of raw material mostly when the weather doesn't allow small boats to go fishing. Generally, 50% of the raw material comes from small boats, of which 94% is caught less than 24 hours before being processed (the rest of the raw material is caught up to 48 hours before processing).

Ný-Fiskur employs 81 people of which 60 work on the processing line.

All the production (fresh fish) is exported, mainly to Europe (Belgium).

Ný-Fiskur buys fish (gutted or ungutted) from different auctions by using the Market Clock and usually from the following areas:

- Reykjanes area
- Snæfellsnes area
- Vestfjörðs area

The fishing areas Ný-Fiskur buys from are shown in Figure 13.

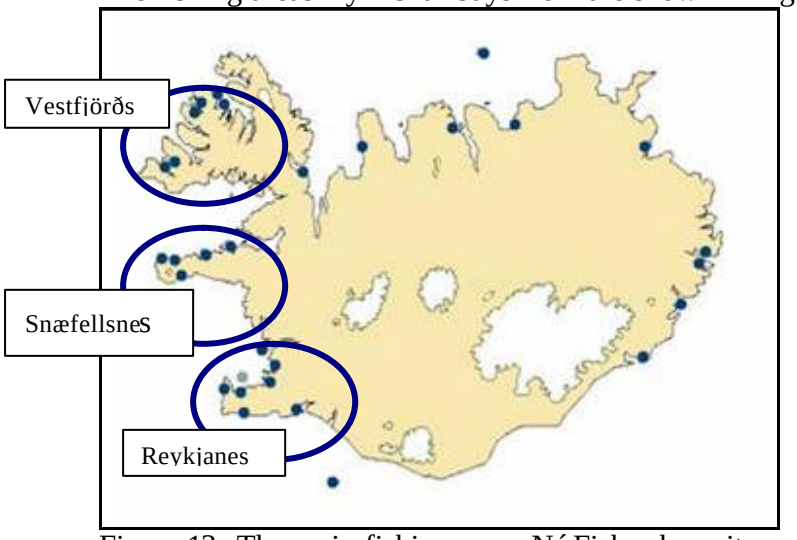
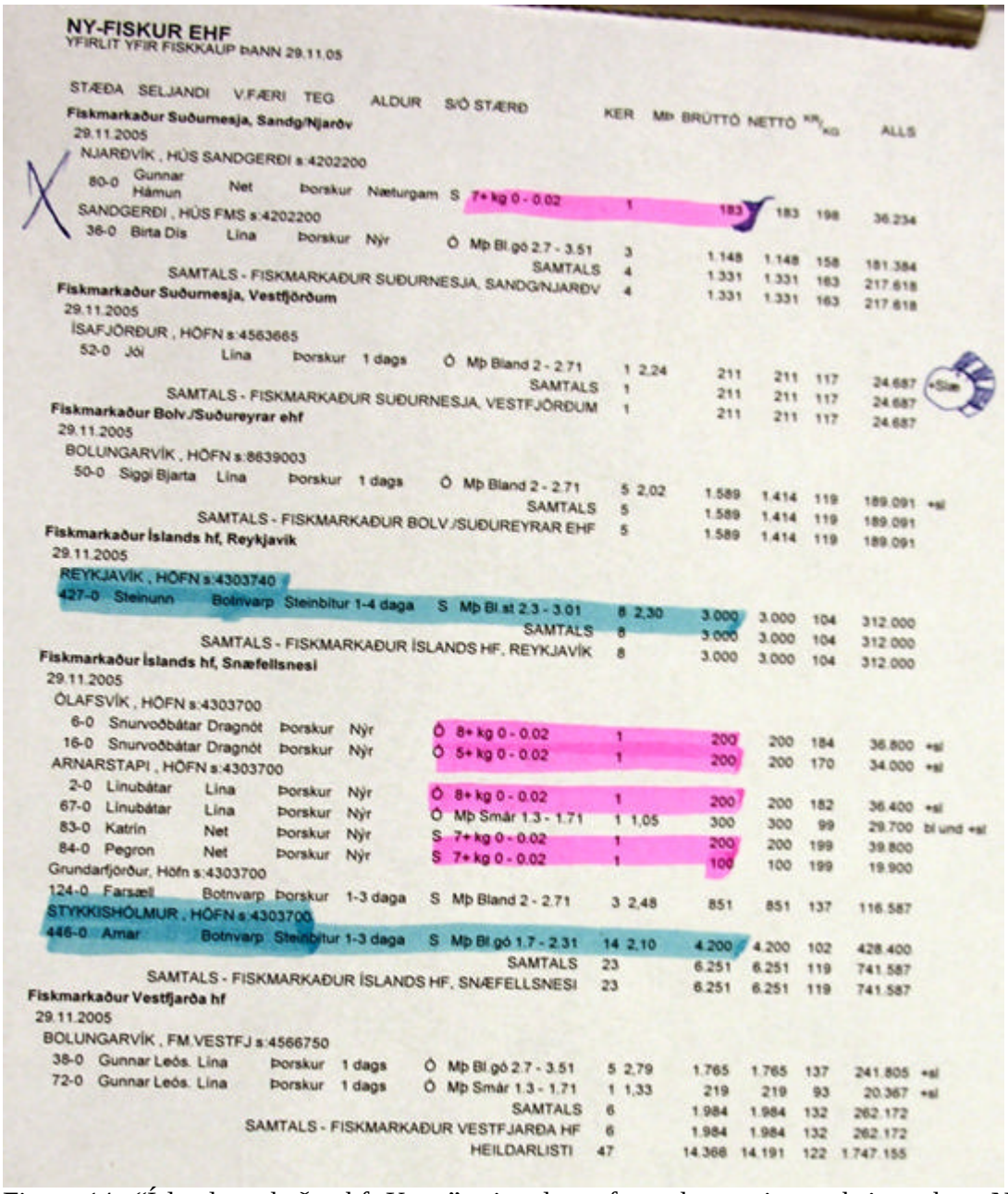


Figure 13: The main fishing areas Ný-Fiskur buys its raw material from.

They can also get fish straight from boats, but through the auction system. Sometimes they know from which boat/boats the catch comes from but sometimes the fish is just marked with “fish from line boats”, etc, and then the auction is the connection point to the boats.

At the reception stage, the fish was kept in slurry ice until processing. There, the lots are mapped according to landing harbours or auction point until the grading step.

Considering that the lot used in this experiment was bought through the Íslandsmarkaður auction, Nýr-Fiskur, the “Íslandsmarkaður hf- Kaup” (Figure 14) was used. “Íslandsmarkaður hf- Kaup” is a document printed out from the auction site, where relevant traceability information can be found and kept. This information - the auction ID, fish lot, weight, name of the vessel, fishing gear and size grade - can be used by the buyer as a means of confirming the purchasing as well as planning the processing.



NY-FISKUR EHF
YFIRLIT YFIR FISKKAUP ÞANN 29.11.05

STÆÐA	SELJANDI	V.FÆRI	TEG	ALDUR	S/Ó	STÆRÐ	KER	Mþ	BRÚTTÓ	NETTÓ	KR/KG	ALLS	
Fiskmarkaður Suðurnesja, Sandg/Njarðv													
29.11.2005													
NJARÐVÍK , HÚS SANDGERÐI s:4202200													
80-0	Gunnar Hámun	Net	Þorskur	Næturgam	S	7+ kg 0 - 0.02	1		183	183	198	36.234	
SANDGERÐI , HÚS FMS s:4202200													
36-0	Birta Dís	Lína	Þorskur	Nýr	Ó	Mþ Bl.gó 2.7 - 3.51	3		1.148	1.148	158	181.384	
						SAMTALS	4		1.331	1.331	163	217.618	
						SAMTALS - FISKMARKAÐUR SUÐURNESJA, SANDG/NJARÐV	4		1.331	1.331	163	217.618	
Fiskmarkaður Suðurnesja, Vestfjörðum													
29.11.2005													
ÍSAFJÖRÐUR , HÖFN s:4563665													
52-0	Jói	Lína	Þorskur	1 dags	Ó	Mþ Bland 2 - 2.71	1	2,24	211	211	117	24.687	+Slæ
						SAMTALS	1		211	211	117	24.687	
						SAMTALS - FISKMARKAÐUR SUÐURNESJA, VESTFJÖRÐUM	1		211	211	117	24.687	
Fiskmarkaður Bolv./Suðureyrar ehf													
29.11.2005													
BOLUNGARVÍK , HÖFN s:8639003													
50-0	Siggi Bjarta	Lína	Þorskur	1 dags	Ó	Mþ Bland 2 - 2.71	5	2,02	1.589	1.414	119	189.091	+sl
						SAMTALS	5		1.589	1.414	119	189.091	
						SAMTALS - FISKMARKAÐUR BOLV./SUÐUREYRAR EHF	5		1.589	1.414	119	189.091	
Fiskmarkaður Íslands hf, Reykjavík													
29.11.2005													
REYKJAVÍK , HÖFN s:4303740													
427-0	Steinunn	Botnvarp	Steinbítur 1-4 daga		S	Mþ Bl.st 2.3 - 3.01	8	2,30	3.000	3.000	104	312.000	
						SAMTALS	8		3.000	3.000	104	312.000	
						SAMTALS - FISKMARKAÐUR ÍSLANDS HF, REYKJAVÍK	8		3.000	3.000	104	312.000	
Fiskmarkaður Íslands hf, Snæfellsnesi													
29.11.2005													
ÓLAFSVÍK , HÖFN s:4303700													
6-0	Snurvoðbátar Dragnót	Þorskur	Nýr		Ó	8+ kg 0 - 0.02	1		200	200	184	36.800	+sl
16-0	Snurvoðbátar Dragnót	Þorskur	Nýr		Ó	5+ kg 0 - 0.02	1		200	200	170	34.000	+sl
ARNARSTAPI , HÖFN s:4303700													
2-0	Línubátar	Lína	Þorskur	Nýr	Ó	8+ kg 0 - 0.02	1		200	200	182	36.400	+sl
67-0	Línubátar	Lína	Þorskur	Nýr	Ó	Mþ Smár 1.3 - 1.71	1	1,05	300	300	99	29.700	bl und +sl
83-0	Katrín	Net	Þorskur	Nýr	S	7+ kg 0 - 0.02	1		200	200	199	39.800	
84-0	Þegron	Net	Þorskur	Nýr	S	7+ kg 0 - 0.02	1		100	100	199	19.900	
Grundarfjörður, Höfn s:4303700													
124-0	Farsæll	Botnvarp	Þorskur	1-3 daga	S	Mþ Bland 2 - 2.71	3	2,48	851	851	137	116.587	
STYKKISHÓLMUR , HÖFN s:4303700													
446-0	Arnar	Botnvarp	Steinbítur 1-3 daga		S	Mþ Bl.gó 1.7 - 2.31	14	2,10	4.200	4.200	102	428.400	
						SAMTALS	23		6.251	6.251	119	741.587	
						SAMTALS - FISKMARKAÐUR ÍSLANDS HF, SNÆFELLSNESI	23		6.251	6.251	119	741.587	
Fiskmarkaður Vestfjarða hf													
29.11.2005													
BOLUNGARVÍK , FM.VESTFJ s:4566750													
38-0	Gunnar Leós.	Lína	Þorskur	1 dags	Ó	Mþ Bl.gó 2.7 - 3.51	5	2,79	1.765	1.765	137	241.805	+sl
72-0	Gunnar Leós.	Lína	Þorskur	1 dags	Ó	Mþ Smár 1.3 - 1.71	1	1,33	219	219	93	20.367	+sl
						SAMTALS	6		1.984	1.984	132	262.172	
						SAMTALS - FISKMARKAÐUR VESTFJARÐA HF	6		1.984	1.984	132	262.172	
						HEILDARLISTI	47		14.368	14.191	122	1.747.155	

Figure 14: "Íslandsmarkaður hf- Kaup" printed out from the auction website, where Ný-Fiskur got information about the lots bought on 29/11/05 (e.g. vessel, fishing gear, gross weight, etc).

At Ný- Fiskur, the whole bled cod was processed in accordance with the flow chart in Figure 15.

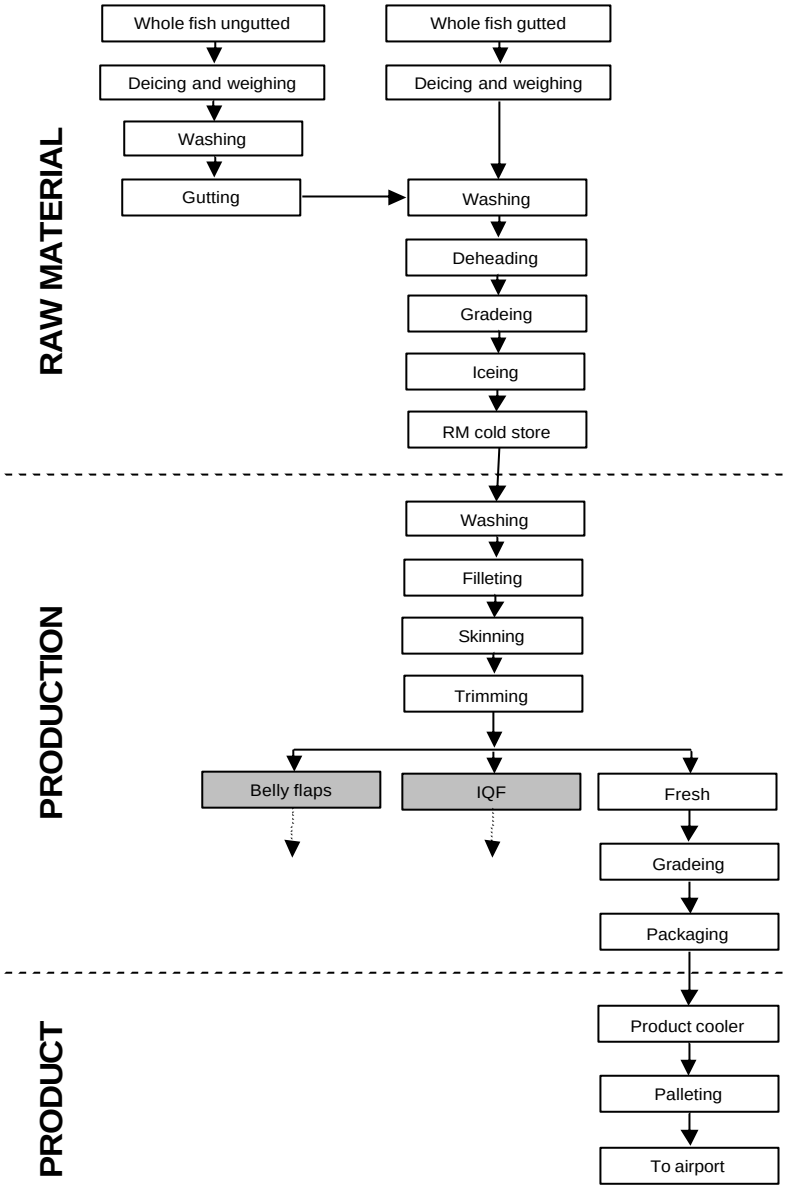
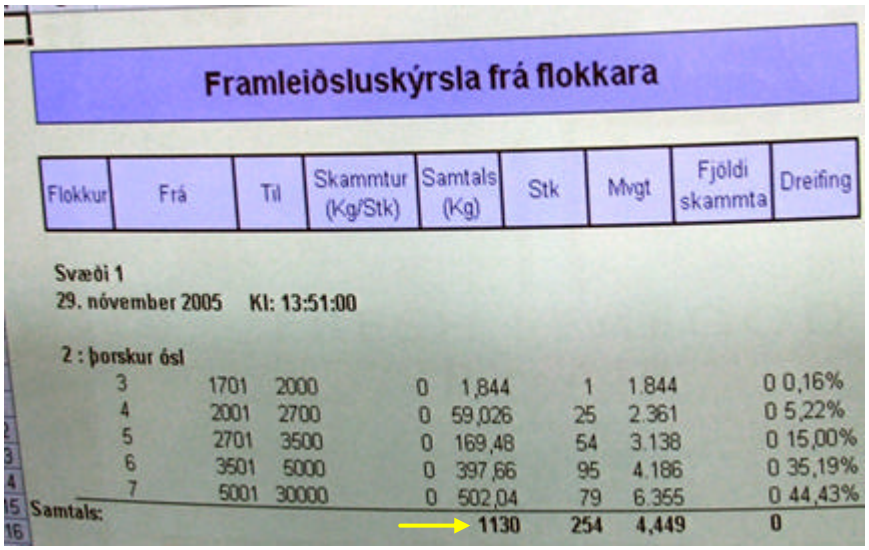


Figure 15: Flow chart of fish processing at Ný-Fiskur.

At the conveyor belt, after dicing and washing, the fish from each lot was weighed to check it against the given weight from the auction (in this case it was 1.4% less than

given). The relevant information was collected (e.g. weight, etc) and sent to a central system computer (Figure 16).



Framleiðsluskýrsla frá flokkara

Flokkur	Frá	Til	Skammtur (Kg/Stk)	Samtals (Kg)	Stk	Mvgt	Fjöldi skammta	Dreifing
Svæði 1								
29. nóvember 2005 Kl: 13:51:00								
2 : þorskur ósl								
3	1701	2000	0	1,844	1	1.844	0	0,16%
4	2001	2700	0	59,026	25	2.361	0	5,22%
5	2701	3500	0	169,48	54	3.138	0	15,00%
6	3501	5000	0	397,66	95	4.186	0	35,19%
7	5001	30000	0	502,04	79	6.355	0	44,43%
Samtals:				1130	254	4,449	0	

Figure 16: Data from Ný-Fiskur central computer showing the weigh values to be checked against the given values from the auction, 29/11/05.

The quality assessment of the whole cod also took place by sensory evaluation of random samples (Figure 17). No special sensory scheme was used and the sensory evaluation was based on:

- The appearance of gills, eyes and skin
- The texture (firmness of flesh)
- The odour
- Temperature measurements of random samples of the lot (the highest t° found was 2.1 °C).

The highest temperature value is recorded and if the fish temperature at arrival is over 4°C, the lot is rejected. The temperature measurements and quality assessment of the raw material is the basis for accepting or rejecting the lot (which is very seldom as they only buy cod caught within two days). It is also used to decide if the lot will be used for fresh fillets/loins air freighted to Europe. According to Ný-Fiskur's sensory evaluation criteria, the lot used in the experiment had good quality to produce fresh loins to export.

The temperature measurement and the sensory evaluation were carried out by the quality manager.

Figure 17: Quality manager proceeding sensory evaluation of the whole cod at Ný-Fiskur, 29/11/05.

The fish is then headed and graded. At the grading step, the fish is graded according to the weight and then collected into tubs with slurry ice, as shown in Figure 18.

Figure 18: Fish kept in tubs with slurry ice after grading step at Ný- Fiskur, 29/11/05.

Each graded weight is labelled according to catch area, as follows:

- Fish from the Reykjanes area is treated as one batch and identified as SV I
- Fish from Snæfellsnes area: SV II
- Fish from Vestfjörðs area: SV III
- Others areas: SV IV to VI

Right before the tubs go into the raw material cold storage, an internal label is printed out (Figure19) and glued on the tubs with graded fish. The printing time is also recorded, giving relevant traceability information.

The graded fish was kept in the raw material cold storage in the temperature range of 3°C to 5°C, until the next day (30 November). The time when the tubs were placed in the cold storage was recorded as well as when they were checked out. The temperature of the cold storage is checked and it is logged every five minutes.

Figure19: Internal label being printed out after grading step at Ný- Fiskur, 29/11/05.

The internal label had the following information:

- Total weight of fish
- Average weight of fish
- Number of fish in tub
- Tub number
- Species
- Name of the boat
- Fishing gear used
- Reception date
- Size grade
- Catching area
- Ný-Fiskur ID number

The internal label used for the experiment is shown in Figure 20.

Figure 20: Internal label placed on tubs with graded fish used in the experiment, Ný-Fiskur 29/11/05.

On 30 November, at 14:30, the lot was checked out of the cold storage right before processing. The tub number and check out time were registered in the computer enabling traceability through the processing.

To understand the temperature changes through the processing of the fresh fish to export, handset thermometers were used to measure the temperature of the whole cod, the fillets during the processing and the end product at the packaging step. The results are shown in Table 1..

Table 1: Temperature measurements of fish samples at Ný- Fiskur on 29 and 30 November.

Step	Product	Date	Time (H)	Temperature (°C)
Reception	Whole cod	29/12/05	15:30	2.3
Filleting	Fillets with skin	30/12/05	14:20	2.1
Packaging	Loins (de-skinned)	30/12/05	15:00	See table 2

At the processing step, the lot was filleted, de- skinned and trimmed. Quality assessment continued by means of sensory evaluation of random samples taken to evaluate worms, quality of trimming, gaping, colour and odour. The quality assessment was made by five trained personnel. Temperature is not checked on a daily basis.

At the packaging step, the loins were placed in 3 kg polystyrene boxes with false bottoms, as shown in Figure 21. Once again, random samples were taken to confirm the quality of the lot ready to be exported; colour and gapping were evaluated by means of a grading system with scores from 0 to 4 (the best quality) as well as the temperature measured. The information was recorded on a specific form. No specific scheme was used to assess the quality, but Ný- Fiskur is now starting to implement the QIM method for sensory evaluation.

Figure 21: Polystyrene boxes with false bottom used at Ný-Fiskur to pack fresh loins, 30/11/05.

After the identification of the samples (five polystyrene boxes with fresh loins), the temperature measurements (by means of handset thermometers) took place and the results are shown in Table 2. The loins were then covered with a polystyrene film and the boxes closed.

Table 2: Results of the temperature measurements of the final product samples.

Box n°	Loins temperature (°C)
1	2.3
2	2.5
3	1.6
4	2.1
5	2.1
Average temperature	2.12

The labels were printed out all at once and then placed on each box with the following information (Figure 22):

- Ný- Fiskur's ID
- Specie
- Type of product
- Catching ground
- Lot number
- ID to connect the product to the buyer
- Production date
- Fishing gear
- Information about storage
- Weight
- Origin of product

Specification regarding the processing order is not available.

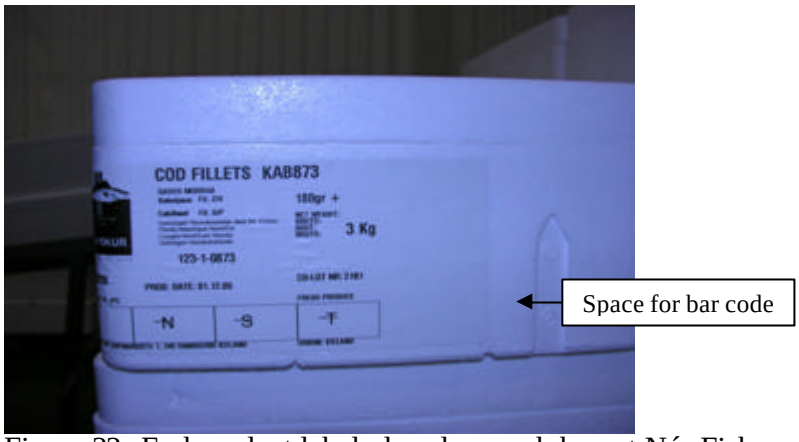


Figure 22: End product label placed on each box at Ný- Fiskur.

The boxes were then gathered in pallets, and the samples for RIVO were all placed in the same pallet. The pallet was then covered with a plastic and the Airway Bill Number (AWB) was glued on top of it, as shown in Figure 23. Information regarding the composition of each pallet is kept in a paper based system, and made available on demand. The pallet was loaded in the truck (owned by Ný- Fiskur) and taken to the airport at 15:10 h. The airport is 10 minutes from Ný- Fiskur's facilities.

Figure 23: Airway bill glued on the pallet dispatched from Ný- Fiskur on 30 November.

The traceability and quality available information is summarised in Table 11. in the Appendix.

Ný- Fiskur is now starting to implement the EAN System, and the label has a free space for the bar code, as shown in Figure 22. However, the following constraints were observed:

- At the reception stage Ný- Fiskur mixes lots from different sources (vessels) to create a processing batch and sometimes it is not possible to identify the exact source of the lots.
- At the packaging stage, the labels are printed out at once (according to the production day and type of product); specification regarding the time when a specific lot was processed is not available and some traceability information can be lost (e.g., the correlation between the end product and its raw material source)

According to the TraceFish standard, the aspects mentioned above should be clearly identified and recorded.

Some quality related aspects were also considered relevant:

- The quality assessment of the raw material was not recorded
- The average temperature of the end product was 2.1°C
- The AWB number is glued on the pallet, instead of being part of the label on each box

4.1.3 Air Transport Company- Icelandair Cargo

The truck with the pallets (and the samples) from Ný-Fiskur arrived at Keflavik International Airport at 15:20 h.

As mentioned before, Icelandair Cargo is one of the air transportation companies in charge of air freighting fresh fish from Iceland. Fresh fish products are considered a "First Freight" shipment, which has first priority onboard the aircraft. Icelandair is not certified against any GMP standard.

At the Icelandair Cargo storage house, the process is according to the diagram shown in Figure 24.

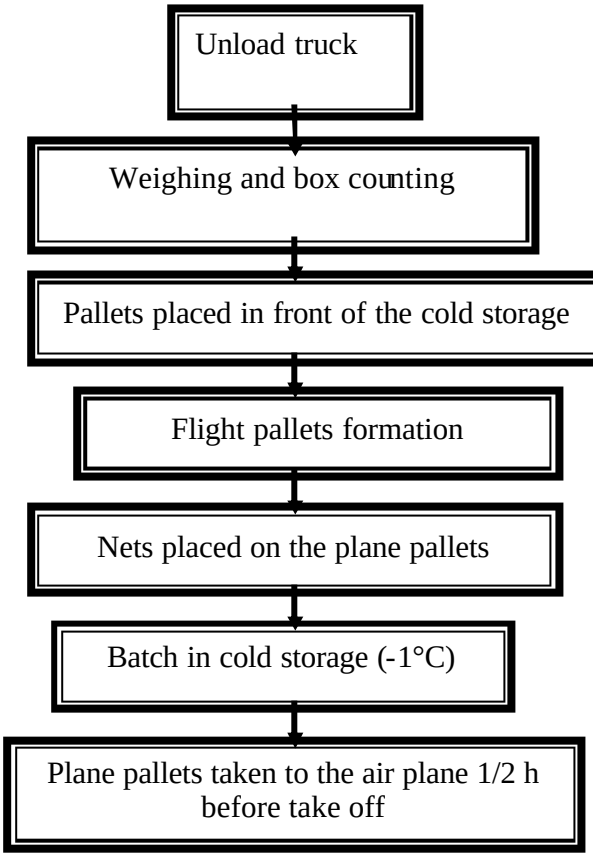


Figure 24: Flow chart of the process at Icelandair Cargo storage house, from unloading off the truck to loading of pallets in the plane.

Icelandair Cargo does not check the temperature of the shipments on a regular basis, but they can offer this service on demand. The reason is that the storage house is not a clean area and opening boxes would compromise the quality of the fish. But on demand, one box is taken out of this area and temperature measurements take place.

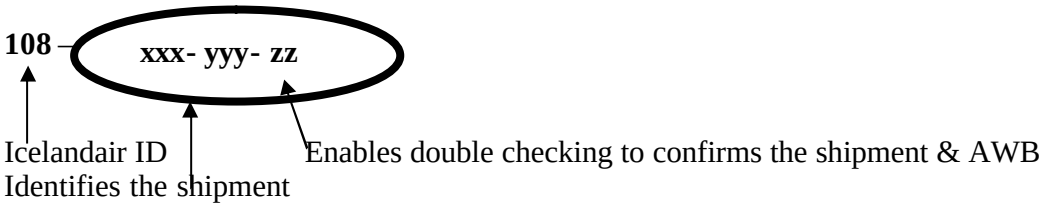
After unloading of the pallets from the truck, all the necessary information related to the pallets was checked and recorded, which mainly included:

- Boxes counting
- Weighing (the Total Gross Weigh is used)
- Shippers information (name and address)
- Consignee information (name and address)
- Type of product
- Receiving date
- Flight number
- Airport of departure
- Airport of destination
- Handling information

This information was typed in the document "Airway Bill" (Figure 25), AWB, which has a serial and unique number (AWB number). The AWB number is a sequence of 11 numbers where the last four digits are the Unique ID for each shipment. It provides information that enables traceability in Icelandair Cargo Company. The AWB was written on the pallets for easy identification by ground staff.

A range of AWB numbers is given to companies to enable them to add it to the labels (instead of placing it only on the pallet). Regarding the Ný-Fiskur pallets, the AWB number was only glued on the pallet, as described before.

The AWB number is composed of the following:



The Airway Bill document is shown in the Figure 25.

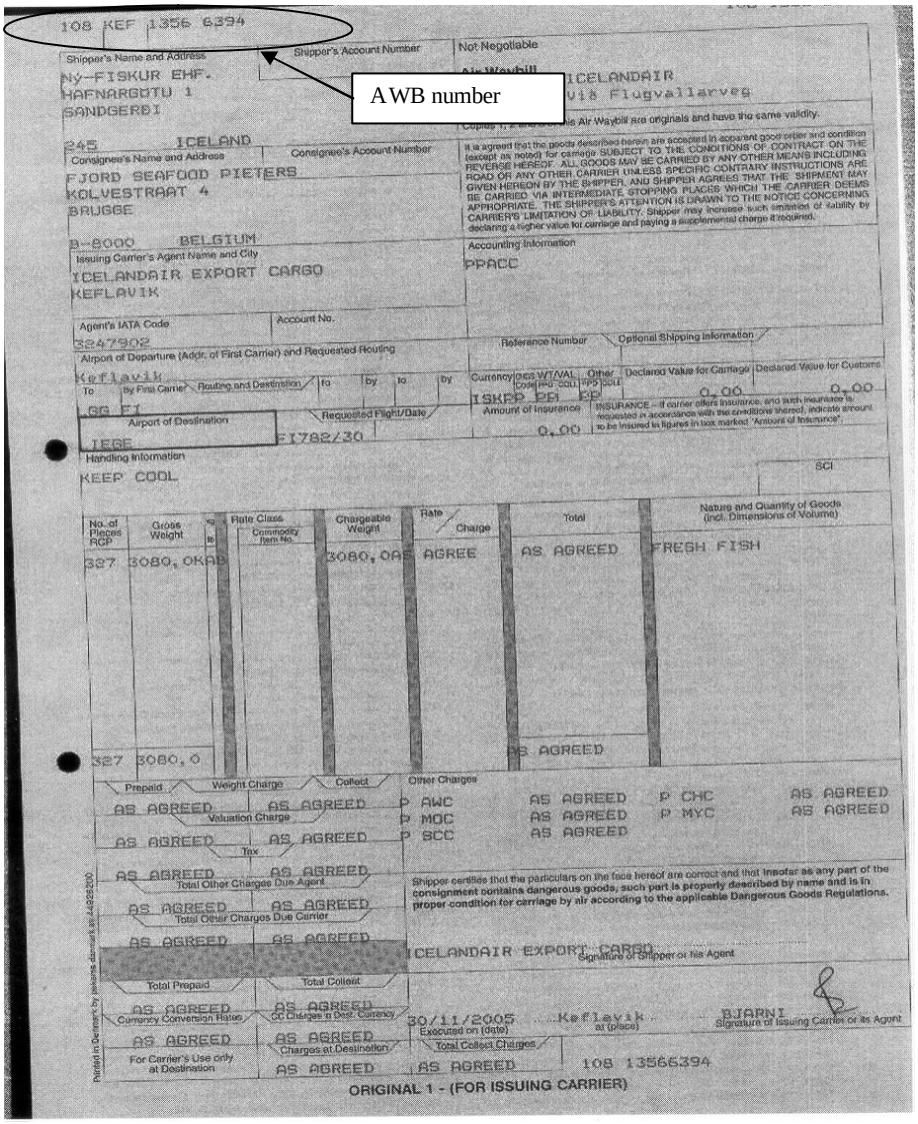


Figure 25: Airway bill document, related to Ný- Fiskur's exports on 30 November.

Sometimes the content of the pallets must be rearranged to fit the shape of the flight pallet. To enable traceability in this case, the AWB number labelled on each box, the number of the boxes and the total gross weight provides the necessary information. Regarding the Ný- Fiskur shipment, only the number of the boxes and the total gross weight could be used, as the AWB number was glued on the pallet.

After double- checking all the information, the AWB information was booked in the airplane as shown in Figure 26.

Figure 26: Ný-Fiskur export information booked in the Icelandair Cargo airplane, 30/11/05.

In the mean time, the flight pallet was formed and a net was placed around it to keep it in the required shape. Then, the pallet was placed in the cold storage n° 3 (Figure 27) at -1°C (as seen on the display, but actually the temperature was -3°C).

Icelandair Cargo does not check the temperature of the cold storage. However, if problems occur (e.g. temperature out of the established limits), an alarm is raised at Securitas (a security company) which undertakes corrective actions. However, Icelandair Cargo keeps video recordings of all activity in the loading area. On demand, it's possible to have the time profile for a shipment.

Figure 27: Flight pallet loaded into the cold storage n° 3 at Icelandair Cargo, at Keflavik International Airport, 30/11/05.

The pallet was loaded into the airplane a half an hour before departure. During the flight time, the temperature control is automatic and the range is usually from 2°C (when it is cooling down) to 8°C. The temperature profile during the transport is presented below.

Icelandair Cargo provides some information regarding the flights on its website. Figure 28 shows the relevant information regarding the flight which transported Ný-Fiskur's shipment to Belgium on 30 November.

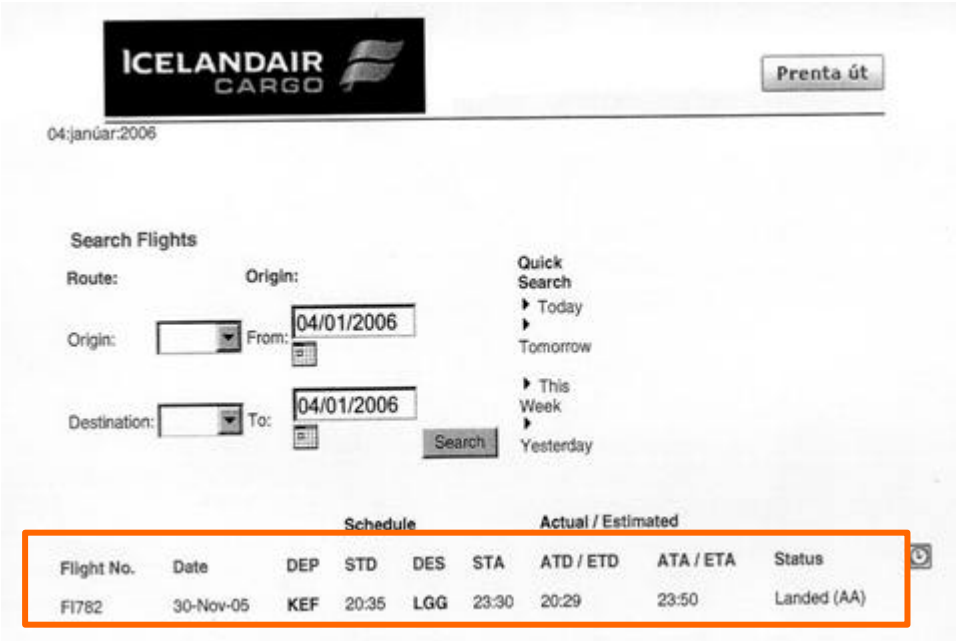


Figure 28: Flight information on the freighted fresh loins from Ný- Fiskur, 30/11/05.

Legend:

- DEP: Departure
- STD: Scheduled Time of Departure
- DES: Destination
- STA: Scheduled time of arrival
- ATD: Actual Time of Departure
- ATA: Actual Time of Arrival

In Belgium, the pallets were trucked to F.S. Pieters. If there is no demand for delivering products, the connection is the Custom Clearing which guarantees that the products are only taken out from the warehouse by its owner (by means of identification, documents of the owner, etc). Regarding the exports from Iceland, usually the same agents take care of the shipments. The available traceability and quality information in summarised in in the Appendix, and the following aspects were considered to be of importance:

- Icelandair Cargo has no GMP certification.
- It doesn't check the temperature when receiving the shipments (only on demand)
- Records on the cold storage temperature are not kept.

- During the flight time, the temperature control is automatic but no records are kept.

4.2 The temperature profile from Ný- Fiskur to F. S. Pieters

It is in the interests of the fresh products industries to maintain freshness by optimal handling and transport conditions to ensure high quality of their products on the market (Ólafsdóttir 2005). However, temperature fluctuations can be seen through the production and distribution chain, which could compromise the fresh fish quality and safety.

The loggers (iButton and onset) used on the air freighted samples were found by RIVO staff and sent by post to the IFL. On 29 December, they were read and the results presented below.

4.2.1 The surrounding temperature profile from Ný- Fiskur to F. S. Pieters

The onset logger was placed on top of the pallet with the samples on 30 November and recorded the temperature until 3 December. Considering that it was removed from the truck on 1 December, emphasis was given to the temperature profiles from November to 1 December.

To enable better comprehension, the surrounding temperature profile is explained in phases (Figure 29), as described below:

- Transport from Ný-Fiskur to Icelandair Cargo: this refers to the surrounding temperature information related to the time when the pallet was loaded onto the truck and taken to Icelandair Cargo (Keflavik International Airport); the highest temperature value was 16.8°C.

- Icelandair Cargo: at the Icelandair Cargo storage house, the highest temperature measured was at 16:00 h (12.8°C) and it was at the time before the pallet's placement in cold storage; the lowest temperature value was -4.0°C at 16:42 h, which was the temperature during the cold storage. The pallet was kept in cold storage for 2 hours and 42 minutes.

- Pallet's transportation to the plane: this refers to the temperature values related to the time after the removal from the cold storage and transport to the plane. An increase in the temperature was seen when the pallet was transported to the airplane (4.1°C). Considering that the pallet was kept outside of the plane for 54 minutes (from 19:09 h to 20:03 h) the temperature dropped to 0.9°C.

N.B The time from the cold storage to loading onto the airplane took 2:06 h.

- Loading onto the plane: it took around a half an hour to load the pallet onto the plane and the highest temperature value was 6.1°C.

- Flight time: the lowest temperature values were 2.4°C, during the period when the airplane was first cooled down (45 minutes after take-off) and before landing, when it was cooled again (3.8°C); the highest temperature value during the flight was 7.9°C. During the flight, the average surrounding temperature was 5.5°C.

- Unloading the pallets off the plane at Liege Airport, Belgium: the unloading and the transport to the storage house took around 1 hour and the average temperature was 2.9 °C.

- Pallet in the warehouse, before loading onto the cooling truck: in the warehouse, the temperature increased up to 13.7°C, due to the absence of a cooling system. It took around one and a half hours to load the pallet onto the cooling truck.

- Transport to F.S. Pieters: the transportation by cooling truck to F.S Pieters lasted 2 hours and 39 minutes and the lowest temperature was 0.6°C. At 4:54 am the truck arrived at F. S. Pieters and the pallet was unloaded.

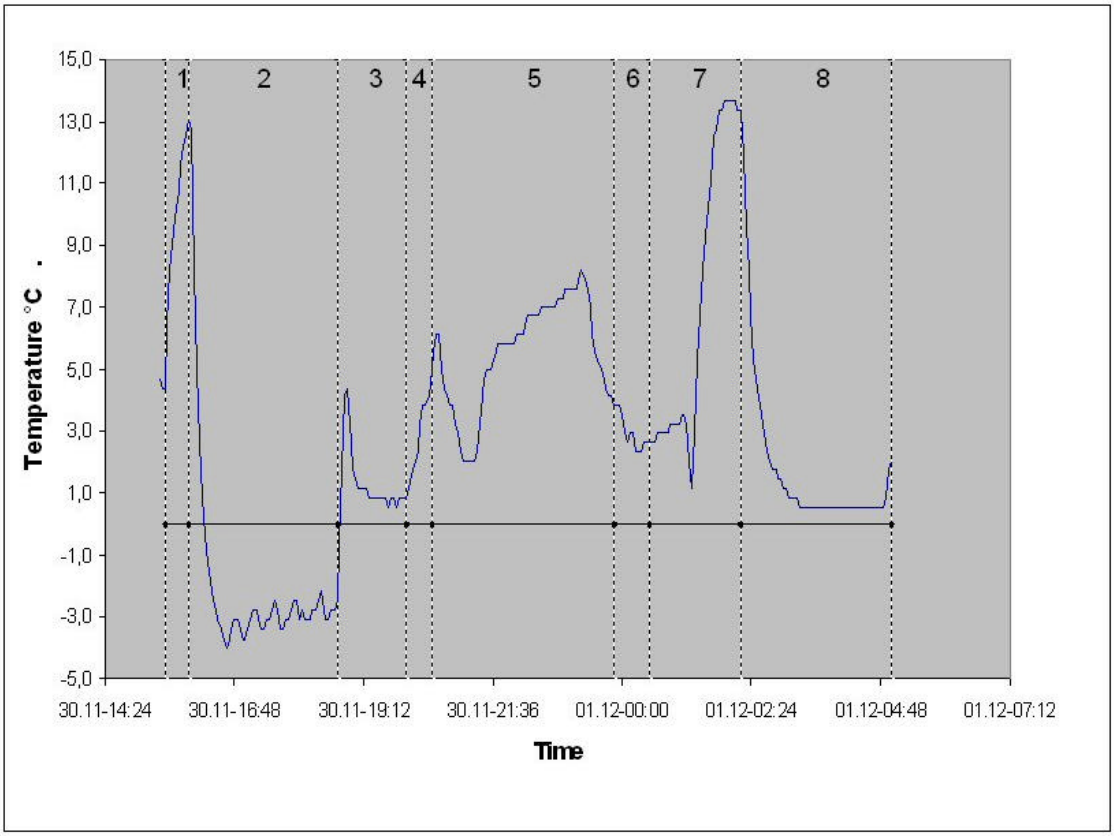


Figure 29: The surrounding temperature profile during transportation, starting at Ný-Fiskur and ending when the pallet was removed from the truck at F.S Pieters, Belgium.

Legend: 1. Transport from Ný-Fiskur to Icelandair Cargo; 2. Icelandair Cargo-placement of the pallet in cold storage; 3. Pallet's transportation to the plane; 4. Loading onto plane; 5. Flight time; 6. Unloading the pallet from the plane at Liege Airport (Belgium); 7. Pallet in the warehouse, before loading onto the cooling truck; 8. Transport to F.S Pieters.

4.2.2 The influence of the surrounding temperature in the fresh fish air freighted to Belgium

The iButton loggers placed in 5 samples (polystyrene boxes with fresh loins) recorded temperature from 29 November to 3 December. Considering that they were removed from the box on 1 December, the study only emphasises the relevant data till they were removed.

The results of each box are explained separately, to enable a better comprehension.

Box 1 (placed in the middle of the pallet, one free side, as shown in Figure 7).

4.2.2.1 Regarding the iButton loggers placed on the top and centre of the box, the temperature decreased from 3.5°C to 3°C after its placement in the cold storage at Icelandair Cargo (where the surrounding temperature was reduced from 16.9°C to -4.0°C) and remained constant until its removal at F.S Pieters facilities. The iButton logger placed on the bottom showed more variations following the surrounding temperature. During the loading time and the flight time, the temperature fluctuated between 2°C and 2.5°C; before loading onto the cooling truck in Belgium, the temperature increased to 3°C (Figure 30).

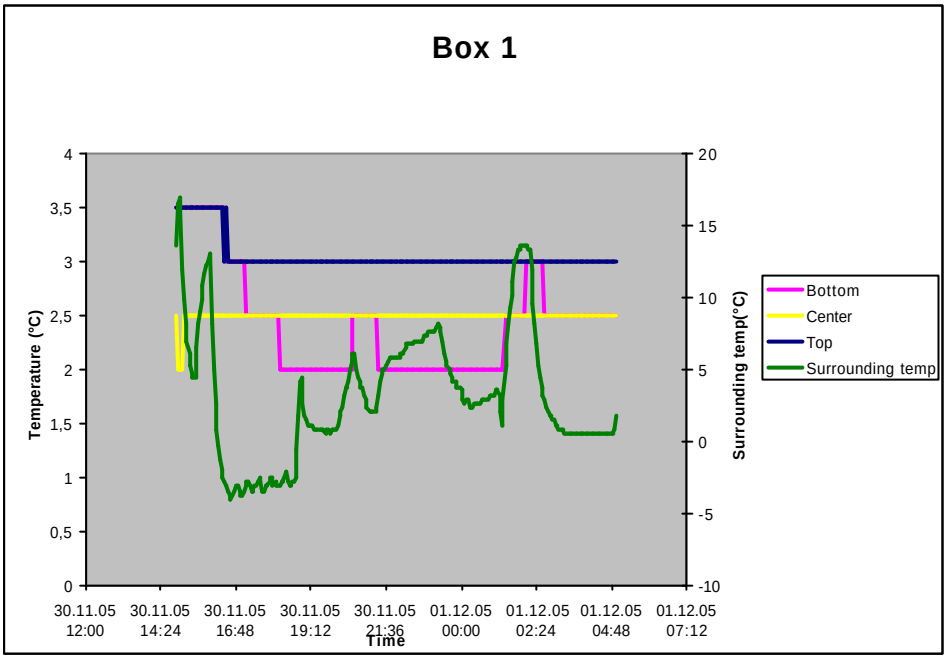


Figure 30: The surrounding temperature and product temperature for box 1 (represented by the "iButton" placed on top, bottom and centre) from Ný- Fiskur to F. S. Pieters.

4.2.2.2 Box 2 (placed on top of the pallet, in the corner, three free sides as shown in Figure 7)

All the loggers followed the surrounding temperature variation; the iButton logger placed on top and bottom, had the same variation (the highest temperature was 3°C, related to the period before the placement in the cold storage at Icelandair Cargo and before the placement in the cooling truck in Belgium); the lowest value was 2.5°C, in the cold storage at Icelandair and in the cooled truck in Belgium. The iButton logger placed in the centre fluctuated between 2.0°C to 2.5°C (Figure 31).

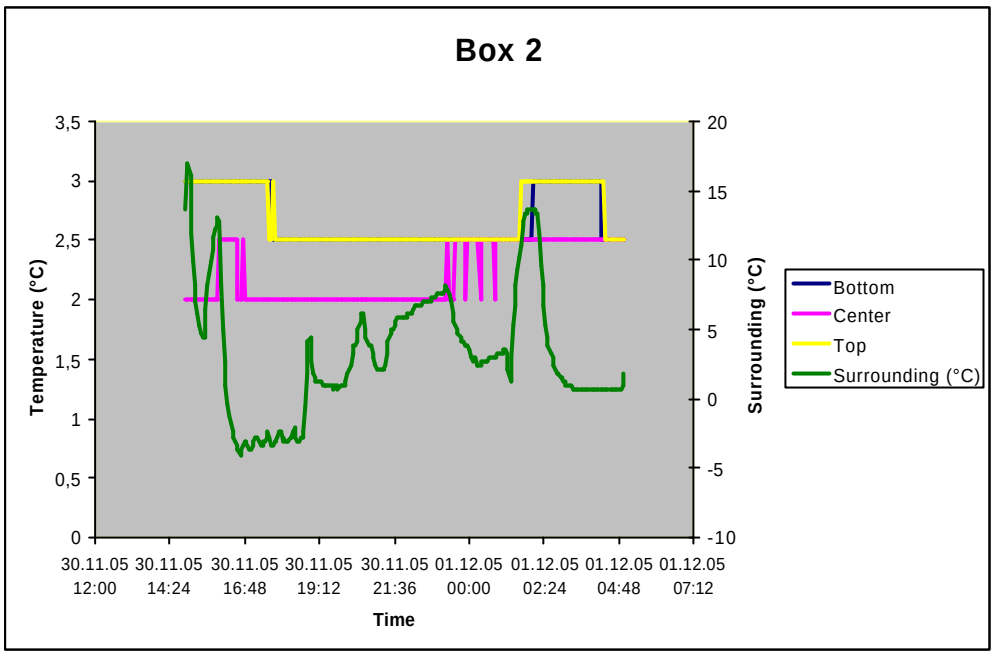


Figure 31: The surrounding temperature and product temperature profiles for box 2 (represented by the "iButton" placed on top, bottom and centre) from Ný- Fiskur to F. S. Pieters.

4.2.2.3 Box 3 (placed on top of the pallet, centre, with two free sides)

All the loggers followed the surrounding temperature variation; the highest value (3.5°C) was registered by the iButton logger placed on the top and bottom, before loading onto the cooling truck in Belgium; the lowest value was registered by the iButton loggers placed in the centre and bottom (2°C), related to the cold storage at Icelandair storage house and part of the flight time (Figure 32).

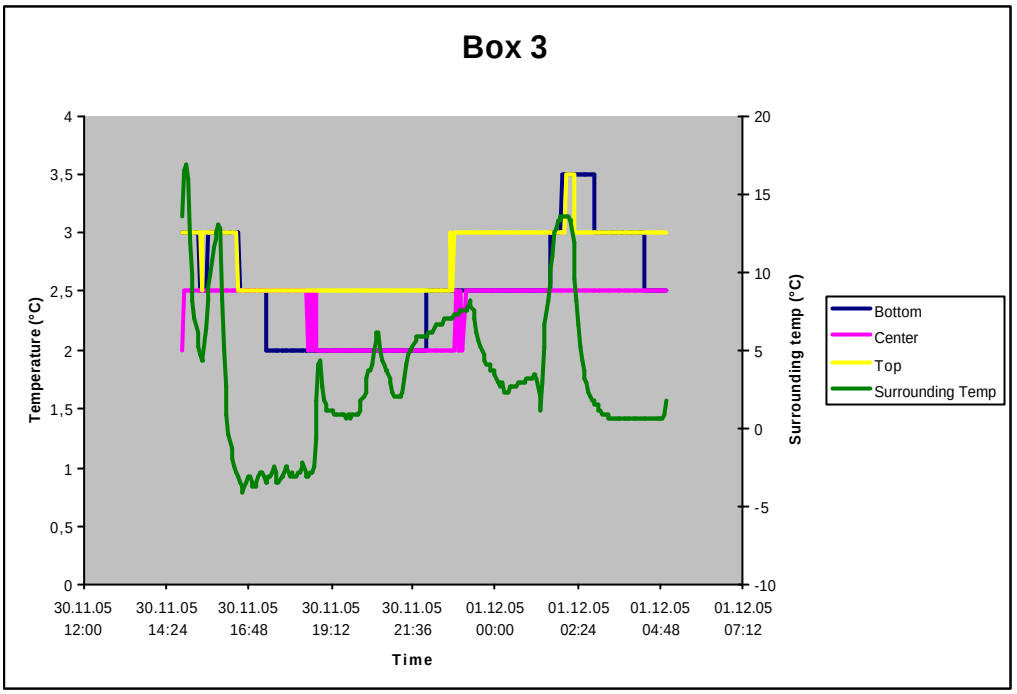


Figure 32: Graph on the surrounding temperature and product temperature for box 3 (represented by the "iButton" placed on top, bottom and centre) from Ný- Fiskur to F. S. Pieters.

4.2.2.4 Box 4 (placed in the middle of the pallet with only one free side)

The iButton logger placed on top didn't fluctuate; the temperature remained constant at 2.5°C; the iButton logger placed in the centre fluctuated (from 2.5°C to 3°C) before the loading time in the plane as well as before loading onto the cooling truck (although it remained at 3.0°C during the flight); the iButton logger placed on the bottom fluctuated before the cold storage in Icelandair Cargo and before loading the pallet onto the cooling truck in Belgium; during the flight time the temperature remained at 2.5°C (Figure 33).

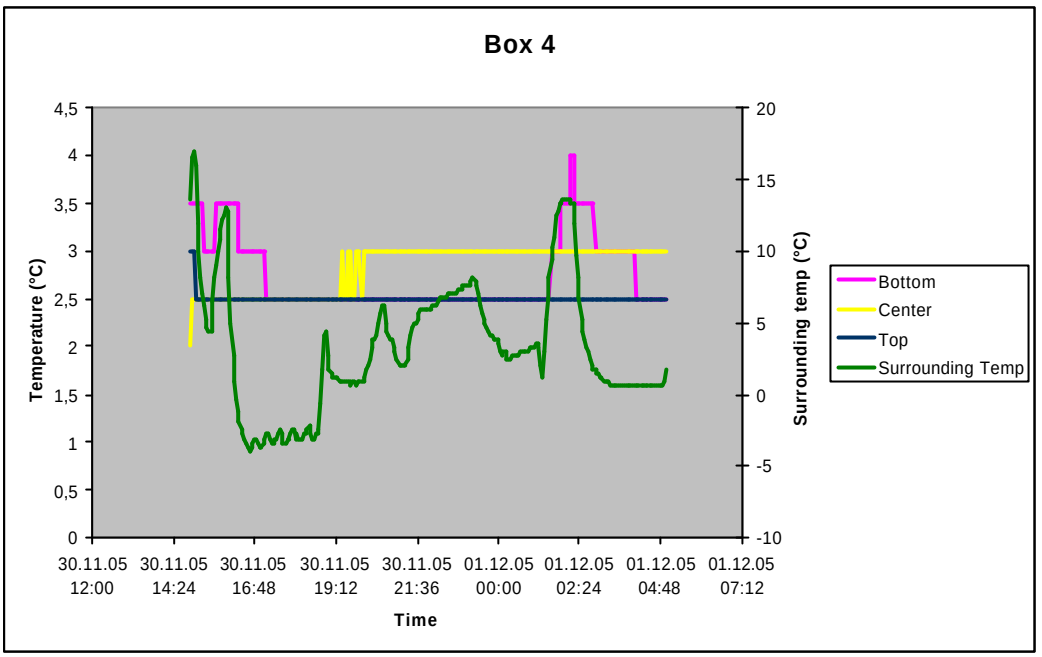


Figure 33: The surrounding temperature and product temperature for box 4 (represented by the "iButton" placed on top, bottom and centre) from Ný- Fiskur to F. S. Pieters.

4.2.2.5 Box 5 (placed in the centre of the pallet, with only one free side)

The iButtons placed on top and bottom showed almost the same variation with the decreasing of the temperature after the placement of the pallet in the cold storage (from 3.0°C to 2.5°C). After that the temperature remained constant until arrival at F. S. Pieters; the one placed on top showed a slight fluctuation before loading the pallet onto the plane where the temperature rose to 3°C; the iButton placed in the centre remained constant (2.5°C) since arrival in the Icelandair storage house to the warehouse at Liege, Belgium (Figure 34).

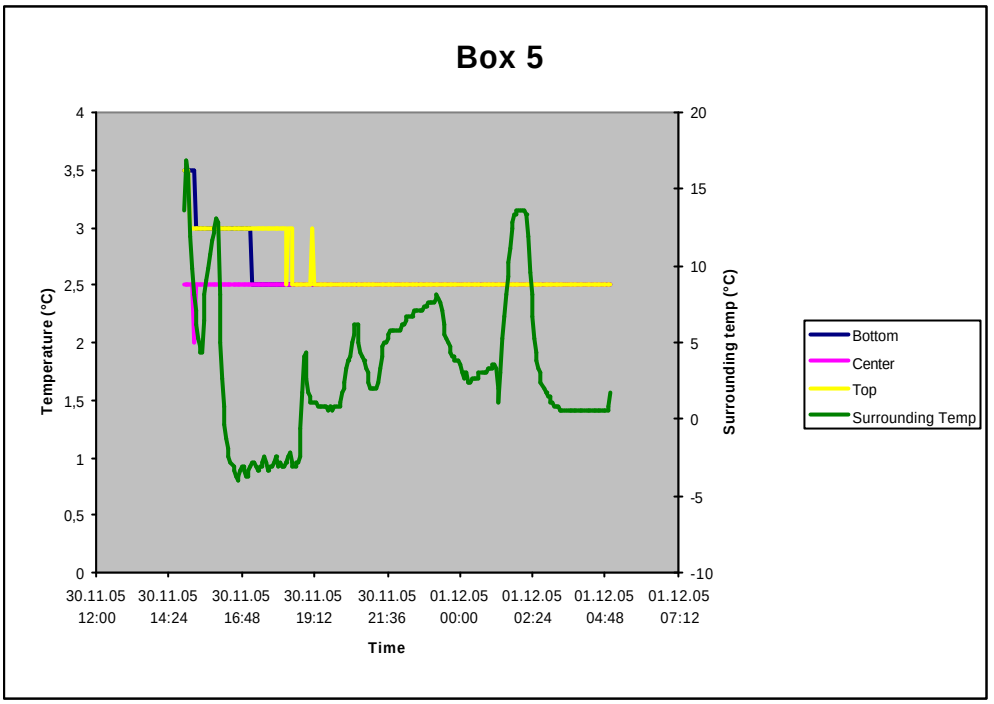


Figure 34: The surrounding temperature and product temperature for box 5 (represented by the "iButton" placed on top, bottom and centre) from Ný- Fiskur to F. S. Pieters.

To summarise the results, the average temperature of the iButton loggers placed in box 1 was used. Box 1 was considered representative of the lot due to its placement in the middle of the pallet leading to the exposure of only one side to the surrounding temperature.

The temperature of the fresh loins in box 1 followed the surrounding temperature profile, as shown in
Figure 35 and Table 3. The most relevant variations were seen when the temperature difference between the surrounding temperature and the product temperature was 4°C or more, for 1.5 hours or more, as described bellow:

- An average temperature difference of -5.1° was seen during the cold storage at Icelandair Cargo storage house for 2:45 h

- A temperature difference of 4.4°C was seen in the warehouse at Liege Airport during loading of the pallet onto the cooling truck; a 1:42 hour was needed.

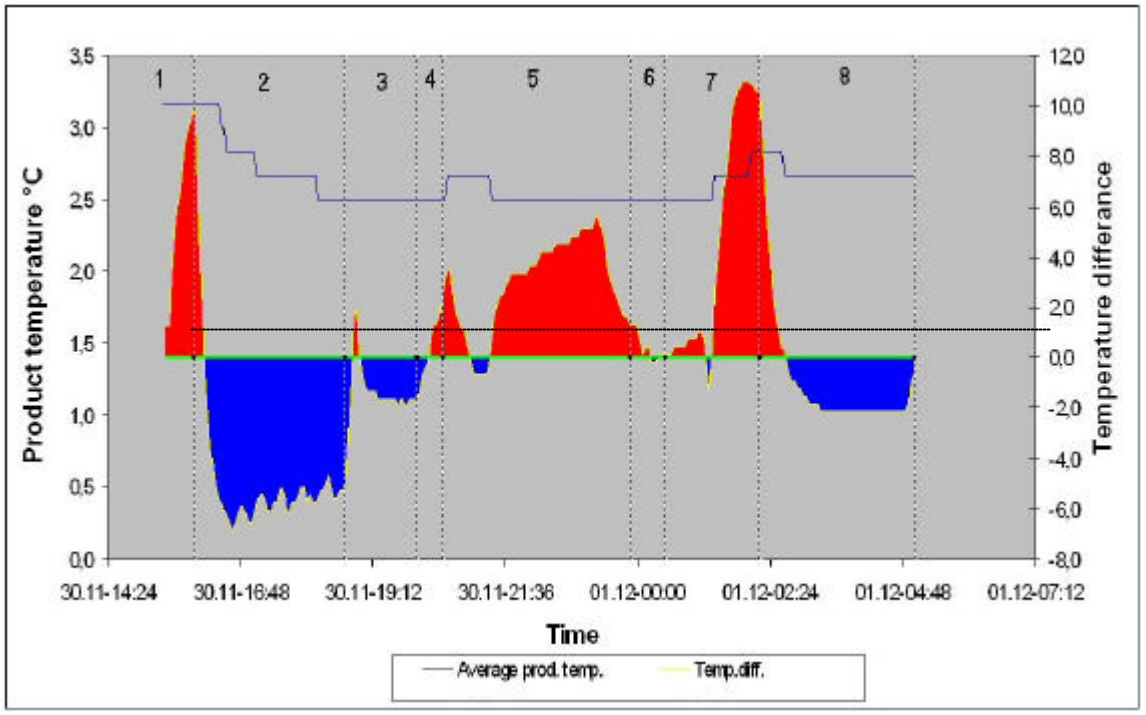


Figure 35: The influence of the average temperature difference (between the surrounding temperature and the product temperature) in temperature of the loins.

Legend: 1. Packaging at Ný- Fiskur; 2. Transport to Icelandair Cargo and placement of the pallet in cold storage; 3. Pallet taken from cold storage and transported to the plane; 4. Loading onto plane; 5. Flight time; 6. Unloading the pallet from the plane in Liege Airport (Belgium).

Table 3: Average temperature, difference between the surrounding temperature and the product, and duration for the main links from Ný-Fiskur to F. S. Pieters.

	Date	Time	Time interval	Average surrounding temp.	Average temp. box 1	Temp. difference. box 1
Packaging at Ný-Fiskur	30.11.05	14:50			3,17	
Leaving Ný-Fiskur	30.11.05	15:10	00:20	14,24	3,17	11,07
Arriving at Icelandair Cargo	30.11.05	15:20	00:10	6,68	3,17	3,51
Put into cold store	30.11.05	15:57	00:37	8,93	3,17	5,76
Taken from cold store	30.11.05	18:42	02:45	-2,60	2,50	-5,10
Put onto plane	30.11.05	20:00	01:18	1,23	2,50	-1,27
ATD	30.11.05	20:29	00:29	3,02	2,50	0,52
ATA	30.11.05	23:50	03:21	5,52	2,50	3,02
Unloaded in Belgium	01.12.05	00:30	00:40	2,88	2,50	0,38
Put in cooled truck	01.12.05	02:12	01:42	7,26	2,83	4,43
Arrival at F.S. Pieters	01.12.05	05:00	02:42	1,69	2,67	-0,98

4.3 Current traceability and quality system in fresh fish exports from Cap Vert

4.3.1 CPCI, harbour and processing

As mentioned before, CPCI is a certified storage house (the HACCP system is already implemented) located is S. Vicent Island (SV), where fresh and frozen fish are processed and packed before export. The registration number is CV004. It is also a harbour where small boats (11 m in length made of fibber glass) unload their daily catch (Figure 36). Usually the fish is unloaded in boxes and after weighing they are transferred to tubs with sea water and slurry ice. Generally, the CPCI has the following structures:

- A harbour for small boats (11 m)
- One processing room
- One ice machine for 10 tonnes/day
- One freezer for 6 tonnes/day
- One cold storage for 150 tonnes
- One packaging storage room
- Offices (one for the production manager, one for the quality control manager and one for the administrative staff)

Figure 36: CPCI and one of the 11 m boats, S. Vicent Island, Cap Vert.

Currently, CPCI is facing the following limitations:

- It needs to run structural modification (basically to separate clearly the contaminated and non contaminated areas as well as the acclimatisation of the processing room)
- To enable filleting, the CPCI needs appropriate equipment.

Only a few hundred kg (up to 500 kg) can be exported due to the following weaknesses:

- The Capverdian airline company (TACV) has insufficient cargo space in the domestic flights.
- Lack of an international airport on S. Vicente Island (the lots have to be transported to Sal or Santiago Island where there are international airports)

Regarding the above limitations, the CPCI processes and exports only one lot daily, coming from one source; thus, the traceability system is simplified. The fresh fish processing is done according to the flow chart shown in
Figure 37:

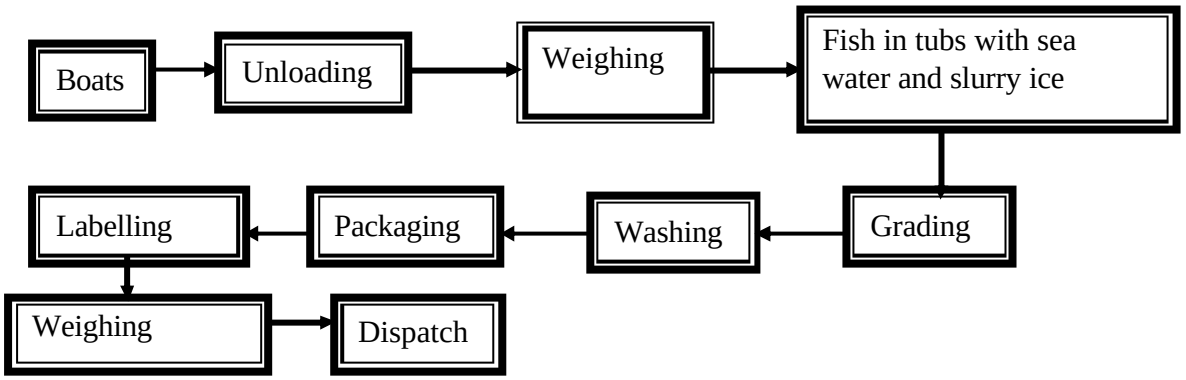


Figure 37: Flow chart currently in use for fresh fish processing at CPCI.

Right after catch, the fish is kept in ice. The boats contact the CPCI a few hours before arriving to show their intention to unload the fish in the harbour. They are then authorised to use the CPCI harbour to unload the fish.

Right before unloading, the quality control manager checks the sanitary conditions on board, remaining ice, as well as the fishing license. This is a routine in the CPCI due to the requirements (in law) to process and export only fish caught by certified boats. The unloading is done in plastic boxes; quality assessment is made on a daily basis (by means of the EU scheme), as well as temperature measurement of random samples. This information is recorded.

It is relevant to say that the reception of raw material is a CCP (Critical Control Point) in CPCI's HACCP system, where, the following Critical Limits are established:

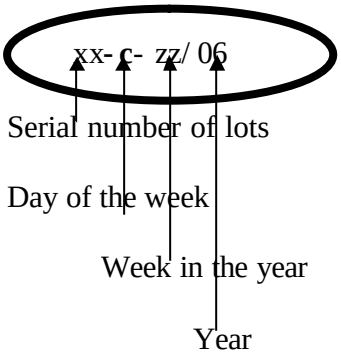
- The fish temperature at the reception stage should be less than 4°C to be acceptable
- *"Extra"* and *"A"* are the acceptable scores to process for export, during quality assessment of the whole fish. The EU scheme is used.

Tuna species can develop histamine poison which should be prevented by good handling, icing right after catch, gutting as well as good hygiene practices on board, during processing and distribution. These quality aspects were not treated in this study.

After unloading, the lots are weighted and transferred to tubs with sea water and slurry ice and transported to the processing room. At this stage, all the required information regarding the boat, the lot and unloading process is recorded in the "reception control sheet", where the following information can be found:

- Name of the boat
- ID of the boat
- Date of catch
- Date of landing
- Time of landing
- Lot number
- Species
- Name of the owner of the lot
- Catching ground is not recorded (but it's a daily catch, meaning that is within in CV's EEZ)
- Temperature measurements and average
- Sensory evaluation core
- Gross weight

The lot number is composed of the following:



At the processing room, the fish is graded according to size and packed in polystyrene boxes with ice bags. Quality related information is recorded. The processing time is not recorded, and the grading step is just to select the fish in order to better pack it in the boxes.

After packaging, the lot is weighed (each box and then the whole lot) and the information recorded.

The labels are then printed out and glued on each the box, where the following information can be read:

- Type of product
- Species
- Production date
- End of shelf life
- Lot number
- Name, address and ID of the processing plant (CV 004)
- Name and address of the owner
- Name and address of the buyer
- Product origin country (“ Product of Cape Vert”)
- Weight

The information on the label is required by Capverdian law (Portaria n° 06/2001). Additional information is kept in CPCI records, as the date of dispatch or any quality related information.

The lots ready to export are inspected and a Health Certificate is issued by the Competent Authority. The Health Certificate follows the batch to its destination.

Considering that the new international airport will be a reality in January 2007 (currently under construction), fresh fish exports will definitely increase and become more complex. At this point, processing, quality management and the traceability system will have to be improved.

4.3.2 TACV, Capverdian Airline Company

Cap Vert Airlines, TACV, is the flag carrier of the Republic of Cape Vert. TACV is an entity established under Capverdian laws as a public enterprise for the purpose of conducting domestic and international air transportation. It is the company in charge of air transportation of fresh fish exports.

Since S. Vicente Island doesn’t have an international airport yet, the fresh fish is dispatched to Sal Island (which operates one of the international airports) and then air freighted straight to the Netherlands.

4.3.2.1 Dispatch from S. Vicente Island

To enable the dispatch of fish products, the TACV requires some documents such as:

- The AWB document
- Statement of the Consigner
- Health Certificate (issued by the Competent Authority)

After checking the documents above, the required information is then filled out in the AWB document which has the AWB number. The AWB number is a serial of 11 numbers, where the three first numbers (696) represent the TACV identification.

The AWB required information includes:

- Number of boxes
- Weighing (the Total Gross Weigh is used)
- Shippers information (name and address)
- Consignee information (name and address)
- Type of product
- Receiving date
- Flight number
    - Airport of departure
    - Airport of destination
    - Handling information

If there are two different lots to be dispatched, the AWB number, number of the boxes and the gross weight of each enable the traceability.

All the information above is booked on the plane. The TACV works according to international standards and the process is similar to the one used by Icelandair Cargo.

Right after booking, the lots (less than 500 kg) are placed in a small refrigerator where they are kept until a half an hour before take off. The temperature of the product is not measured and they do not keep records on the temperature of the refrigerator either.

For domestic flights, small planes are used (up to 35 passengers). The boxes are loaded onto the plane (the flight pallet is not used for domestic flights) and placed according to the lots.

On the airplane, the temperature is controlled automatically but no record is kept. The flight to Sal Island takes about 35 minutes.

4.3.2.2 Dispatch from Sal Island

At arrival at Sal Island, the lot is unloaded from the plane and transported to cold storage. Once again, the temperature is not measured and records of the cold storage are not kept. Regarding the international flight, all the documents are checked again. The lots are loaded onto the plane a half an hour before take off box per box (without flight pallet formation). The same AWB document is used. In the Netherlands, the lots are kept in a warehouse until its removal by the owner. The connection is the Custom Clearing which ensures that the products are only taken out from the warehouse by their owner (by means of identification, documents of the owner, etc).

5 DISCUSSION AND RECOMMENDATIONS

5.1 Traceability and quality related information in fresh fish exports to Belgium

All the Icelandic members in the chain use a paper based traceability system combined with electronic data. Only Ný- Fiskur is preparing the implementation of the EAN (Bar code) system. According to the TraceFish standard, almost all the relevant information categorised as "shall" is available to each member. Only the temperature records are missing or need to be improved to enable traceability, quality and safety.

5.1.1 Auction

The auction has an efficient traceability system in place and the necessary information is made available by means of the Clock Market. However, some information can be lost when mixing the lots. To solve this problem, each small lot should be tied to its source by means of accurate records (e.g. tub ID, species, tub weight, gross weight of the lot and the seller). Quality related information should also be tied to each small lot, such as the temperature and the quality grading score.

The auction does not check the temperature of the lots and the cold storage on a daily basis. According to the TraceFish standard, the temperature of the fish should be checked and the information recorded for each and every landed lot. Regarding the cold storage temperature, it should be check and recorded at least once a day.

Fish temperature is a key factor for quality and safety. Considering that the reception step is a Critical Control Point (CCP), fish temperature should be combined with the sensory evaluation before the sell. Quality assessment of each landed lot should also be done by means of sensory evaluation based for instance, in the Quality Index Method (QIM), and this information should be recorded.

QIM is a seafood freshness quality control system providing a rapid objective and reliable way to evaluate fish freshness (Martinsdóttir *et al.* 2001).
Ný-Fiskur processing plant

The traceability system at Ný- Fiskur is efficient, according to the TraceFish standard. However, at the packaging stage all the labels carry the same information and therefore it's difficult to link the packages to the time of production because the daily production is all printed out together. According to this, some information can be lost and in case of a product recall, Ný- Fiskur has to withdraw the daily production instead of the affected lot.

To enable a more efficient traceability, at the packaging stage, the labels could be directly connected to the time at which it was produced and this information could be added to the label. This procedure would enable the recall of the affected part of a lot instead of an entire lot.

As mentioned before, Ný- Fiskur is now implementing the EAN (bar code) system, which will enable full internal traceability and a more efficient transference of traceability and quality related information throughout the chain.

The quality assessment of the raw material is now being improved; the QIM method is being implemented.

5.1.2 Icelandair Cargo transportation company

Icelandair Cargo is not certified against any GMP scheme. Although costly and categorised as a "may" by the TraceFish standard, the certification against ISO, for instance, would lead to an increase in the trust and competitiveness of the company.

Icelandair doesn't check the temperature of the lots (only on demand) and they also don't keep records of the cold storage temperature. According to the TraceFish standard, temperature checks of the receiving lots are relevant to keeping quality and safety. To enable the quality assurance of the air freighted lots, information on the temperature from the previous food business could be recorded as well as the temperature measurement of random samples by means of a handset thermometer.

Although the TraceFish standard doesn't refer to the control and record of the cold storage temperature, its implementation is recommended (by daily checks or logging of the cold storage) as it will ensure:

- The quality and safety of the shipments.
- In case of a product recall, this information is relevant for purposes of traceability, quality and safety.
- Reliable evidence in case of customer complaints.

5.2 The temperature profile from Ný- Fiskur to F. S. Pieters

The variation of the surrounding temperature during the study was in the range of - 4.0°C (when the pallet was placed into the cold storage at Icelandair Cargo) to + 13.4°C (in the warehouse at Liege Airport, in Belgium), representing a difference of 17.4°C.During the flight, the average surrounding temperature was 5.5°C.

The temperature profile of the boxes followed the surrounding temperature fluctuations. The most relevant variations were seen in the boxes with two or three exposed sides (boxes 2 and 3) due to a bigger exposed surface to the surrounding temperature. The iButton placed on the bottom, although following the surrounding temperature profile, varied slightly before the top and centre iButton loggers due to free spaces inside which led to earlier exposure to the cold air.

The variation on the product temperature in general, depends on the temperature difference and heat transfer between the surrounding temperature and the product

temperature. This is shown in the following formula, which explains the overall heat transfer in a situation like this (Geankoplis 1978):

$$q = U * A * ?T$$

q = heat transfer (W),
U = overall heat transfer coefficient (W/m^2 °C)
A = area (m^2)
$?T$ = temperature difference between the surrounding temperature and the internal temperature of the product (°C)

Applying the formula in this study, it is clear that if one of the factors changes (U, A or ? T), the heat transfer will also change proportio nally. Considering that the surrounding temperature is the only factor that can be "controlled", its variation directly affects the heat transfer and consequently the product temperature, as shown bellow:

- During the cold storage at Icelandair Cargo storage house, the temperature difference was -5.1 for 2:45h. Here the product temperature decreased 0.7°C

- In the warehouse at Liege Airport 1:42 hours was needed to load the pallet onto the cooling truck. The temperature difference was 4.4°C, leading to an increase of the product temperature of 0.3°C.

During the flight, no variation in the product temperature was seen due to a relatively small temperature difference. However, had the product temperature been close to 0°C, which is recommended, an increase in product temperature would have been expected.

To improve the fresh fish exports from Ný-Fiskur, through Icelandair Cargo, the following recommendations are provided:

- At Ný-Fiskur, the fresh product should be kept close to zero degrees.

- At Icelandair Cargo, 2:06 hours passed from the cold storage to the loading time onto the plane; this process should be done in a shorter time, in order to minimise the effects of the outside temperature on the fresh fish. Considering that this experiment was done in the winter, the outside temperature didn't affect the fish.

- It is not possible to explain why the airplane is cooled down twice (after the take off and before landing).

- Considering that fish is a very perishable food, during the flight time, temperature fluctuation should be avoided and records kept, at least when transporting fresh fish products.

- During the flight it is recommended to keep the temperature as low as possible.

- At Liege airport, one and a half hours were required to unload the pallet from the plane and place it onto the cooling truck; due to the absence of a cooling system in the warehouse, the placement of the lots in the cooling truck should be done in a shorter time. During summer an even greater effect can be expected.

Thus, the most important aspect is to minimise the temperature difference between product and surroundings. This will maintain a steady product temperature during transport.

5.3 Suggested traceability system for the Capverdian fresh fish exports

As mentioned before, the aim of this part of the Capverdian study was to suggest a suitable traceability system that could be implemented in a more intense fish processing and exporting environment from S. Vicente Island.

5.3.1 CPCI harbour and processing plant

With the structural changes in the CPCI to enable both filleting and freezing, the processing line will change. Consequently, the pre-requisite programmes (GMP and GHP) as well as the HACCP system will have to be improved in order to enable quality, food safety and traceability. The suggested flow chart regarding fresh fish processing is shown in Figure 38.

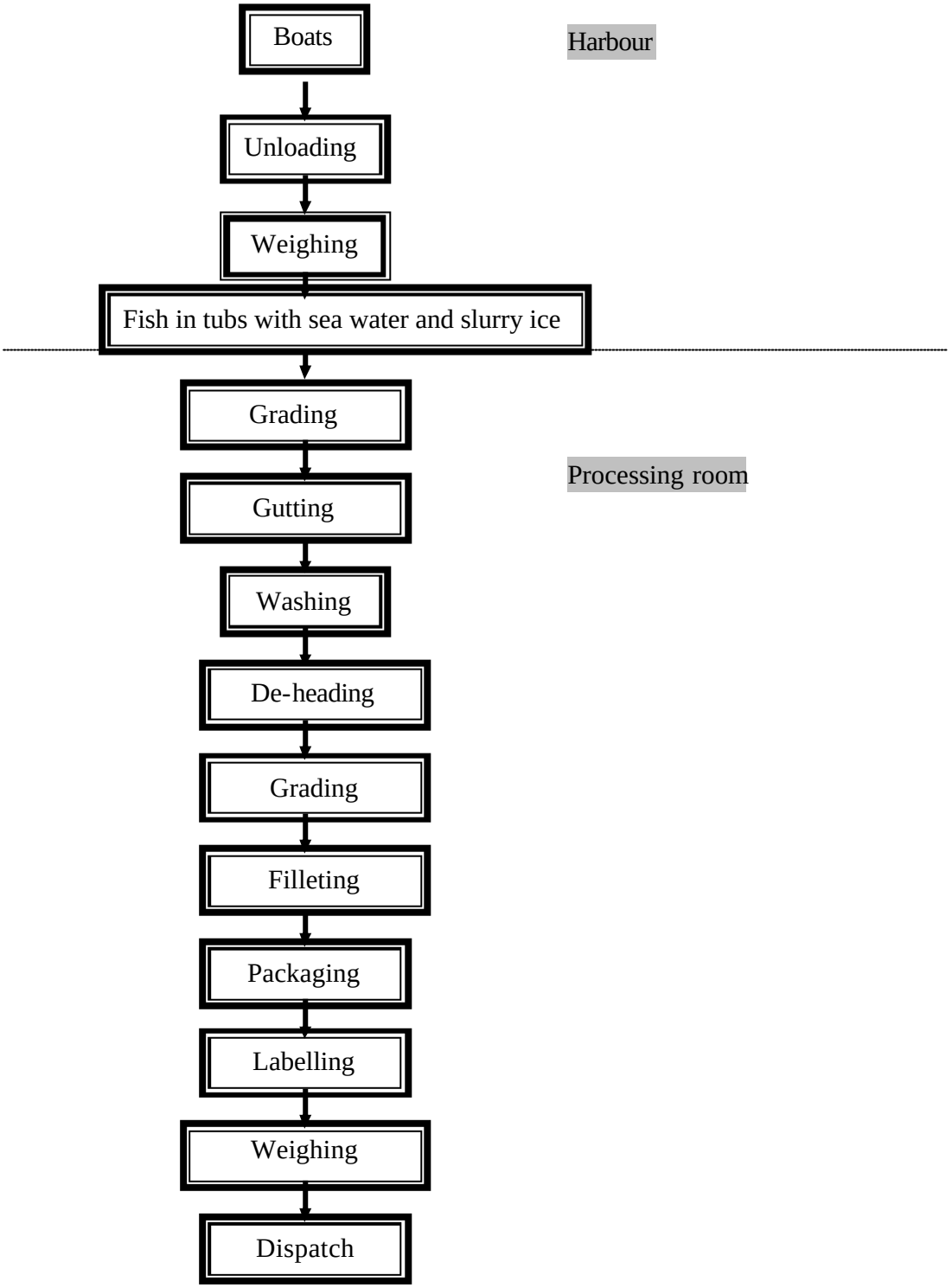


Figure 38: Suggested flow chart for fresh fish processing in CPCI in 2007.

5.3.1.1 The purchasing

The companies communicate with the boats to know which species, the quantity and the estimated time of arrival at the harbour. As mentioned, the 11 m (length) boats unload fish less than 24 hours after catching. After the decision to buy the lot, the buyer communicates with the manager of CPCI to confirm their intention to process the fish right after the unloading time. The purchasing is recorded by the processor.

5.3.1.2 Receiving fish at CPCI (unloading, weighing and lots in tubs step)

At CPCI, the fish is unloaded in boxes. The lot is weighed, temperature checks done and it is then placed in tubs with slurry ice and taken to the processing room. In the mean time, the quality/producer manager fills out the form "reception of raw material" (Table4), where the following information can be found and used either by the CPCI, seller or buyer.

Table 4**:** Reception of raw material form to record the relevant information regarding the raw material and its source.

Lot number	Date of landing	Place of landing	Specie	Quantity	Vessel ID	Owner	Catch location	Date of catch	T°

N.B The buyer can use the lot number created at CPCI, or create his own number which has to be linked to the CPCI lot ID and also to the purchasing record

After the weighing step, the lots are placed into tubs with slurry ice; here, the quality manager fills out an intake ticket (Table 5) which is attached to each tub that composes the whole lot. An example of the intake ticket is shown in the following example:

Table 5: Intake ticket to be attached to each box at CPCI.

Intake ticket n°	Lot n°
Date of landing	Species
Boat	Quantity (in kg)
Buyer	Tub n°
Time	Temperature

- The "intake ticket number" relates to the serial of lots reception in one day.
- The "lot number" is its ID and it is the same as recorded in the "reception of raw material sheet"
- The "tub number" refers to the ID of the tubs; the same receiving lot can have more than one tub; in this case each tub is identified with a unique number (e.g. 1 of 10)
- The "time" is related to the time when the intake ticket is filled out

- "Temperature" refers to the fish temperature measurements of each tub

The "reception of raw material sheet" has additional quality related information regarding the receiving lot, such as:

- Catching ground is not recorded (but it's a daily catch, meaning that is within CV's waters)
- Temperature measurements and average
- Sensory evaluation score, based on EU scheme

5.3.1.3 Processing

In the processing room the fish is graded according to the size. Here, the quality manager keeps the intake ticket and attaches the "Processing ticket" (Table 6) with the following linked information:

Table 6: Processing ticket to be attached to each tub at CPCI.

Date:	Lot n°
Size grade	Description:
Quality grade	Quantity (in kg)
Time	Tub n°
	Temperature

According to the size, the lot can be processed either in the same day or on the day after. In this case, the tubs are placed in a raw material cold storage and on the next day the same procedure takes place, as described above.

The "processing ticket" is very important either when the whole batch is not processed on the same day (part of it is kept in the raw material cold storage) or when more than one batch is processed on the same day. It is always important to have records that can be linked to the tickets.

At this step, random samples are also taken in order to enable the histamine measurements (in tuna species, the maximum acceptable is 100 mg/kg) by means of a kit. After that, the quality manager proceeds to quality grade each size grading group (based on the EU scheme). This information is kept in the "reception of raw material sheet".

After the grading step the fish in the tubs starts to be processed (according to the size grade) and relevant information is transferred to the "processing control sheet" (Table 7). One example of the "processing control sheet" is shown bellow, where the relevant traceability and quality related information can be found.

Table 7: Processing control sheet to record the relevant information about the processing of the lots.

Date	Time	Lot n°	Tub n°	Species	Temperature	Weight in	Quality grade	Wight out

N.B It is very important to record the time when the tub goes into the processing.

During processing, random samples are taken from the line to measure the temperature. This information is recorded in the "processing control sheet", where additional information can also be recorded to enable food safety and quality.

At the filleting step random samples are taken in order to check the temperature and assess quality, based on an internal scheme. As mentioned before, the time record is very important in order to link only a small group in case of recall, instead of the daily or batch production.

At the filleting stage new records are kept in a special form called the "filleting control sheet" (Table 8), where the following traceability and quality related information can be found:

Table 8: Filleting control sheet to record the relevant information regarding the filleting step

Date	Time	Lot n°	Tub n°	Quality grade	Species	Temperature	Weight in	Weight out	Final quality grade

Additional information can also be recorded to enable food safety and quality.

At the packaging stage, the fillets are packed in 5 kg polystyrene boxes with ice bags. Each box is then weighed and then the whole lot and the information is recorded in the "dispatch control sheet" (Table 9).

Table 9: Dispatch control sheet to record the relevant information regarding the final product and its shipment.

Owner	Date of dispatch	Next food business	Production date	Lot n°	Quality grade	Species	Number of boxes	Box weight	Total gross weight

After packaging, the lot is weighed (each box and then the whole lot) and the information recorded.

The labels are then printed out and glued on each box, where the following information can be found:

- Type of product
- Species
- Weight
- Size grade
- Production date
- End of shelf life
- Batch number
- Name, address and ID of the processing plant (CV 004)
- Name and address of the owner
- Name and address of the buyer (in the Netherlands)
- Product origin country (“ Product of Cape Vert”)

All the printed information on the label as well as additional quality and safety related information is attached to the “dispatch control sheet” as required by Capverdian law (Portaria n° 06/2001).

Right before the dispatch, the lots ready to export are inspected and a Health Certificate is issued by the Competent Authority. The Health Certificate follows the batch to its destination, and one copy stays in the CPCI records. In the revision of the national law it is suggested to add requirements regarding traceability.

5.3.2 TACV Cape Vert Airlines

At this moment, S. Vicente Island already has an international airport and the products can be exported straight to the EU. To enable the dispatch of fish products, the TACV requires the following documents:

- The AWB document
- Statement of the consigner
- Health certificate (issued by the Competent Authority)

After checking the above-mentioned documents, the required information is then filled out in the AWB document, which has the AWB number. The AWB number is a serial of 11 numbers, where the three first numbers (696) represent the TACV identification.

The AWB required information includes:

- Number of boxes
- Weighing (the Total Gross Weigh is used)
- Shippers information (name and address)
- Consignee information (name and address)
- Type of product
- Receiving date
- Flight number
- Airport of departure
- Airport of destination
- Handling information

The AWB number, box number and the gross weight of each shipment enable the traceability. All the information mentioned above is booked on the plane. The TACV works according to international standards and the process is similar to that used by Icelandair Cargo.

Right after booking, the flight pallet is formed and the batch is placed in cold storage at 0°C where it is kept until a half an hour before take off. The temperature of the product is measured in an inspecting room and recorded. To enable temperature measurements of the cold storage, one temperature logger could be placed in it. The temperature loggers can be used for three years and if problems occur, the logger can be read and the profile seen.

On the plane, the temperature is controlled automatically. To enable recording of the temperature profile during the air transportation, a temperature logger could be used.

In the Netherlands, the lots are kept in the warehouse until the time when they are taken by the owner. In this case, the connection is the custom clearing which guarantees that the products are only taken out of the warehouse by their owner (by means of identification, documents of the owner, etc).

6 CONCLUSION

The correlation between traceability and quality management systems is important to ensure both quality and safety and it is implemented to some extent in the fish auction and at Ný- Fiskur. This correlation is made by means of records based on quality assessment of fish and temperature measurements connected to the information regarding the produced lots.

All the Icelandic members have traceability systems that fulfil the TraceFish standard for captured fish and the relevant information can either be transferred through the chain, or made available on demand. The TraceFish standard has proven to be very practical and realistic to help companies to implement and/or improve their traceability systems.

For this project, a rather short chain was used. Despite this, relatively large fluctuations in the surrounding temperature were experienced, leading to either heating or cooling of the product. These fluctuations were mainly during handover from one party/function in the chain to the next. Many chains in Cape Verde and Iceland are both longer and more complex with more parties involved. In these long chains great care is needed in temperature control and data management if perishable products, like fresh fish, are to arrive in maximum quality for the consumer. The danger of losing traceability data also increases with the increased complexity of the chains. Standards like the TraceFish technical standard, which stipulates how data is coded and transmitted, can decrease the danger of traceability data being lost.

Considering the above, the following recommendations are made regarding the chain:

- The fish should be kept at a temperatures close to zero degrees.
- Temperature fluctuation should be avoided.
- The difference between the surrounding temperature and the product temperature should be kept as low as possible.
- Records of product temperature should be kept, especially at handovers.
- Records of the surrounding temperature should be kept throughout the chain.

The Capverdian study has shown that, although traceability is not a national requirement yet, even in a simple production, traceability is already implemented and correlated to the quality management system (HACCP) to some extent. However, it is suggested that national legislation should be revised in order to fulfil the demands of the EU market and improve safety in Capverdian fish products. TraceFish standards could be adopted as a tool for the implementation/improvements in Capverdian industries.

Although the TraceFish standard for captured fish does not require the measurement and record of the cold storage temperature by the transporters, it is of importance to implement it, as it will enable the assurance of quality and safety of the shipments as well as reliable evidence in case of customer complaints.

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APPENDIX

Table 10: AUCTION- List of traceability available information according to the TraceFish Standard.

DATA ELEMENT		DESCRIPTION	AVAILABILITY	CATEGORIZATION		
AUCTION				SHALL	SHOULD	MAY
	Food business ID	Owned by fish business operators	V	X		
	Auction establishment ID	Name	V	X		
	GMP certification	HACCP				X
FOR EACH UNIT RECEIVED						
Identities						
	Unit ID	Tubs with internal label	V	X		
	Trade Units IDs in logistic unit	Tubs, lots ID	V	X		
Source						
	Previous food business ID	Boat information	V	X		
	Date and time of reception	Recorded	V	X		
Control Checks (related to the logistic or separate trade units, as appropriate)						
	Temperature of unit when received (°C)	Only when problem occurs, not in a daily basis	X		X	
	Unit temperature record	Only when problem occurs, not in a daily basis	X		X	
Transformation Information (for each trade unit that is transformed by auction)						
	Related created trade unit IDs	Bid number, date, tub n°, buyer ID, Auction ID	V	X		
FOR EACH NEW TRADE UNIT CREATED BY AUCTION						
	Trade Unit ID	Bid number, date, tub n°, buyer ID, Auction ID	V	X		
Description						
	Type of unit	Tubs	V	X		
	Net weight	Average weight (one tub is weighed and average made)	V	X		
	Species	Cod (for the experiment)	V	X		
	Primary production method	Bled on board	V		X	
	Area/country of origin	Iceland –area 27 - FAO			X	
	Product form	Ungutted (for the experiment, but can	V	X		

		be also gutted)				
	Size grade	Manual on board (depending on boat)	V		X	
	Production condition	Chilled	V	X		
Production history /related to the logistic or separate trade units, as appropriate)						
	Size grading method	Manual	V			X
Transformation information						
	Related received trade units IDs		V	X		
FOR EACH UNIT AUCTIONED						
Identity						
	Unit ID	Bid number, date, tub n°, buyer ID, Auction ID	V	X		
Description						
	Freshness grade	No specific scheme	V		X	
FOR EACH LOGISTIC UNIT CREATED BY AUCTION						
Identity						
	Logistic Unit ID	Bid number, date, tub n°, buyer ID, Auction ID	V	X		
	Trade Unit IDs in Logistic Units	Records kept	V	X		
FOR EACH UNIT DISPATCHED (Either as a logistic unit or a separate trade unit)						
Identity						
	Unit ID	Bid Number, date, Buyer ID, weight , age, auction ID	V	X		
Production History						
	Landing or auction temperature control method	Only when problems occur	X		X	
	Landing or auction temperature record	Only when problems occur	X		X	
Destination						
	Next food business ID	The clock market has all the data	V	X		
	Date and Time of dispatch	The clock market has all the data	V	X		

Table 11: NÝ- FISKUR- List of traceability available information according to the TraceFish standard.

DATA ELEMENT		DESCRIPTION	AVAILABILITY	CATEGORIZATION		
PROCESSOR – NY- FISKUR				SHALL	SHOULD	MAY
	Food business ID	F. S Pieters, and private owner	V	X		
	Processing establishment ID	Ný-Fiskur ID- Is- 30278	V	X		
	GMP certification	HACCP	V			X
FOR EACH UNIT RECEIVED						
Identities						
	Unit ID	Bit (auction) number	V	X		
	Trade Units IDs in logistic unit	Lots (picture about auction file, where the lot number is identify)	V	X		
Source						
	Previous food business ID	They buy from different auctions, but they are all identified in records	V	X		
	Date and time of reception	yes	V	X		
Control Checks (related to the logistic or separate trade units, as appropriate)						
	Temperature of unit when received (°C)	2.1°C	V		X	
	Unit temperature record	Highest t° recorded from each tub	V		X	
	Further quality control checks	Fish is graded, sensory evaluation used	V			X
Production history						
	Raw material storage temperature control method	Slurry Ice Refrigerated after grading step	V		X	
	Raw material storage temperature record	Cold chamber: 3°C – 5°C	V		X	
Transformation information (for each trade unit)						
	Related created trade unit IDs	CD – Lot information, production date, 123-0873 (related to Pieters and product)	V	X		
FOR EACH NEW TRADE UNIT CREATED BY PROCESSOR						
Identity						
	Trade Unit ID	CD – Lot information 123.873 (related to Pieters and product)	V	X		

Description						
	Type of unit	3, 5 and 18 kg polystyrene boxes with false bottom	V	X		
	Net weight	Labeled on each box	V	X		
	Name/Type of product	Fresh Cod loins KAB128	V	X		
	Product specification	OK	V			X
	Species	Cod	V		X	
	Primary production method	"Caught in North-East Atlantic (captured)"	V		X	
	Area/country of origin	"Product from Iceland"	V		X	
	Composition	Cod loins 100%	V	X		
	Production condition	Fresh (no ice on top)	V	X		
	Date of durability	Not available (product will be re processed)			X	
Production history						
	Process specification	Available in computer form + paper based	V			X
	Product line IDs	Only one line is used (until now)	V			X
	Date and time of production	Available in computer form	V		X	
	HACCP	OK	V			X
	Hygiene checks	Ok	V			X
	Process temperature records	OK	V			X
	Product quality control checks	OK but need improvements	V			X
Transformation information						
	Related to received trade units IDs		V	X		
FOR EACH LOGISTIC UNIT CREATED						
Identity						
	Logistic unit ID	Paper based	V	X		
	Trade unit IDs in logistic unit	Paper based	V	X		
FOR EACH UNIT DISPATCHED (Either as a logistic unit or a separate trade unit)						
Identity						
	Unit ID	Paper based	V	X		
Production History (related to the logistic or separate trade units, as appropriate)						
	Product storage temperature control method	None, transported as a pallet in a truck (10 minutes until Icelandair Cargo- Keflavik Int. Airport)	V		X	

	Raw material storage temperature record	Product was dispatched right after processing	NOT APPLICABLE!!!		X	
Destination						
	Next food business ID	Icelandair Cargo – 108 (Icelandair ID)	V	X		
	Date and Time of dispatch	15:10 h	V	X		

Table 12: ICELANDAIR CARGO - List of traceability available information according to the TraceFish standard.

DATA ELEMENT		DESCRIPTION	AVAILABILITY	CATEGORIZATION		
TRANSPORTER AND STORER – ICELANDAIR CARGO				SHALL	SHOULD	MAY
	Food business ID	Icelandair Cargo – ID 108	V	X		
	Transport vehicle or storage establishment ID	- Storage: chamber n° 3 (-1°C) - air plane, flight n°	V	X		
	GMP certification	No				X
FOR EACH UNIT RECEIVED						
Identities						
	Unit ID	AWB- 108 1356- 6394	V	X		
	Trade Units IDs in logistic unit	Lot, AWB labeled on each box		X		
Source						
	Previous food business ID	"Ný – Fiskur "- processing plant - ID- Is- 30278	V	X		
	Date and time of reception	30/11/05 15:25 h	V	X		
	Place of collection	Keflavik International Airport –Icelandair Cargo storage house	V	X		
Control Checks (related to the logistic or separate trade units, as appropriate)						
	Temperature of unit when received (°C)	Not measured!	X		X	
FOR EACH NEW LOGISTIC UNIT PRODUCED BY TRANSPORTER OR STORER (FLIGHT PALLET)						
Identity						
	Logistic unit ID	AWB number	V	X		
	Trade unit IDs in logistic unit	Shipper, type of product, total gross weight, number of boxes	V	X		
FOR EACH UNIT DISPATCHED (Either as a logistic unit or a separate trade unit)						
Identity						
	Unit ID	AWB number		X		
Production History (related to the logistic or separate trade units, as appropriate)						
	Transporter or Storer temperature control method	Temperatures checks only on demand Temperature control in Plane is automatic (>4°C < 7°C), no records	X		X	
	Transporter or Storer	No records	X		X	

	temperature record					
Destination						
	Next food business ID	In the AWB document-F.S Pieters-Belgium	V	X		
	Date and Time of dispatch	Records kept	V	X		
	Place of delivery	Belgium –Liege + trucking to F.S. Pieters	V	X		

Table 13: CPCI-List of traceability available information according to the TraceFish standard.

DATA ELEMENT	**DESCRIPTION**	**AVAILABILITY**	**CATEGORIZATION**		
PROCESSOR – CPCI			SHALL	SHOULD	MAY
Food business ID	CPCI-State	V	X		
Processing establishment ID	CPCI-CV004	V	X		
GMP certification	HACCP	V			X
FOR EACH UNIT RECEIVED					
Identities					
Unit ID	Lot number	V	X		
Trade Units IDs in logistic unit	Lots, weight	V	X		
Source					
Previous food business ID	Fibber glass boats	V	X		
Date and time of reception	Ok	V	X		
Control Checks (related to the logistic or separate trade units, as appropriate)					
Temperature of unit when received (°C)	Up to 4°C	V		X	
Unit temperature record	Each lot	V		X	
Further quality control checks	Fish is graded, sensory evaluation (EU scheme)	V			X
Production history					
Raw material storage temperature control method	Slurry Ice and sea water	V		X	
Raw material storage temperature record	Only one lot processed; raw material is not stored	V		X	
Transformation information (for each trade unit)					
Related created trade unit IDs	Lot n°, production date	V	X		
FOR EACH NEW TRADE UNIT CREATED BY PROCESSOR					
Identity					
Trade Unit ID	Only one lot processed	V	X		

Description						
	Type of unit	10 kg polystyrene boxes	V	X		
	Net weight	Labeled on each box	V	X		
	Name/Type of product	Fresh Tuna loins	V	X		
	Product specification	OK	V			X
	Species	*Tunnus albacares*	V		X	
	Primary production method	Caught in Cape Vert EEZ	V		X	
	Area/country of origin	"Product from Cape Vert"	V		X	
	Composition	Tuna loins 100%	V	X		
	Production condition	Fresh (with ice mats on top)	V	X		
	Date of durability	15 days (product will be reprocessed)			X	
Production history						
	Process specification	Paper based	V			X
	Product line IDs	Only one line is used (until now)	V			X
	Date and time of production	Paper based	V		X	
	HACCP	OK	V			X
	Hygiene checks	Ok	V			X
	Process temperature records	OK	V			X
	Product quality control checks	OK but need improvements (Histamine control)	X			X
Transformation information						
	Related to received trade units IDs	OK	V	X		
FOR EACH LOGISTIC UNIT CREATED						
Identity						
	Logistic unit ID	Paper based	V	X		
	Trade unit IDs in logistic unit	Paper based	V	X		
FOR EACH UNIT DISPATCHED (Either as a logistic unit or a separate trade unit)						
Identity						
	Unit ID	Paper based	V	X		
Production History (related to the logistic or separate trade units, as appropriate)						
	Product storage temperature control method	None, transported in a truck (10 minutes until S. Vicente Island Airport)	V		X	
	Raw material	Raw material not stored	NOT		X	

	storage temperature record		APPLICABLE!!!			
Destination						
	Next food business ID	TACV- 696 (Cape Vert Airlines)	V	X		
	Date and Time of dispatch	In AWB document	V	X		

TACV- List of traceability available information according to the TraceFish standard.

DATA ELEMENT		DESCRIPTION	AVAILABILITY	CATEGORIZATION		
TRANSPORTER AND STORER – TACV				SHALL	SHOULD	MAY
	Food business ID	TACV – ID 696	V	X		
	Transport vehicle or storage establishment ID	• air plane, flight number	V	X		
	GMP certification	ISO, ETOPS				X
FOR EACH UNIT RECEIVED						
Identities						
	Unit ID	AWB, lot n°, Health certificate n°	V	X		
	Trade Units IDs in logistic unit	Lot labeled on each box, gross weight		X		
Source						
	Previous food business ID	CPCI- processing plant - ID- CV-004	V	X		
	Date and time of reception	OK (AWB)	V	X		
	Place of collection	S. Vicente Island airport	V	X		
Control Checks (related to the logistic or separate trade units, as appropriate)						
	Temperature of unit when received (°C)	Not measured	X		X	
FOR EACH NEW LOGISTIC UNIT PRODUCED BY TRANSPORTER OR STORER (FLIGHT PALLET)						
Identity						
	Logistic unit ID	AWB number	V	X		
	Trade unit IDs in logistic unit	Shipper, type of product, total gross weight, number of boxes	V	X		
FOR EACH UNIT DISPATCHED (Either as a logistic unit or a separate trade unit)						
Identity						
	Unit ID	AWB number		X		
Production History (related to the logistic or separate trade units, as appropriate)						
	Transporter or Storer temperature control method	Temperature not measured Temperature control in Plane is automatic (>4°C < 7°C), no records	X		X	
	Transporter or Storer temperature record	No records	X		X	
Destination						
	Next food	In the AWB document:	V	X		

	business ID	TACV- Sal Island and then The buyer in the Netherlands				
	Date and Time of dispatch	Records kept	**V**	X		
	Place of delivery	Amsterdam-The Netherlands	**V**	X		