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TRACEABILITY AS A TOOL IN THE QUALITY SYSTEM

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ABSTRACT

This project studies the quality system in a shrimp processing company in Iceland. The study focuses on traceability and safety for cooked peeled shrimp (*Pandalus boreales*) and how traceability is an important tool in this system. The quality system was studied by selecting chapters of the quality handbook, which are related to safety and traceability. The product traceability is ensured by identification and labelling of units in each link and record keeping. Samples are taken for microbiological testing during important steps of the processing line in order to verify the system. High quality and safe products are the result of an effective quality system based on the HACCP system and traceability as a part of the prerequisite programme helps to manage the system. The quality system at the shrimp processing company examined in this report aims at securing food safety and product traceability. The study confirms that it is possible to trace back and forward the history of the product. The traceability of the products based on labelling of the units in each link is well supported by a recording system, registering the information related to safety and quality of the products in each link of the processing line.

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1 INTRODUCTION

Shellfish production in Cuba is an important economic industry. Lobster and shrimp are the main products exported to different markets like Spain, Italy, Canada, France, Japan and others. Aquaculture production is also growing and efforts are being made to include some products in the world market. For that reason it is important to have a good quality system based on HACCP. The quality system based on HACCP is widely used and internationally recognised by Codex Alimentarius, which recommends its adoption (Codex 1997).

Adams *et al*. (2000) explain how Cuba has more recently played an increasingly important role in the world market for these high- valued finfish and shellfish seafood products harvested primarily within Cuba's near shore waters. In addition, the industry has historically played an important role in providing seafood products for the domestic market in Cuba.

Quality and safety assurance is of paramount importance to the Cuban seafood industry, particularly as seafood has become an increasingly important source of export revenue. The Cuban fishing fleet now concentrates on the production of high-valued species such as spiny lobster, shrimp, reef fish, tunas, sponges, and others. Although the economic conditions that have prevailed in Cuba since the "Special Period" have kept import volumes to a minimum, the exportation of high-valued finfish and shellfish continues to be important, with quality and safety being major demand determinants (Adams *et al.* 2000).

The adoption of Hazard Analysis and Critical Control Points (HACCP) procedures by importing countries worldwide has created new standards of quality and safety to which exporting countries must strictly adhere. During 1995, in accordance with these changing international standards, the Cuban seafood industry began instituting HACCP programmes in all Fishery Industry Ministry (MIP) seafood processing plants. Improvements in processing plant sites, equipment, and infrastructure due to HACCP contributed to the satisfactory outcome of European Community Inspection Visits resulting in renewed approval for importation of Cuban fisheries products by European Union (EU) countries. A total of 15 seafood processing facilities have now been approved for exporting to the EU. Since the adoption of HACCP standards began in 1995, the average total cost per ton for quality control measures has decreased by almost 45%, which suggests that spoilage, waste, and shipment rejections have declined dramatically.

According to Huss (1994), record keeping is one of the strong elements in the quality system based on HACCP. This also offers product traceability in the whole chain, from catch until the final product is delivered to the consumer, because procedures for product identification and traceability during all stages should be established. Traceability is becoming an important issue for producers and sellers in all countries, not only in the EU. Traceability of food products is also required for commercial reason such as for production and distribution efficiency, and for verifying market claims for a product or its

production (including ethical, moral and environmental claims such as organic production and sustainable fishery, etc).

Traceability does not ensure good quality or safe food, but the facilitation of full chain traceability for food products will aid the consumer in guaranteeing safe and healthy products with well-documented characteristics.

The EU is now implementing regulations requiring more traceability for fish products (EC 178/2002). The fishery industry in Cuba will be confronted with the challenge of the new regulation when exporting products to the European market. That is the reason why I have selected traceability as the theme of this project. Traceability will be a major concern for all exports in the Ministry of Fishery Industry in Cuba.

Traceability includes not only the principal requirement of being able to physically trace products through the distribution chain, but also being able to provide information on what they are made of and what has happened to them. The further aspects of traceability are important in relation to food safety, quality and labelling according to legislation relating to labelling, animal health and welfare and fish marketing, product liability and safety.

The main objective of this project is to study how the quality system in a shrimp-processing factory in Iceland secures food safety and how the traceability is an important tool in this system.

This objective will be reached by collecting data in a field study to a shrimp processing factory in Iceland and studying the following:

- The quality system in a shrimp processing plant in Iceland with focus on safety.
- The traceability system throughout the process, from catch until end product.
- Definition and labelling of batches in the whole chain.
- Microbiological samples of the raw material, semi finished product and final product through the processing line to compare and verify how microbiological data is related to the processing and quality and safety parameters recorded in the quality system.

A field study to investigate the traceability system of products and quality monitoring in an Icelandic shrimp processing company is a practical experience that will be useful to promote the improvement of quality systems in fisheries companies in Cuba. This will especially be helpful to gain an understanding of the prerequisites for implementing traceability of fishery products according to the new EU traceability regulations.

2 LITERATURE REVIEW

As a background for this project it is necessary to have an overview of the requirements placed on the fishery products in the EU markets including HACCP, traceability, legislation in the EU, quality and safety related with regulation and quality control aspects.

2.1 Haccp

The HACCP was first conceived by The Pillsbury Company to develop safe food for astronauts in collaboration with NASA and the US Army Laboratories at Natick, MA; USA. The original approach to HACCP was based on Failure, Mode and Effect Analysis (FMEA) as applied to engineering systems, where each step of an operation is carefully examined for potential mistakes that can occur, along with possible causes and their likely effects on a finished product. Effective control mechanisms are then put in place to ensure that such potential failures are prevented (Kanduri & Eckhardt 2002).

Also, HACCP is a preventive system of quality control and was developed to minimize consumer risk of illness and injury from foods. Its goal is to prevent the hazards at the earliest possible stage of food processing. It enables food processors to identify, prioritise and minimize various likely hazards. It enables consideration of all the factors that contribute to most outbreaks and of risk- assessment techniques (Kanduri & Eckhard 2002).

The main premise is that if each step of the process is carried out correctly, the end product will be safe food. Effective sanitation operation procedures become the foundation for application of HACCP in food processing.

HACCP places the responsibility on processors who must demonstrate to themselves and to regulatory agencies that the food produced in their establishment is safe, and that production is adequately controlled as a matter of design (Kanduri & Eckhard 2002).

HACCP treats the production of food as a total continuous “system” assuring food safety from harvest to consumption.

The traditional methods for assessing food safety provides only a “snap-shot” of conditions at the time of inspection, whether it is conducted in-house or by a third party such as a regulatory agency. However, assumptions must be made about the conditions before and after that inspection on the basis of the “snap- shot” which may or may not be close to reality (Kanduri & Eckhard 2002).

HACCP takes a proactive approach to food safety. The understanding and application of HACCP principles means that the primary responsibility for demonstrating that hazards specific to the foods they produce are being prevented rests with the industry. In other words, HACCP enables the industry to perform self-inspection combined with government monitoring to assure food safety.

Kanduri & Eckhard (2002), explain historically, the principal focus of HACCP has been food safety and the Food and Drug Administration (FDA) regulations in the United States mandating HACCP-based inspection systems are limited to food safety.

They also note that HACCP concepts can be applied in development of a comprehensive product control system where all phases of safety, as well as other no safety related hazards such as wholesomeness (quality) and economic fraud can be addressed at the same time.

HACCP is not a system that stands alone but is supported by other programmes well known as prerequisites (NACMCF 1997), such as Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP) or Standard Sanitation Operational Procedures (SSOP). These prerequisite programmes provide the basic environmental and operating conditions that are necessary for the production of safe, wholesome food.

Prerequisite programmes may include facilities, supplier control, specifications of raw material, ingredients, packaging materials and products, equipment, cleaning and sanitation, personal hygiene, training, traceability and recall procedures, pest control and others (NACMCF 1997).

2.2 Traceability in the fish industry

In ISO 9000:2000, traceability is defined as the ability to trace the history, application or location of that which is under consideration. In terms of products it relates to the origin of materials and parts, the processing history, and the distribution of the product after delivery (ISO 2000). In other words, traceability means the ability to trace and follow a food through all stages of production and distribution (Tall 2001).

When considering a product, traceability can relate to:

- The origin of material and parts.
- The processing history.
- The distribution and location of the product after delivery.

The Tracefish project (2001) identified two types of traceability: internal and chain traceability. Internal traceability is within one company and relates to data about raw materials and processes to the final product before it is delivered. Chain traceability is focused on the information about the product from one link in the chain to the next, it describes what data are transmitted and received, and how. Olsen (2001) explains that chain traceability is between companies and countries and depends on the presence of internal traceability in each link.

It was mentioned that there are increasing demands for traceability throughout the food chain. The root causes of many of the recent food safety problems have been found in the primary production sector, although the problems are manifested at the other end of the

food chain in the products sold to consumers. Hence there are needs to trace back through the chain to determine the causes of the problems and then, in taking remedial action, to trace forward from those causes to withdraw or recall all the unsafe products produced. With chain traceability in place, these tasks can be done efficiently and with minimal commercial disturbance. Without chain traceability, whole sectors of the food industry may have to be closed down on a precautionary basis and the costs can be ruinous (Denton 2001, Tracefish 2001).

Research on traceability in the fisheries chain has been ongoing for a few years in Europe. The research efforts have mainly been focused on the logistics of the products to ensure that products can be linked to their source while also protecting products of declared origin (both geographical and production system). Research on sophisticated molecular biology techniques as tools to verify the authenticity of species and for tracing contamination of products has also been the focus of research (Börresen 2003).

A Nordic project focused on identifying the information that is available in each link of the chain by doing a survey in the fish industry. One of the main conclusions of that report was that a lot of information is recorded in the chain but little of it flows to the end user. A lot of this information is stored in each link, some is sent to the next link, but most of it is kept in the databases of the companies as a part of the quality system or in the company information system. The information sent to the next link is only what is needed for the next link to be able to transport the product in the chain, or information regarding quality sent to the buyer, owner of the label (Palsson *et al.* 2000). Frederiksen, M. 2002. studied the quality chain management in fish processing. In this study he explains that the crisis in the meat sector caused the industry to focus on traceability systems that are capable of making an effective recall from the market. An effective recall system is able to react fast, identify and locate suspected material and reduce to a minimum the amount of goods needed to recall. To handle crises effectively in fresh fish chains traceability is a must. Also, the quality chain has the ability to react to a crisis in a chain.

Börresen (2003) maintains that the most convenient labelling systems apply the bar code technique for keeping track of the different lots and batches being handled. Different coding and reading systems may be applied, but the EAN-UCC system (European Article Number- Universal Code Council) seems to be the most convenient for global exchange of data and shipping of goods in most of the world.

2.3 Fishery legislation in the EU

The EU market, Canada and Japan are the main export markets for Cuban fishery products. Therefore, it is important to know the requirements and regulations for these different markets. In this case I have selected to study the fishery legislations for the EU market, but other regulations in the world such as US regulations for fishery products are similar because of the globalisation of trade.

Vrignaud (2002) explains four types of measures issued by the EU:

1) Regulations: a regulation is a law that is binding and directly applicable in all Member States without any implementing national legislation. Both the Council and the Commission can adopt regulations.
2) Directives: a decision is law binding on the Member States as to the result to be achieved, but the choice of method is their own. In practice, national implementing legislation in the form deemed appropriate in each Member State is necessary in most cases. All directives set a date by which Member States have to transpose it in national legislation.

3) Decisions: a decision is binding entirely on those to whom it is addressed. No national implementing legislation is required. Both the Council and the Commission can adopt decisions.

4) Recommendations: a recommendation has no binding effect (it is not a law). Both the Council and the Commission can adopt recommendations.

The new regulation (EC 178/2002), requiring increased traceability for fishery products is now being implemented by the EU Council.

2.3.1 Quality and safety related regulations

Directive 91/493/EEC is the main text for fish and fishery products (European Economic Community (EEC) 1991) . In this directive, the health conditions for the production and placing on the market of fishery products are laid down. It also lays down rules on conditions applicable to factory vessels, to on-shore plant, to packaging, to storage and transport. Provisions, which may require more details, are set concerning own-checks, parasites (all visible parasites must be removed), organoleptic, chemical and microbiological checks. 91/493/EEC concerns both domestic (EU) and third countries (non-EU) production. It defines EC standards for handling, processing, storing and transporting fish.

Directive 92/48/EEC lays down the minimum hygiene rules applicable to fishery products caught on board certain vessels in accordance with article 3(1) (a) (i) of directive 91/493/EEC.

Commission Decision 94/356/EC was issued to implement an own-check system (HACCP) (European Economic Community (EEC) 1994) it lays down detailed rules for the application of Council Directive 91/493/EEC, as a regards own health checks on fishery products.

2.3.2 Food labelling regulations

The two main regulations with respect to labelling are the Council Regulation 2000/104/EC (European Economic Community (EEC) 2000b) and the Council Directive 2000/13/EU (European Economic Community (EEC) 2000a) Three sets of information are compulsory on the label of any fishery products on sales at retailers according to the consumer information in Article 4 of 104/2000/EC:

- The commercial name of the species
- The production method (caught at sea, in inland water or farmed)
- The catch area (especially for the products caught at sea)

FAO codes the general catch areas (FAO 1999). The catching area for Cuba is number 31 as is shown in Figure 1. The labelling of catch area to fulfil the requirements of the labelling regulations for products from Cuba will not be complex. The FAO area codes will be used for labelling in relation to documenting the origin of the products for traceability.

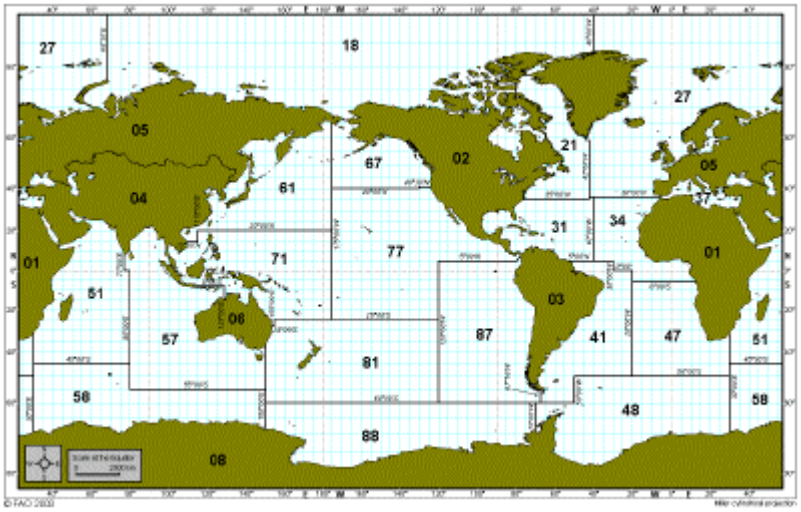


Figure 1: Map of the fishing areas (FAO 1999).

Recognising a need to improve consumer information related to fish, the EU issued a compulsory labelling of fish regulation – Commission Regulation 2065/2001/EC. The detailed rules for the application of 104/2000/EC as regards informing consumers about fishery and aquaculture products were laid down in this regulation (European Economic Community (EEC) 2001) .

Regulation 178/2002/EC is a milestone in EU food legislation. The European Food Safety Authority (EFSA) was established in Chapter 3 (European Economic Community (EEC) 2002). Its mission is to transform EU food law principles.

2.3.3 Traceability in regulations

Regulation 178/2002/EU, called General Principles of Food Law, lays down the general principles and requirements of food law (European Economic Community (EEC) 2002). It defines traceability in Article 3 and specifies traceability requirements in Article 18 (see Box 1). The information required for traceability includes what the food is and what has happened to it, as well as where it has come from and who was responsible for it.

These further aspects of traceability are important in relation to food safety, quality and labelling.

Traceability concerns only the ability to trace things, which means that the necessary information must be available when required. It does not mean that the information must at all times be visible by being labelled on the food.

Article 18
Traceability
1. The traceability of food, feed, food-producing animals, and any other substance intended to be, or expected to be, incorporated into a food or feed shall be established at all stages of production, processing and distribution.
2. Food and feed business operators shall be able to identify any person from whom they have been supplied with a food, a feed, a food-producing animal, or any substance intended to be, or expected to be, incorporated into a food or feed. To this end, such operators shall have in place systems and procedures which allow for this information to be made available to the competent authorities on demand.
3. Food and feed business operators shall have in place systems and procedures to identify the other businesses to which their products have been supplied. This information shall be made available to the competent authorities on demand.
4. Food or feed which is placed on the market or is likely to be placed on the market in the Community shall be adequately labelled or identified to facilitate its traceability, through relevant documentation or information in accordance with the relevant requirements of more specific provisions.
5. Provisions for the purpose of applying the requirements of this Article in respect of specific sectors may be adopted in accordance with the procedure laid down in Article 58(2).

REGULATION (EC) No 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 January2002 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. Official Journal of the European Communities L31/1
http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_031/l_03120020201en00010024.pdf

Box 1: Main text on traceability in EU-regulation No 178/2002

Legislators are now acting on traceability in order to protect the public. Food businesses, particularly the large retailers and those producing branded goods, are increasingly demanding traceability to assure their standards and to protect their businesses (Tracefish 2001).

Chain traceability is not yet generally in place in the captured fish industry. The difficulties of establishing it are largely due to the industry's diversity and complexity of trade (Tracefish 2001).

2.4 Quality control

Huss (1995) and Bonnell (1994) discuss the methods applied to evaluate the freshness of fish, which are divided into two categories: sensory and instrumental techniques. Instrumental methods include biochemical, chemical, microbiological and physical techniques. Each of these methods measures different spoilage indicators in fish and fishery products. Only through a combination of instrumental and sensory analysis can optimal information on the product be obtained.

Traditionally seafood quality has been discussed and estimated on the basis of degree of spoilage of the raw material or the product. These changes are dependent on the species, handling and time and temperature development of the fish in question. The methods are in principle based on autolytic changes, development of microbial growth and oxidation of lipids. In addition, the most common methods are sensory evaluation, which by many, has not been regarded as an objective method. Still, most trade is based on sensory assessments although measurements are not always objective and documented.

Seafood has gained popularity and market shares in many countries due to being exotic, tasty, light and healthy. This trend has been questioned by another trend as consumers are becoming more aware of safety and food poisoning. Discussions on seafood imposing unacceptable health risks have been raised in many countries, mainly due to lack of inspection and documentation of quality. The increased focus on safety is stressed by authorities and consumers (Huss *et al.* 1992).

2.4.1 Freshness

Freshness is the single most important parameter when assessing fish quality. It is a prerequisite for the processor who can choose when and what to produce based on a high degree of freshness in the raw material. Because high freshness is a security towards microbiological spoilage it is important when fish is sold within 5-10 days after harvest. The assessment is done by sensory analysis or by TVB (Total Volatile Bases) analysis.

One of the important issues nowadays in Europe is food safety and food quality. So it is important to keep the quality of fish, as one of the most vulnerable and perishable food items, at a high level in each link of the whole chain in order to be able to guarantee the consumer a healthy, fresh and high quality end product.

Sensory analysis is the most important method for assessing freshness and quality in the fish sector and in fish inspection services (Martinsdottir *et al*. 2001).

Quality Index Methods, a new tool developed by European fisheries research institutes, is a seafood freshness quality control system. It is a promising method in assessing the

freshness of fish in a rapid and reliable way. Also, it is expected to become the leading reference method for the assessment of fresh fish within the European Community in the future. An example of the QIM used for shrimp is shown in Figure 2 below.

Quality Index Method (QIM) Scheme for Fjord Shrimp

Quality parameter		Description	Score
Whole shrimp	Dark in the head	None	0
		Some (25%)	1
		Many (50-75%)	2
		All (75-100%)	3
	Colour	Pink / red	0
		Pale pink	1
		Yellowish	2
		Yellow, green-, greyish discolouration	3
	Odour	Fresh, seaweady	0
		Faint odour, reminds of tar	1
		faint ammonia odour	2
		Obvious ammonia odour, sour, putrid	3
Roe	Roe colour	Copper green	0
		Discoloured, faded	1
		Dark	2
Quality Index			0-11

Figure 2: Quality Index Method (QIM) Scheme for Fjord Shrimp (Martinsdottir *et al.* 2001).

2.4.2 Enzymatic action in crustaceans

Melanosis (black pots) is a very important quality defect in crustaceans and as demonstrated by Kim *et al.* (2000). When the consumers are selecting food choices four attributes are evaluated: appearance, flavour, texture and nutritional value. Appearance is one of the first attributes used by consumers for evaluation and colour makes a significant impact. Colour can be influenced by many compounds, naturally occurring pigments, chlorophylls, carotenoids, anthocyanins, and other; or other colours formed through enzymatic and no enzymatic reactions. One of the most important colour reactions that affects many fruits, vegetables and seafoods, especially crustaceans, is enzymatic browning, caused by the enzyme polyphenol oxidase (PPO). This enzyme has also been labelled phenoloxidase, phenolase, monophenol and diphenol oxidase, and tyrosinase.

Phenoloxidase is responsible for a type of decolouration called melanosis in crustacean species such as lobster, shrimp and crab. The post-mortem dark discoloration on crustaceans, called melanosis or black spot, connotes spoilage, is unacceptable to consumers, and thus reduces the market value of these products. Figure 3 shows an example of a visual scale for the progression of melanosis.

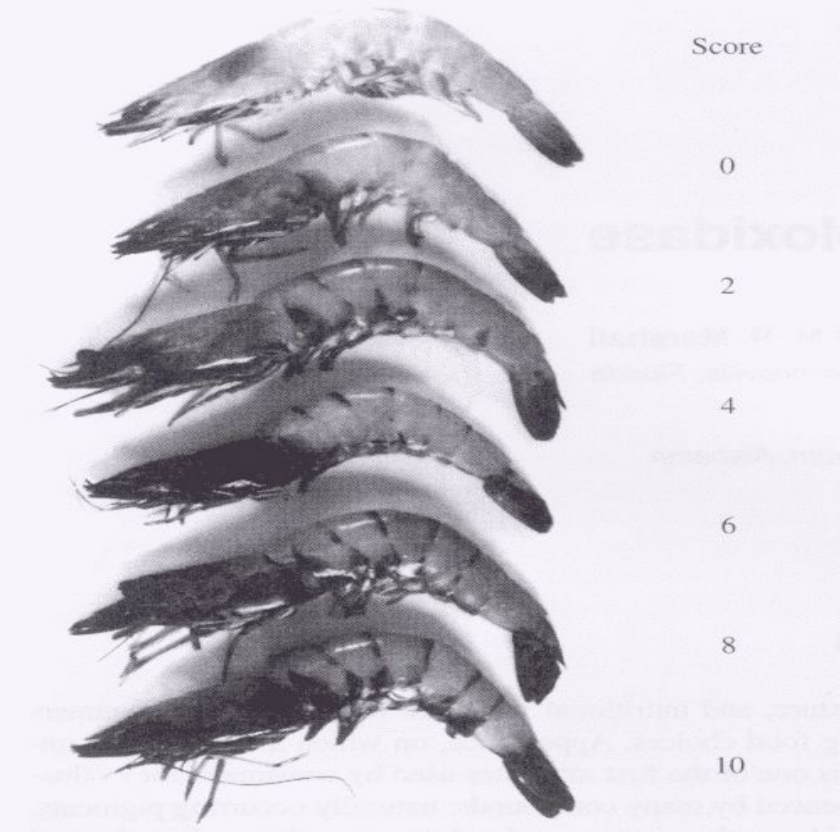


Figure 3: Melanosis progression scale of shrimp (Kim *et al*. 2000).

In addition to the visual scale Table 1 below provides the scale used to describe the progression of melanosis (black spot) on pink shrimp (*Penaeus dourarum*).

Table 1: Scale used to describe the progression of melanosis (black spot) on pink shrimp (Kim *et al.* 2000).

Melanosis scale	**Description**
0	Absent
2	Slight, noticeable on some shrimp
4	Slight, noticeable on most shrimp
8	Heavy, noticeable on most shrimp
10	Heavy, totally unacceptable

Crustaceans rely on polyphenol oxidases to impart important physiological functions for their development. Polyphenol oxidases are important in the sclerotization of the cuticle of insects and crustaceans such as shrimp and lobsters. Sclerotization is the hardening of the shell after moulting, which is part of the growing phase for the organism. A second physiological function of polyphenol oxidase is wound healing. The mechanism of wound healing in aquatic organisms is similar to that in plants: the compounds produced from the polymerization of the quinones posses' active antibacterial or antifungal activities. Unfortunately, polyphenol oxidases can cause browning of the shell post

harvest, which affects the quality of these products and consumer acceptability (Kim *et al*, 2000).

Shrimp is a highly perishable product and its shelf life under refrigerated storage conditions is limited by both enzymatic and microbiological spoilage. Psychotropic bacteria are the major groups of microorganisms responsible for spoilage of refrigerated seafood.

According to recent findings (Chinivasagam *et al.* 1998) during the course of a series of experiments to identify the particular spoilage bacteria found on shrimp, it was confirmed that *Pseudomonas fragi* and *Shewanella putrefaciens* were the major spoilage organisms. Pure cultures originating from shrimp from different regions and from different storage modes were inoculated into a sterile shrimp broth prepared by filtration. It was noted that many of the broths became dark. This suggested the possibility that some spoilage bacteria may be capable of producing melanin, a possibility examined in this study.

The appearance of melanosis or black spots on prawn, shrimp, and other fresh crustaceans is rapid, even in chilled storage, and involves some important economic losses for the fish industry. Melanosis is triggered by a biochemical mechanism, which oxidizes phenols to quinones by polyphenoloxidase (PPO). This is followed by no enzymatic polymerization of the quinones, giving rise to pigments of high molecular weight and very dark, or black, colouring (Montero *et al*. 2001).

In crustaceans, PPO has various locations. It is found on the exoskeleton, chiefly on the shell of the cephalothorax, uropods, and on the pleuron in the region of the pleopods' connection. PPO is also found in the haemolymph. Because of the intense irrigation of the cephalothorax, this is where PPO is most commonly found. It remains active under refrigeration (with or without ice), and in thawed products.

Due to the perishability of such a product, reliable methods of preservation are sought to extend shelf life and to avoid health hazards. Such methods include cold storage in ice, modified ice storage, low-dose gamma radiation, cook-chill processes, and treatment with organic acids and their salts (Al-Dagal & Bazaraa 1999). Wide concentration ranges of organic acid salts such as sodium acetate (0.5 to 10.0%, wt/wt), sodium lactate (0.25 to 4.0%), potassium sorbate (0.1 to 10.0%), and sodium citrate (8.0 to 10.0%) have been used, alone or in combination, to extend the shelf life of fresh meat and sea foods (Al-Dagal & Bazaraa 1999).

2.4.3 Microbiological quality control and monitoring

Microbiological testing is often used as a verification tool to establish that the overall operation is under control. Physical and chemical analyses are the preferred monitoring methods since microbiological methods are often time consuming. However, the future seems to be promising, as rapid microbial detection (for some pathogens such as *Salmonella* and *Listeria*) is becoming available at a reasonable cost (Kanduri & Eckhardt 2002).

The activity of microorganisms is the main factor limiting the shelf life of fresh fish. The aim of microbiological examinations is to evaluate the possible presence of bacteria or organisms of public health significance and to give an impression of the hygienic quality of the fish. This includes temperature abuse and hygiene during handling and processing (Huss 1995). An estimation of the total viable count (TVC) is used as an index in standards, guidelines and specifications. Specific spoilage organisms (SSO) capable of producing hydrogen sulphide or reducing trimethylamine oxide (TMAO) are considered more useful to estimate spoilage and the remaining shelf life of fish and fishery products (Ólafsdóttir *et al*. 1997).

2.4.3.1 Sampling

According to Huss (1994) the number, size and nature of the samples taken for analysis greatly influence the results. In some instances it is possible for the analytical sample to be truly representative of the "lot" sampled. This applies to liquids such as milk and water that can be sufficiently well mixed. In cases of "lots" or "batches" of food this is not the case since a lot may easily consist of units with wide differences in microbiological quality. A number of factors must therefore be considered before choosing a sampling plan. These include:

- The purpose of testing
- The nature of the product and lot to be sampled
- The nature of the analytical procedure.

A sampling plan (attributes plan) can be based on positive or negative indications of a microorganism.

When the samples are taken, they have to be representative of the food lot or batch and submitted to a laboratory in a condition that is microbiologically unchanged from the time of sampling.

Vanderzant & Splittstoesser (1992) explain that when the samples are collected, an appropriate sampling plan should be applied correctly to prevent contamination of the samples and to minimize microbial changes within the samples during transport, storage and handling.

Collection, transportation to the laboratory and preparation for examination is the first priority in the microbiological examination of any food product. Laboratory results and their interpretation are valid only when appropriate samples are examined and handled correctly. Every effort must be made to ensure that samples are representative of the entire lot of material under evaluation, and are protected against extraneous contamination and improper handling, especially at temperatures that may significantly alter the microflora (Vanderzant & Splittstoesser 1992).

2.4.3.2 Microbiological tests

In order to detect pathogenic bacteria (*Salmonella, Listeria monocytogenes, E. coli, Staphylococcus aureus)* a number of microbiological tests of fish and fish products are used by industry and authorities for contractual and internal purposes to check that the microbiological status is satisfactory. Besides these examinations, other organisms can also be detected which are possible indicators of faecal contamination or other types of general contamination or poor manufacturing practices (coliform bacteria, faecal streptococci, aerobic plate count (APC) (Huss 1994).

Huss (1994), maintains that microbiological tests are generally costly, time-consuming and require a lot of manual labour but rapid automated tests are becoming available and being given accreditation. Consequently the number of samples, which can be examined, is limited. Furthermore, it should be emphasized again that a negative test for specific pathogens in a food sample is no guarantee that the whole lot is free of these pathogens. Thus only a very limited degree of safety can be obtained by microbiological testing. There are other limitations for some of these tests.

The introduction of agar media in the late 1800s allowed the development of methods to enumerate microorganisms by colony count. Such methods have been used extensively for determining approximate viable microbial populations in foods. These procedures are based on the assumption that each microbial cell in a sample will form a visible, separate colony when mixed with an agar or other solid medium and permitted to grow.

Total viable count (TVC):

TVC is defined as the number of bacteria (cfu/g) in food product, obtained under optimal conditions of culturing. Thus the TVC is by no means a measure of the "total" bacterial population, but only a measure of the fraction of the microflora able to produce colonies in the medium used under the conditions of incubation. This parameter in terms of quality gives an overview of the handling of the product related with temperature changes in all the steps of the process. Therefore, it is good to have this value in order to know if the process was run properly.

Enterobacteriaceae:

Application of coliform, *Enterobacteriaceae*, and faecal coliform testing is done to evaluate the overall quality of a food and the hygienic conditions present during food processing. Examination for faecal contamination indicators is of generalized use in the testing of food which may act as vehicles for the transmission of food borne diseases.

Total and faecal coliforms:

Coliform (Total) organisms are aerobic to facultative anaerobic, no spore-forming Gram-negative rods which ferment lactose with the production of acid and gas at 32-35°C within 48 h. Coliforms (*Escherichia*, *Enterobacter, Citrobacter* and *Klebsiella*) are used

as indicators of post-harvest contamination, particularly of faecal origin. A majority of them are harmless for human health, *0*, with the exception of a few strains of *E. coli*, which have limited pathogenicity in the elderly and infants. One such example is *E. coli* 0157:H7 (Kanduri & Eckhardt 2002).

E. coli is a normal inhabitant of the intestinal tract of humans and other warm-blooded animals. Therefore, its presence outside the intestines, in food or water, might be regarded as evidence of poor sanitary conditions. *E. coli* is sensitive to sub-zero temperatures and therefore unsuitable as an indicator of faecal contamination in frozen fish (Kanduri & Eckhardt 2002).

These tests are directed to detect the members of *Enterobacteriaceae,* which ferment lactose but not the presence of non-lactose fermenting members of the food microflora such as *Salmonella*.

Salmonella:

The affection by salmonella appears to have increased during the past 20 years. Two key factors for reducing salmonella contamination are: consumer education and implementation and maintenance of adequate laboratory quality control programmes in the food industry. Food processors don't want their companies' products involved in salmonella outbreaks, because the consequences can be economically devastating. The industry has therefore implemented rigid quality control programmes to minimize the risk of salmonella contamination of its products (American Public Health Association 1992).

Kanduri & Eckhardt (2002), describe *salmonella* as a rod- shaped, motile, no spore-forming and gram-negative organism, widely present in all warm blooded animals. *Salmonella* has been found in water, soil and insects, on factory surfaces and kitchen surfaces, also in animal faeces, raw meats, raw poultry, frogs' legs, fish, shrimp and other seafood.

The *Salmonella typhi* can cause typhoid fever in humans. Other forms of salmonellosis produce milder symptoms, such as diarrhoea, mild fever, nausea, abdominal cramps, muscle pain, occasional vomiting and prostration. Chickens and turkeys carry Salmonella in their intestines without any outward symptoms. Fortunately, thorough cooking kills them.

Shigella:

Smith and Buchanan (1994), explain that shigellosis, well known as bacillary dysentery, is a localized ulcerative infection of the colon. Organisms of the genus *Shigella* are transmitted directly or through food or water contaminated by faecal matter. The infective dose is low in order of 10^1 or 10^4 cell/person. The genus *Shigella* is grouped within the family *Enterobacteriaceae*. The incubation period is 12 to 50 hours after ingestion of the organisms. A gastrointestinal syndrome is presented with diarrhoea in a majority of the cases.

Salads are the most common food implicated in shigellosis. Contaminated potato salad is the most common cause of outbreaks, followed by other types of salads containing chicken, fish, or seafood. However, a variety of foods have been involved in *Shigella* outbreaks, including seafood, meat, and chicken dishes, that usually contain ingredients cooked or raw, made into salads or other dishes without heating before consumption, or temperature abused before serving (Smith and Buchanan 1994).

Listeria monocytogenes:

According to Kanduri & Eckhardt (2002), the bacterium is ubiquitous in nature, occurring in soil, vegetation and water. Plant cleanliness is crucial to control this organism. There are seven species recognized in the genus *Listeria: L.monocytogenes, L. innocua, L. seeligeri, L. ivanovii, L. welshimeri, L. grayi* and *L. murrayi*. But the *Listeria monocytogenes* is the most important and known to be pathogenic to humans.

This is a Gram-positive, invasive type, motile psychotropic bacterium (capable of one doubling every 1.5 days at 4°C) that grows best at 35°C. It is quite resistant to the harmful effects of freezing, drying, salt and heat. While lower temperatures enhance their survival, high temperature short time (HTST) pasteurization temperatures of 71.7°C for 15 s (75°C for 10 s) are sufficient to kill them. *Listeria* infection has a high case-fatality rate, resulting in death or stillbirth in one third of all outbreak cases in susceptible individuals.

Staphylococcus aureus:

Staphylococcus aureus is a spherical bacterium (coccus), which appears in pairs, short chains, or bunched, grape-like clusters. These organisms are Gram-stain positive. They are generally considered as mesophilic, with an optimum growth temperature of 37°C.

Some strains produce a highly heat-stable toxin that causes illness in humans. In fact, it causes one of the most commonly occurring types of food poisoning after ingesting the food containing preformed toxin in it.

The most common symptoms are nausea, vomiting, retching, abdominal cramping and prostration. The onset of symptoms is usually rapid, and recovery generally takes two days. A toxin dose of <1.0 µg in contaminated food will produce symptoms of intoxication. This toxin level is achieved when *S. aureus* populations exceed 10^5/g of the sample.

This kind of bacteria is commonly found on humans (nose, hair and skin) and could find its way into food (Kanduri & Eckhardt 2002).

2.4.3.3 Microbiological criteria for seafood

According to Huss (2000), with the increased use of the HACCP system in the management of food quality and safety one may ask, if microbiological testing and criteria are still necessary as the HACCP system aims at controlling hazards during processing. A number of microbiological criteria (MC) are still required by both national and international legislation, but there is considerable debate whether MC are needed or necessary in all instances to increase food safety. Traditionally, control of microorganisms in food was demonstrated by microbiological testing of samples at various stages of production and the final product. Results were compared with criteria developed to give some degree of assurance that the food was safe and of good quality. It is now fully recognised that this type of activity can never give an absolute assurance of product quality and safety. A much higher degree of assurance can be provided by a preventative approach based on application of the HACCP principles at all steps in the food supply and processing system.

Usually, three types of MC have been applied in the control of food:

- Standards
- Guidelines
- Specifications

These terms have been defined and redefined a number of times, but it is generally recognised that the term “standard” is an MC contained in a law or regulation with mandatory compliance. In case of non-compliance some (specified) action is required by the regulatory agency. A microbiological “guideline” is an MC applied at any stage in food processing and aids in identifying situations requiring actions for food safety or quality reasons. Results obtained from testing assist in trend analysis and situations (products, processes) not complying with guidelines should result in investigative action to identify and rectify the cause. A “specification” is an MC used for contractual purposes by food business as part of their own safety management system and should not be confused with legal requirements.

The purpose and application of MCs should only be applied to products or processes when no other means of securing safety and shelf life are available and when the use of an MC enhances food safety. Thus, there must be scientific evidence that an MC is effective, practical and meaningful in terms of consumer protection.

MCs may be useful in the following situations:

- To indicate the microbiological status of raw materials, ingredients and final products of unknown origin (e.g. at port-of-entry).
- As verification of HACCP- based control systems, Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP).
- To assess whether the prevalence of a pathogen in specific foods is increasing/decreasing relative to a target level.
- For contractual purposes by food business.

3 CASE STUDY IN THE SHRIMP FACTORY

3.1 Introduction

The main objective of the field trip to the shrimp processing company was to study the quality system, to study how traceability works in this system and to take samples of different parts of the process to submit to a microbiological lab. The sampling was done in order to verify that the process is running according to what is stated in the quality manual related to hygiene and safety of the product.

The study was divided into three parts:

1. Quality manual
2. Traceability system
3. Microbiological survey

As a part of the prerequisites in the HACCP system, in order to secure food safety, it is important to know all the requirements, such as legal requirements and customer requirements, based on the nature of the product. As the product description shows, this product is a ready to eat product, which means that it is a high care or high risk product and this is reflected in the analyses conducted. Using the prerequisite programme (legal requirements) as a background the plant has analysed its process with the aim to secure the safety of the product. Contributing factors to the safety is the process flow and the processing environment. The HACCP analyses results in two major CCP, the cooking and the metal detection. The environment requirement is the physical separation of high risk and low risk areas of production, as well as hygiene requirements, including personal hygiene. The quality manual is aimed at procedures and protocols to ensure safety and quality of the product with regard to legal requirements.

3.2 Quality manual

There are requirements of an “Own Check System” for all producers. This requirement includes the setting up of a quality manual that describes how the production is controlled and a safe product achieved. The main bulk of the manual covers the management structure, process overview, a hazard analyses and written procedures in key areas.

Also, the quality manual plays an important role in the product quality management system. The quality objective is to process high quality and safe products to meet the requirements of the customers and to expand export markets.

The contents of the quality manual are shown in Table 2.

Table 2: Contents of the quality manual.

1. Management responsibility.
2. Quality policy and objectives.
3. Design and extent of the quality system.
4. Production description.
5. Purchase of packing material and additives – Certificates.
6. Purchase of raw material and ingredients
7. Layout of production.
8. Flow chart of production.
9. Production quality control system.
10. Plant quality control system.
11. Hygiene.
12. Control of foreign matter – Glass control.
13. Pest control.
14. Temperature in production areas.
15. ***Control of test equipment.***
16. ***Control of chemicals.***
17. Rule of conduct – Employees and guests.
18. Training of new employees.
19. Traceability and recalling of product.
20. Rules of sampling and microbiological standards – Control of non conforming product.
21. Criteria standards for quality inspection and method description.

The study of the quality manual was focused on selected chapters (bold in Table 2) that were considered important for this project, because they are related to the traceability system and the quality control system. The content of these chapters is reviewed below.

QM-4: Production description

The product description identifies the product as a ready to eat product and therefore the process as a high risk/high care production.

Product: Cooked and peeled shrimp.
Family name: *Pandalus borealis* (cold water shrimp)
The shrimp is cooked, peeled, graded by size and frozen individually.
They are red or pink with a sweet taste.
They are cleaned and put into salt water graded and glazed and packed in the bag according to working rules, 400 g to 12 kg.
Best before 18 months with glaze and three months without glaze.
Keep below -18°C.
Product end use: Product is thawed and consumed without further cooking.

QM-6: Purchase of raw material and ingredients

According to the quality handbook and in all quality systems it is important to know the suppliers of the raw material and ingredients. It is also important for the traceability to know which are the suppliers and if they have a licence to produce food grade material. All the ingredients and packaging bought should have product specifications, certificates

from suppliers confirming that all the legal requirements with regards to their product and its processing are met.

For ingredients like salt this may include a breakdown of its purity and possible use of ingredients like anti caking agents, etc. The certificate in all the cases covers the following:

- Property (chemical compound and specification with quantity of each).
- Physical characteristics. Production description.
- Preparation.
- Odd and harmful components.
- Safety technical ecological aspects.
- Storage.
- Best before.

The shrimp is sourced from many fishing grounds but mainly the Barent Sea and Flemish Cap.

The raw material suppliers are evaluated according to procedures "General rules and guidelines for the evaluation of suppliers of raw material into processing of cooked and peeled shrimp".

These guidelines include requirements that the suppliers have a licence recognized by the Directorate of Fisheries, demands on handling procedures and access to all documents relating to the material.

When the raw material is landed it is evaluated, both by an independent auditor which then turns in a certificate and by the plant itself. All batches are labelled with:

- Catch day.
- Name of the trawler.
- Size grade (where applicable).

QM-7: Layout of production

The processing environment must secure a physical separation of the product after cooking to ensure that contamination does not occur. This is accompliced by a physical barrier between high and low risk areas of the process. After cooking, the shrimp enter a high risk area, where there is restricted access of staff through a separate changing room. Protective clothing is used, strict personal hygiene rules are in place as well as physical conditions like positive air pressure, filters in the air conditioning system, separate drainage systems etc.

In the layout of production there are differences between the low risk area and high risk area. For each area the personnel use different colour clothing, in this case white clothes

for high risk area and blue for the low risk areas. The employees have been trained in all the aspects related with quality and safety of the product and personal hygiene.

QM-9: Production quality control system

There are written procedures for key areas of the process, which explain all the procedures in detail about the processing and HACCP plan for shrimp processing. (see Appendix 10)

Product specifications that cover the requirements made about raw material and product quality are shown in Appendix 2.

Procedures for the packaging used are shown in Appendix 3.

Following are descriptions of important steps in the process linked to quality and safety:

Cooking:

The cooking process is designed to destroy *Listeria monocytogenes*. Written procedures are in place to secure that this target is reached. Evaluation of the raw material with regards to contamination levels was used to build a cooking profile that stipulates the cooking time/temperature necessary. The effectiveness of the cooking is verified with temperature profiles for each batch and the core temperature of shrimp on exit from each cooker. A major factor in the reliability of these results is the constant monitoring of the cooking environment (temperature and pressure). Temperature and the time have to reach at least 75°C for 10 seconds. This is a CCP.

Metal detection:

A metal detector is in place for monitoring packed products; bulk products as well as retail products. This is defined in the quality system as a CCP and therefore procedures are in place, describing in detail the required accuracy of the equipment, how, where and how often these are monitored by staff and reaction to any discrepancies.

Brine:

For traceability it is necessary to record the salt producer's lot number. The brine is pumped from the "low risk" area into the "high risk" area. Specification for this operation is described in Appendix 2.

Glaze:

The glazing of shrimp is a protective measure. The levels vary with regards to the size and grade. Glaze evaluation and amount according to specifications. (see Appendix 2)

Inspection:
Inspection of the product is done on each size grade at least every 60 minutes. The quality criteria used in these inspections are according to specification and can vary between size grades as well as customers. (see Appendices 2 and 10)

Chemical and microbiological measurements:

Representative samples are taken from each day's production to verify that the product is within specification. Backup samples are kept for each production date.

All microbiological and chemical analyses must be conducted by an accredited laboratory. In this case the Icelandic Fishery Laboratories (IFL).

Labelling:

Each inner packaging (bag) is labelled according to legal requirements and specification. Additionally each outer carton is labelled with a carton label and finally each pallet is labelled. Both are labelled according to legal requirements and product specifications. All of this information such as carton label and pallet number is necessary for traceability back and forward of the product.

Transportation:

During dispatch, the temperature of the product is monitored. The condition, amount and temperature is documented during the dispatch and signed off by both the plant and the receiver of the product. The monitoring of the temperature is to ensure the safety (wholesomeness /quality) of the products and the temperature records are part of the traceability information detailing the history of the product.

Minimum requirements are made to the transport company with regards to condition of vehicles and storage facilities as well as the quality system.

QM-10: Plant quality control system

The maintenance and documentation of the quality system is in the hands of the Quality Manager but the responsibility is with the General Manger, Production Manager and the Quality Manager.

A HACCP team is in place in the plant. This team reviews the HACCP system once or twice per year and additionally if required because of changes in the production.

Management meetings are held once a month and are attended by the Quality Manager and Production Manager as well as the General Manager. Various areas, for example legal issues that are connected to the quality system are discussed in these meetings and if necessary decisions on system changes are made.

An internal audit is carried out three times a year to see if the process and systems are working properly. All records and documents are stored in a handbook according to the quality manual.

QM-11: Hygiene

Unauthorized or unnecessary passing through the working area should be prohibited at all times. Employees working in peeling/cooking must take special notice of this, because of how close the raw shrimp are to the cooked shrimp. This applies both during production and cleaning.

A sanitizer for hands and gloves must be in place where the employees enter the working area. Nobody is allowed to enter the working area during working hours or after cleaning, without washing and sterilizing his or her hands. All rubber gloves used in the low risk area must be washed with soap and sterilized after work. All chemicals used for cleaning/sterilizing must be kept in a separate, locked compartment/room when not in use.

The water used in the brine may be mixed with chlorine before adding the salt, the max strength allowed is 1 ppm. Water used to glaze the shrimp may also be mixed with chlorine up to 1 ppm.

QM- 12: Control of foreign matter-glass control

The company has a policy applying general rules to prevent contamination with foreign body. There is a special glass/hard plastic policy, where all glass/hard plastic in production are evaluated and replaced with other material or covered with protective film where is possible. The reaction procedures for broken glass have been introduced to all staff. (see Appendix 4)

QM- 15: Control of test equipment

The thermometers are calibrated every day after work. LÖGGILDINGARSTOFA is the company that makes the calibration of the equipment. This is a governmental agency for Electrical Safety Accreditation Market Surveillance Metrology. The equipment is accredited once a year by this company. Another company called SÝNI SKOÐUNARSTOFA comes three times a year to check the factory as an audit for the system. All of this information is recorded and is important for traceability.

QM-16: Control of chemicals

The chemical company carries out inspections of their chemicals and one person of the cleaning team takes care of all the chemicals in the plant. According to the requirements, the chemicals used for cleaning/sterilizing are kept in a separate, locked compartment/room when not in use. Also, they have procedures how to use the chemicals during the cleaning and to train the employees how to clean. Pictures are available from the most difficult area to clean and they check them especially on site.

QM-18: Training of new employees

The training is performed according to the quality manual for some employees working with the raw material in the reception area (low risk area), the quality inspection and the peeling machine (high risk), the packaging II (low risk) and the cleaning (high and low risk). The employees are trained according to what they are going to do in the factory. All the information is recorded in the quality handbook.

QM-19: Traceability and recalling of products

The traceability system is done by labelling the batches in each link of the processing line, using the pallet number as a final label. How the traceability works in this company is explained in Chapter 3.2 of this project, which refers specifically to traceability.

If any information from the quality system indicates that a product run is of sub-standard quality or does not conform to the demands and product specifications of a customer then the product shall immediately be recalled. Procedures are in place for product recall, stipulating the division of responsibility for all action taken, including who shall be notified and what information needs to be accumulated.

QM-20: Rules of sampling and microbiological standards

The company has a contract with IFL and this contract is renewed every year.

The samples are sent to the lab once a week. If IFL find something in the samples like *listeria*, IFL inform the company right away and then the company have to take samples again. Two times per the month the company takes samples for hygiene using ATP measurements and once a month for *listeria* tests (swap). Water samples are taken twice a year and also the white clothes after they are cleaned. A personal hygiene test is taken twice a year from the fingers.

Control of non-conforming products:

Nonconforming products are kept separate and labelled in the cold store while new samples are taken. If a problem still exists the traceability of the product is used to go back to see what happened through the production chain and further action decided.

QM-21: Criteria standards for quality inspection and methods description

The quality parameter that is controlled is the freshness of the shrimp looking into the appearance, texture, flavour and odour (see Appendix 3).

Discussion

The quality manual in the plant describes the procedures in the process and it is important to have in place as part of the own checks system. Also in the quality system it is an

important tool to see if the process is under control and according to the specifications and regulations established.

The HACCP system is implemented in the company according to EU regulation, the company have two critical control points (CCP), one in the cooking room and the other in the metal detector. In the cooking room they measure the temperature and the time at least 75°C for 10 seconds. In the metal detector, critical limits are not allowed. They apply preventive measures and in the process the quality control record all the measures in each place. They have also limits for the raw material and some other parts of the process.

Procedures for key points in the processing line would include the procedures for the CCP (cooking time, temperature, limits, reaction to out of limits, etc; similar to metal detection). Procedures for the calibration, general hygiene, and cleaning are also in the quality manual. (see examples in Appendices 6, 7 and 9)

Procedures are in place for the receiving, handling and production of material. This is based on the raw material specification and product specifications. This stipulates the quality criteria used. (see Appendices 2 and 3)

3.3 Traceability

EU Directive 178, the obligation to traceability, comes into force on 1 January 2005. In this project the shrimp processing industry in Iceland is used as model to understand the impact and significance of this directive for fish trade. In this context, the demands made by the directive and the techniques currently used in the shrimp processing industry for the labelling of shrimp products in practice will be studied. This includes tracing a product's origin. The shrimp processing industry in Iceland has already implemented the above requirements in their companies but the question is whether the shellfish industry in Cuba has the procedures in place to verify the origin of their products. This project will be useful as an example to understand the impact of EU Directive 178 for trade of fisheries products and may give guidelines to the Cuban fisheries trade regarding restructuring or implementing full chain traceability for their products.

One of the important things to have in mind, when talking about traceability, is that the quality system gives you the possibility to trace back the product but only if the product is fully documented. But of course, as it was discussed before, traceability does not ensure the quality and safety of the products.

Three key factors to ensure traceability were emphasised by Liu (2002), UNU/FTP fellow in her final report, they are:

- Links.
- Identification of units in each link.
- Labelling of units with unique identifiers (Ids).

The main links in shrimp processing related to traceability of the products are explained below. The identification of traceable units within each link and their labelling is also explained.

Catching and receiving:

Through the chain, there is a combination of physical labels and documented information. For catching there is a slight variation regarding frozen raw material and fresh raw material. In both cases there is a physical identification label on the material stating the name of the vessel and the day of catching, each tub/block is marked with the name of the ship and the day of catch. Further information is then available from the ship on a need to know bases. On time of receiving the raw material the various quality parameters are documented for that catch in addition to legally required information on ship and day coding. The figure below shows an example of the tub label in this company.

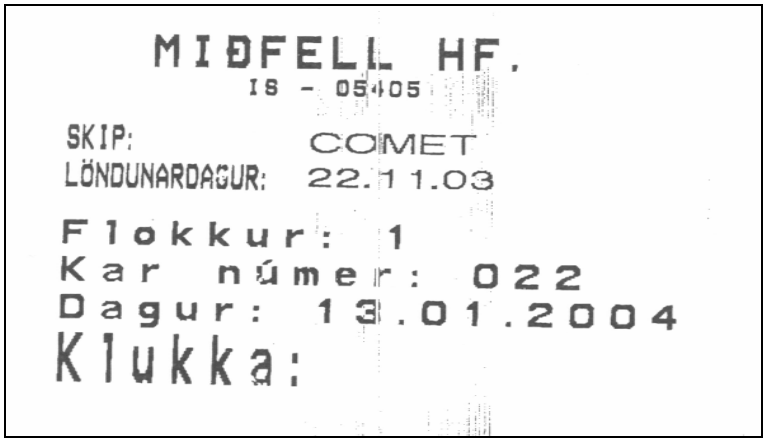


Figure 4: The label used on tubs for raw material in the receiving area.

Maturing:

In production the raw material goes first into maturing for up to 24 hours. The name of the ship and size code is documented and the time it enters the maturing. In this step the record is filled out in a form as is shown in Figure 5 below:

SÍF HF. Pallet sample

Producer: **PLANT 21** Production days from :

Product number: **P655** Number of cases per pallet: **78**

Pallet number: **20721**

Date	Time	Silo	Wgt bag	Clumping 2	Clumping >=3	Wgt de-gl.	Glaze %	Whole number	Bits #	Count tot.	Bits g	Bits %	Shell #	Flavour	Colour	Smell	Brine Conc.	Brine Temp	Product. temp.	Sign.	Comment

	Wgt. de-gl.	Glaze %	Whole	Bits #	Count	Bits g.	Bits %	Shell #
Average								

Figure 5: Form used to record the necessary logistic information and parameters regarding handling, quality and safety of the product in the maturing link.

Processing:

During further processing (cooking etc) the sampling of the product starts after grading. At this time the plant is producing specific products according to product specifications where all quality criteria are documented (Appendix 2). All inspections are done per pallet, i.e. as the first run of a specific product starts an inspection process start and continues as a pallet is being filled of the product. As each inspection is performed the time of the inspection is also documented. When the pallet is full the inspection results are printed out and stored under the product number and pallet number. The documentation of the time of the inspection then links that product up to all other general inspections done (temperature, brine, cooking profiles etc). All the information available in this step for traceability is identified by the pallet number.

In the packaging the product is labelled as explained below:

- Each bag filled is labelled with the production code according to legal requirements.
- Each box filled is labelled with a carton label (see Figure 6).
- Each pallet filled is labelled with a pallet label (see Figure 7).

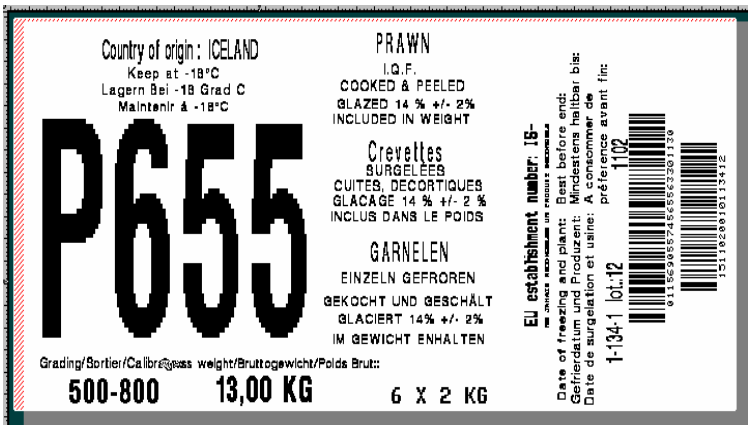


Figure 6: Example of a carton label in the processing link.

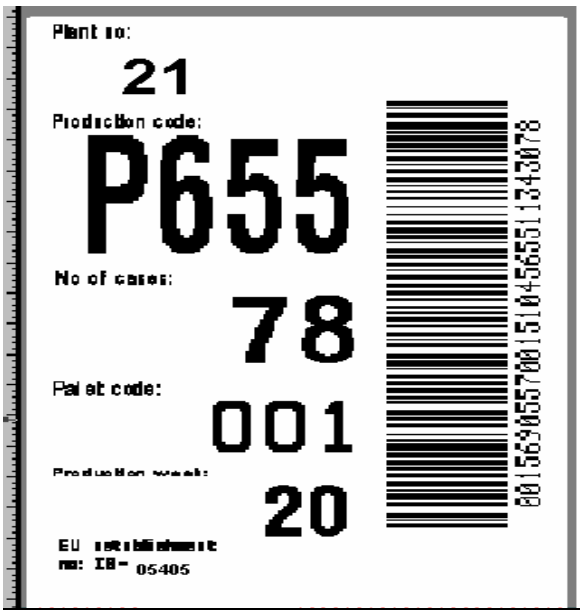


Figure 7: Example of a pallet label.

Cold store:

All storage and transport of the product is documented using the pallet number as an identification number. The information available in this step is the product code, production day and time period.

Export:

For export the pallet number is still used as an identification number

Sale of individual items:

At point of sale the bags are the items being handled. This means that at this time the identification number becomes the labelling on the bag, which includes the EU health code of the plant and the production day code. The identification of the product is given by Julian code, which includes year, day and producer. Figure 8 below shows an example.

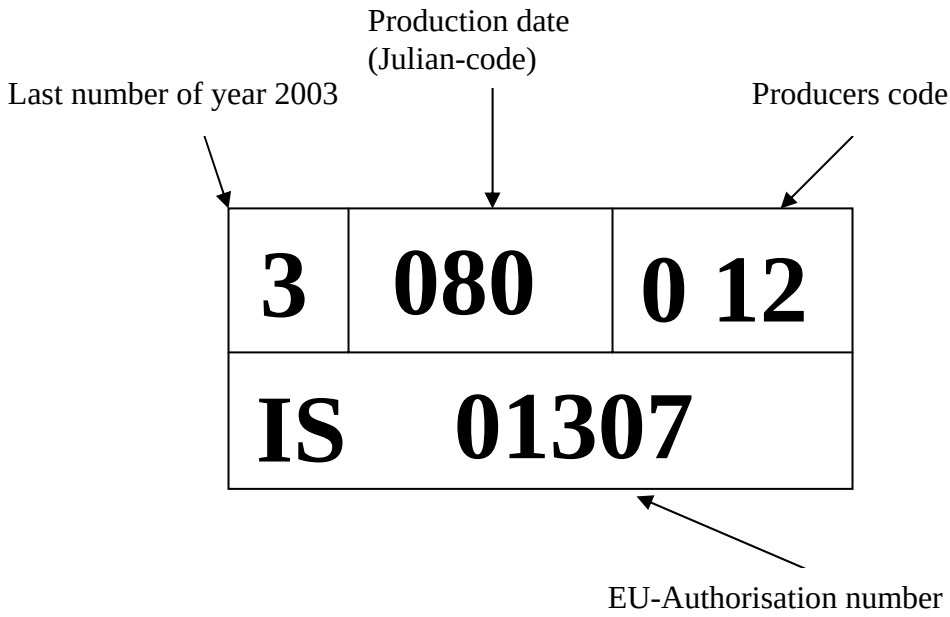
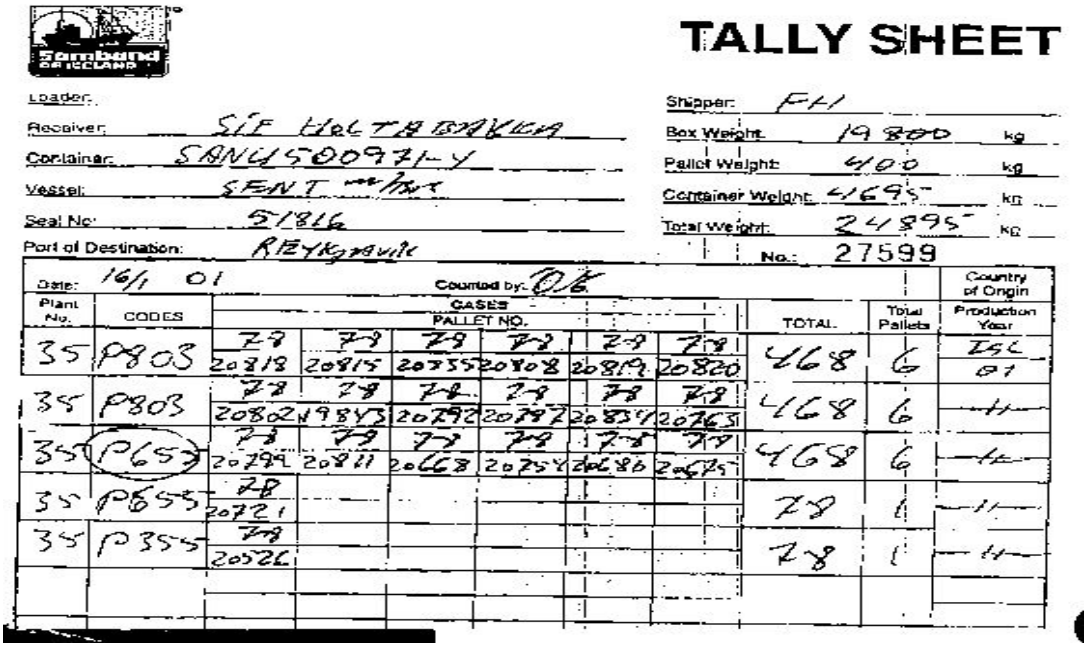


Figure 8: Example of a label on a final product.

Also for the transportation there is a form called a Tally Sheet, which includes the product code and the pallet number. Figure 9 shows an example.



TALLY SHEET

Loader:
Receiver: SIF HOLTABAKKA
Container: SANU5009714
Vessel: SENT
Seal No: 51816
Port of Destination: REYKJAVIK

Shipper: FH
Box Weight: 19800 kg
Pallet Weight: 400 kg
Container Weight: 4695 kg
Total Weight: 24895 kg
No.: 27599

Date: 16/1 01 Counted by: DG

Plant No.	CODES	CASES PALLET NO.						TOTAL	Total Pallets	Country of Origin / Production Year
35	P803	28 20818	28 20815	28 20755	28 20808	28 20819	28 20820	468	6	ISL 01
35	P803	28 20802	28 19843	28 20792	28 20787	28 20837	28 20763	468	6	"
35	P65?	28 20794	28 20811	28 20668	28 20754	28 20686	28 20795	468	6	"
35	P655	28 20721						28	1	"
35	P355	28 20526						28	1	"

Figure 9: Example of information recorded in the Tally Sheet.

A flow chart for the shrimp processing is shown in Figure 10. The important links for the traceability system are indicated by green circles. These links have a special role regarding recording and the labelling of the batches and units through the processing line. In the receiving area the raw material is labelled with the catching day, name of the trawler, catching area and all the tubs are labelled as is shown in Figure 4 above. In the maturing the inspection of the product starts and is included the pallet number, which includes all the information about the receiving area as is shown in the figure 5. The carton and pallet label also have information about the product such as production day, producer code, product code and the EU authorisation number. The retailer is where the product is delivered, which in case of problems of contamination or others, it is possible to go back using the traceability to know what happened during the process and apply the corrective action.

Figure 10 also shows two links in red, which indicate the critical control points or safety points in this process. These points are strictly controlled in the process and all the information about the measurement are recorded and kept in the quality handbook.

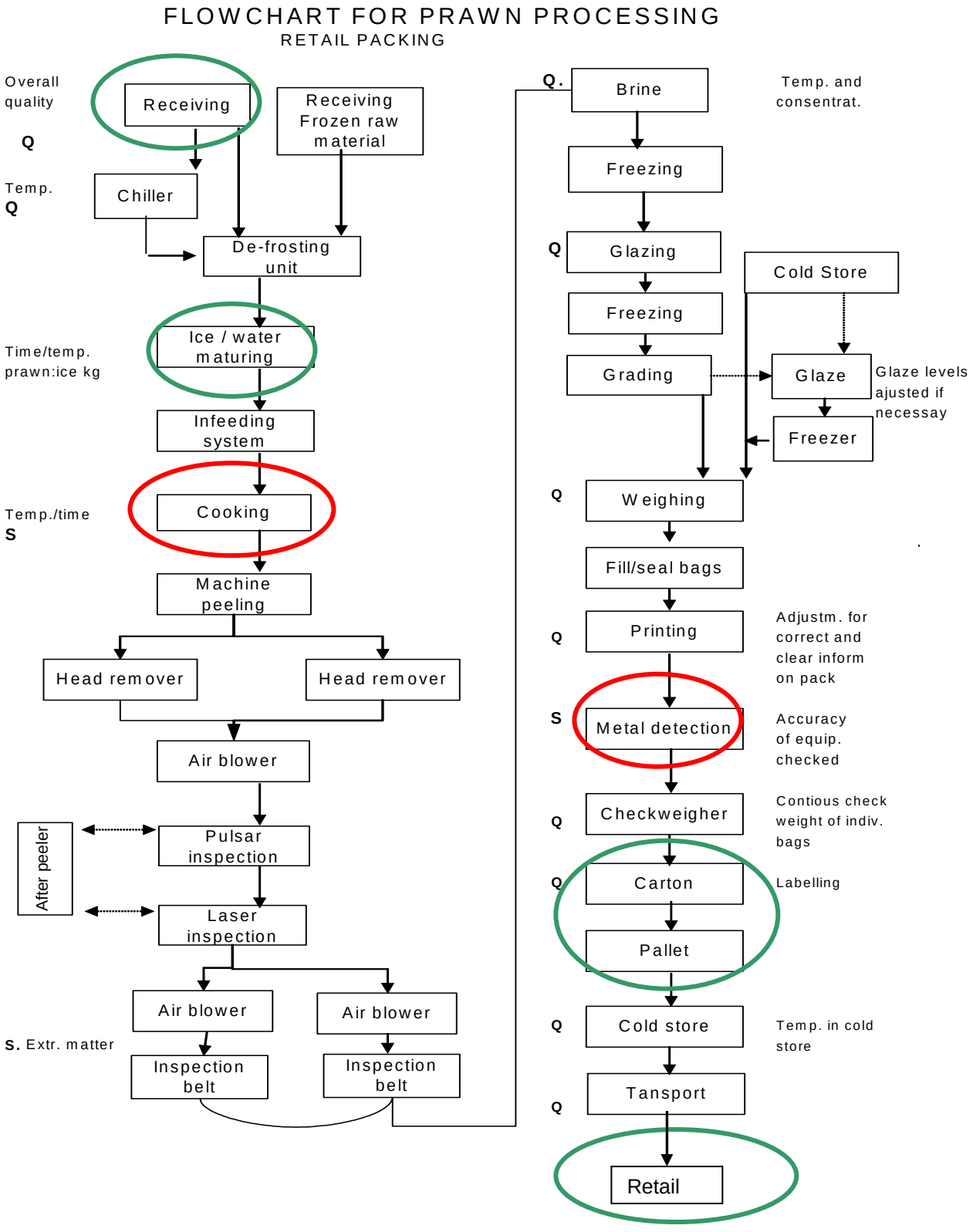
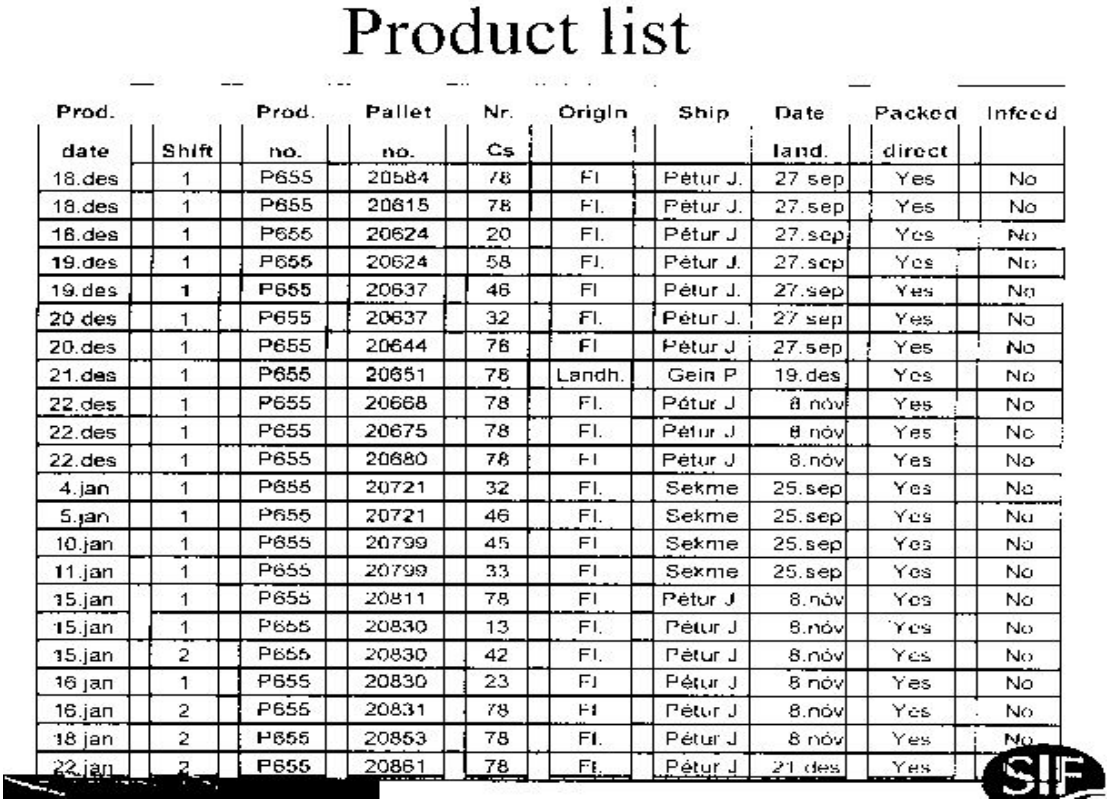


Figure 10: Flow chart for shrimp processing showing links important for traceability (green) and safety (red).

As was explained, traceability is only possible if a good quality system based on a HACCP plan is implemented. A process where all the processing history is recorded from catching until the product is delivered to the consumer allows traceability of products in case of problems requiring the recall of products.

In this case, by using the pallet number it is possible to know the production day and also the catching day and the name of the ship, as is show in the Figure 11.



Product list

Prod. date	Shift	Prod. no.	Pallet no.	Nr. Cs	Origin	Ship	Date land.	Packed direct	Infeed
18.des	1	P655	20584	78	FI	Pétur J.	27 sep	Yes	No
18.des	1	P655	20615	78	FI.	Pétur J.	27.sep	Yes	No
18.des	1	P655	20624	20	FI.	Pétur J	27.sep	Yes	No
19.des	1	P655	20624	58	FI.	Pétur J.	27.sep	Yes	No
19.des	1	P655	20637	46	FI	Pétur J.	27.sep	Yes	No
20 des	1	P655	20637	32	FI.	Pétur J.	27 sep	Yes	No
20.des	1	P655	20644	78	FI	Pétur J	27.sep	Yes	No
21.des	1	P655	20651	78	Landh.	Gein P	19.des	Yes	No
22.des	1	P655	20668	78	FI.	Pétur J	8 nóv	Yes	No
22.des	1	P655	20675	78	FI.	Pétur J	8 nóv	Yes	No
22.des	1	P655	20680	78	FI	Pétur J	8.nóv	Yes	No
4.jan	1	P655	20721	32	FI.	Sekme	25.sep	Yes	No
5.jan	1	P655	20721	46	FI.	Sekme	25.sep	Yes	No
10.jan	1	P655	20799	45	FI	Sekme	25.sep	Yes	No
11.jan	1	P655	20799	33	FI	Sekme	25.sep	Yes	No
15.jan	1	P655	20811	78	FI	Pétur J	8.nóv	Yes	No
15.jan	1	P655	20830	13	FI.	Pétur J	8.nóv	Yes	No
15.jan	2	P655	20830	42	FI.	Pétur J	8.nóv	Yes	No
16 jan	1	P655	20830	23	FI	Pétur J	8 nóv	Yes	No
16.jan	2	P655	20831	78	FI	Pétur J	8.nóv	Yes	No
18 jan	2	P655	20853	78	FI.	Pétur J	8 nóv	Yes	No
22.jan	2	P655	20861	78	FI.	Pétur J	21 des	Yes	

Figure 11: Example of how the information is recorded.

Discussion:

To have a good quality handbook where all the procedures have been written is an important aspect in the quality system, because this handbook explains how things have to be done, related with quality and safety, traceability, labelling, regulation, etc.

The traceability, as it is seen by Huss (2003), is part of the prerequisite programme for the quality system. Traceability as a tool in the quality system in the company, gives the possibility to track the product forward and trace it backward using the logistics of the traceability. The key to traceability is the labelling of the units and batches. In the Icelandic companies the batches and the units are labelled in each link of the processing chain. Using the pallet number all the information recorded such as production day,

catching day, name of the ship or trawler and the information about the quality of the product is accessible in the computer and in the quality handbook.
Cuba has a quality system based on HACCP, but based on the experience gained in this study performed in the Icelandic company, it can be concluded that it is necessary to improve the quality system in Cuba. The main focus to improve the quality system will be on training the people, a quality handbook and labelling the batches and units in the processing chain. The experience gained about how the quality system ensures food safety and also how the traceability works in this system is useful for implementation of traceability in Cuba.

3.4 Microbiological survey

Microbiological testing is a tool used to verify if the overall operation is under control and if the safety of the product is according to the parameters established in the quality system and recorded in the quality handbook. It is also used as part of the traceability system when it is necessary to know when the product was processed and to prove that the product is safe. The company takes several samples during the week to submit to the microbiological lab for analysis. The samples are sent every Monday of the following week.

In this project, microbiological sampling was done to verify the hygiene of the process and the handling of the product. The results of the microbiological analysis will be used to compare with the parameters established in the quality manual. Eight samples were taken from different parts of the process as illustrated in the following section.

3.4.1 Methods for microbiological sampling

During processing, samples were taken from the important steps of the process such as:
Raw material, cooking room, shrimp and shell after peeling, shrimp after blower, shrimp after hand peeling, and shrimp after glazing and from the final product. Figures 12 to 18 show the sampling sites.

Figure 12: Samples taken from the raw material after grading in the reception hall.

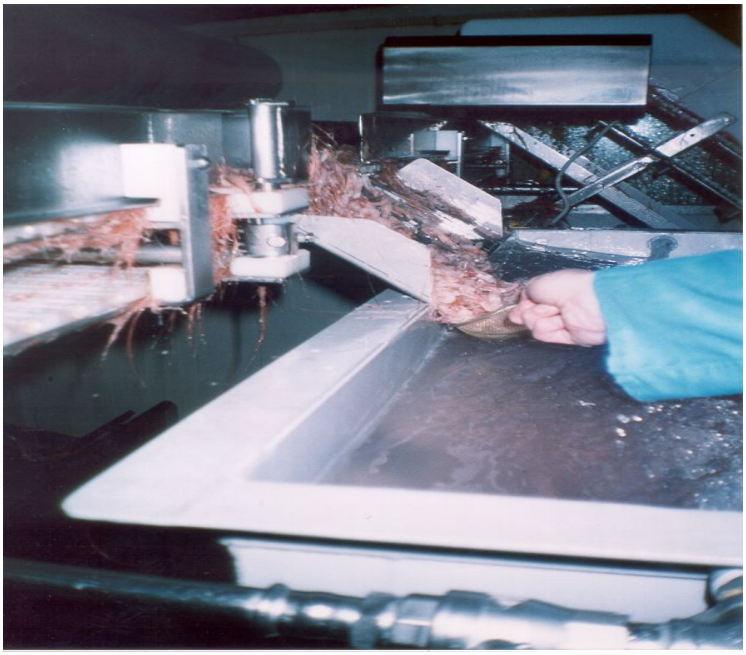


Figure 13: Samples taken from the product in the cooking room.

Figure 14: Samples taken from the shrimp shell below the peeling machine.

Figure 15: Samples taken from the product after peeling.

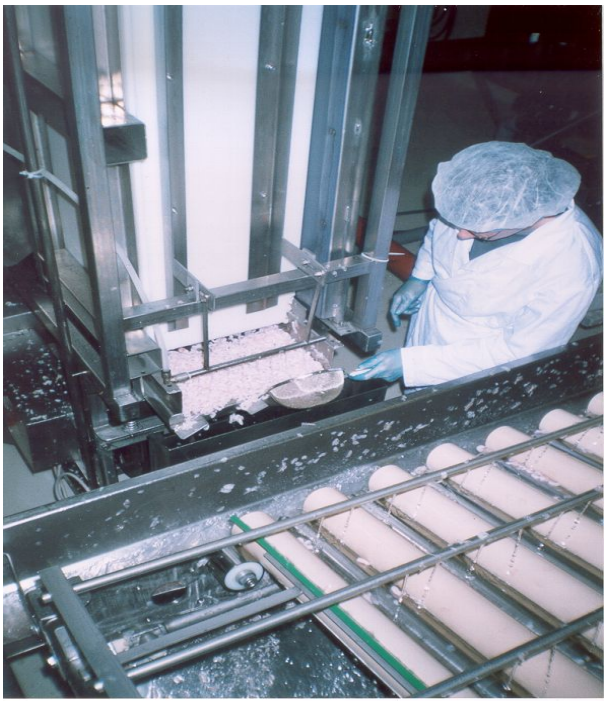


Figure 16: Samples taken from the product after blower.

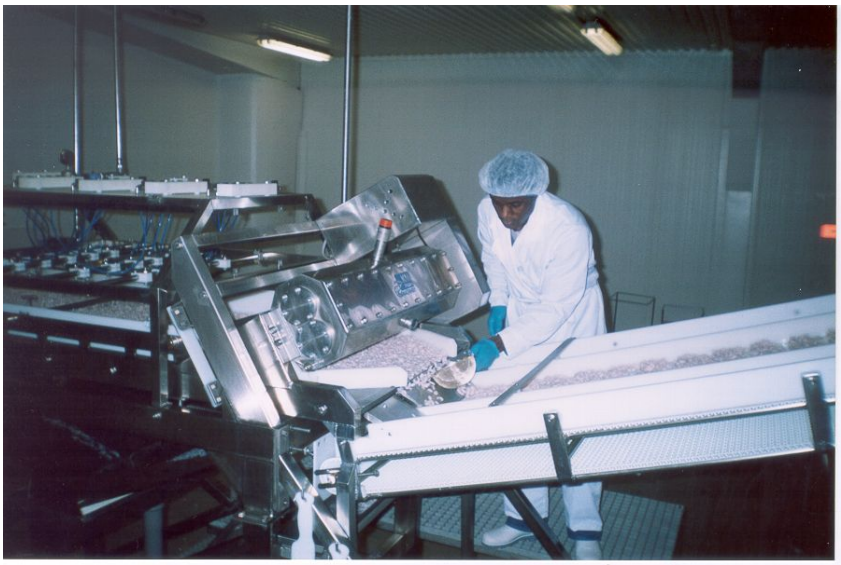


Figure 17: Samples taken from the product after glazing.

Figure 18: Samples taken from the final product in the packing area.

3.4.2 Methods for microbiological analysis

All of the samples were submitted to the microbiological lab for analysis and labelled with a code number. The analyses performed were:

- Total plate count at 30°C
- Total coliform
- Faecal coliform
- *Staphylococcus aureus*
- *Listeria*

The microbiological methods used by the Icelandic Fisheries Laboratories were used for these analysis The basic methodology used in their laboratories is according to the Compendium of Methods for the Microbiological Examination of Foods published by the American Public Health Association (Vanderzant & Splittstoesser 1992). The methods used for individual tests are briefly described below:

Total Plate Count: The conventional "pour-plate" method is used. Counts are done on Plate Count Agar with 0.5% NaCl. Incubation temperatures are either 35 or 30°C. Incubation time is 48 hours. Occasionally, counts at 22°C (72 hours) are used for psychotropic bacteria.

Total and faecal coliforms: The most probable number (MPN) method is used. Preenrichment is in LST broth (35°C for 24/48 hours) and confirmation tests are done in BGLB broth for total coliforms (35°C for 48 hours) and in EC broth for faecal coliforms (44.5°C for 24 hours). Confirmation test for *Escherichia coli* is done by the MUG method (44.5°C for 24 hours).

Staphylococcus aureus: The isolation medium used is Staphylococcus med. No. 110 with egg yolk added. The incubation temperature is 35°C for 72 hours. Typical colonies are tested for coagulase. The staphyslide test (Becton Dickinson) is also sometimes used for confirmation.

Listeria: The methodology for *Listeria* is based on information from the US Department of Agriculture (USDA-FSIS 1989), the (American Public Health Association (APHA) 1992) and others. Enrichment broth is UVM modified *Listeria* broth (30°C for 24 hours). Then they inoculate into Fraser broth (35°C for up to 40 hours). Growth from black tubes is streaked onto Modified Oxford Agar (MOX) (35°C for 48 hours). Confirmation tests are done on five colonies and include Gram-staining, catalase and motility. Species identification includes haemolysis on Blood agar and testing on API Listeria (System for the identification of Listeria, bioMérieux SA/France).

The procedure for all of these analyses is described in Appendix 1.

These are the microbiological limits for peeled and cooked shrimp as stated by the buyers:

TVC at 30°C..... < 1000 CFU/g
Total coliforms..... < 10 MNP/g
Faecal coliforms..... < 0.3 MNP/g
Staphylococcus aureus..... < 10/g
Listeria..... 0 in 25 g

3.4.3 Results and discussion

The results obtained from the survey are shown in Table 3 and in Figures 19 and 20 below.

According to the results obtained from the analysis, it is possible to see that there are a higher number of bacteria at the beginning in the raw material, due to the handling of the product or some other contamination from the environment.

But it needs to be said that other forms of contamination, like faecal coliforms and *Listeria,* were not found in the raw material or in the product. That means that the safety of the product was under control by controlling the time/temperature and hygiene in each step.

Table 3: Results of the analysis of samples taken in Miðfell Shrimp Company.

Samples site	TVC at 30°C (CFU/g)	Total coli. (MPN/g)	Faecal coli (MPN/g)	*Listeria* 25g (Pos/neg)	*S. aureus CFU/g*	T°C
Raw material in tubs	19000	2.8	<0.3	Neg.	-	5.2
Raw material in cooking room	11000	1.1	<0.3	Neg.	-	3.2
Shrimp shell	60	0.4	0.4	Neg.	-	9.1
Product after peeling	40	<0.3	<0.3	Neg.	-	-
Product after blower	80	<0.3	<0.3	Neg.	-	6
Product after hand peeling	400	<0.3	<0.3	Neg.	-	7.5
Product after glazing	960	<0.3	<0.3	Neg.	-	-8.8
Final product	730	<0.3	<0.3	Neg.	< 10	-19.4

The *Staphylococcus aureus* test was made only on the final product. The results in Table 3 show that the number is less than 10 CFU/g. Based on the limits established in the company this means that the product is safe with respect to *S. aureus.*

These results show not only the microbiological aspect, but it also the efficiency of the GMP/SSOP or GHP systems which are in place in the factory and are the pre-requisite systems to ensure good quality and safety products.

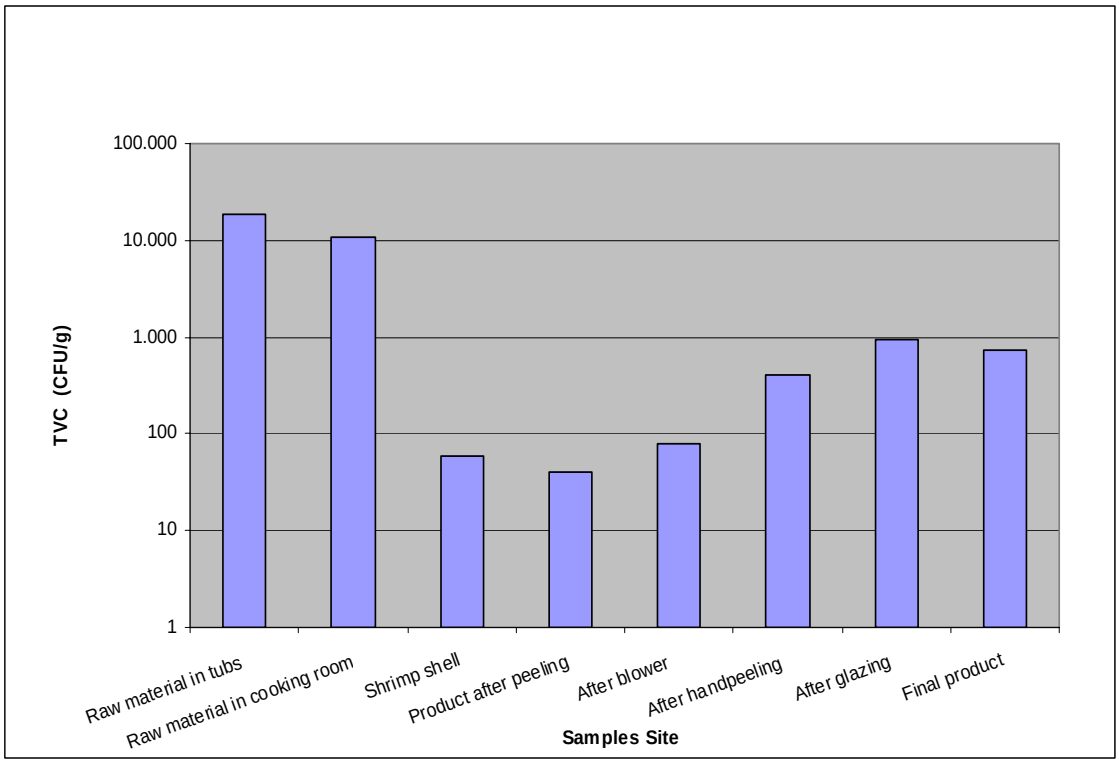


Figure 19: Number of bacteria during the process of peeled and cooked shrimp.

Figure 19, shows how the number of bacteria is reduced after peeling with a value less than 100 CFU/g. This decrease in number of bacteria is because almost 90% of the bacteria are killed in the cooking room. There are increases in the number of bacteria after the blower maybe because of environmental causes, but this does not mean that the product is not safe. In all the cases this number is under the limits established for the company.

The temperature changes (Figure 20) in all of the processing steps were according to the parameters established for each one (see specifications in Appendix 2). The temperature has to be under control at all times because the growth of bacteria is related mainly with this parameter.

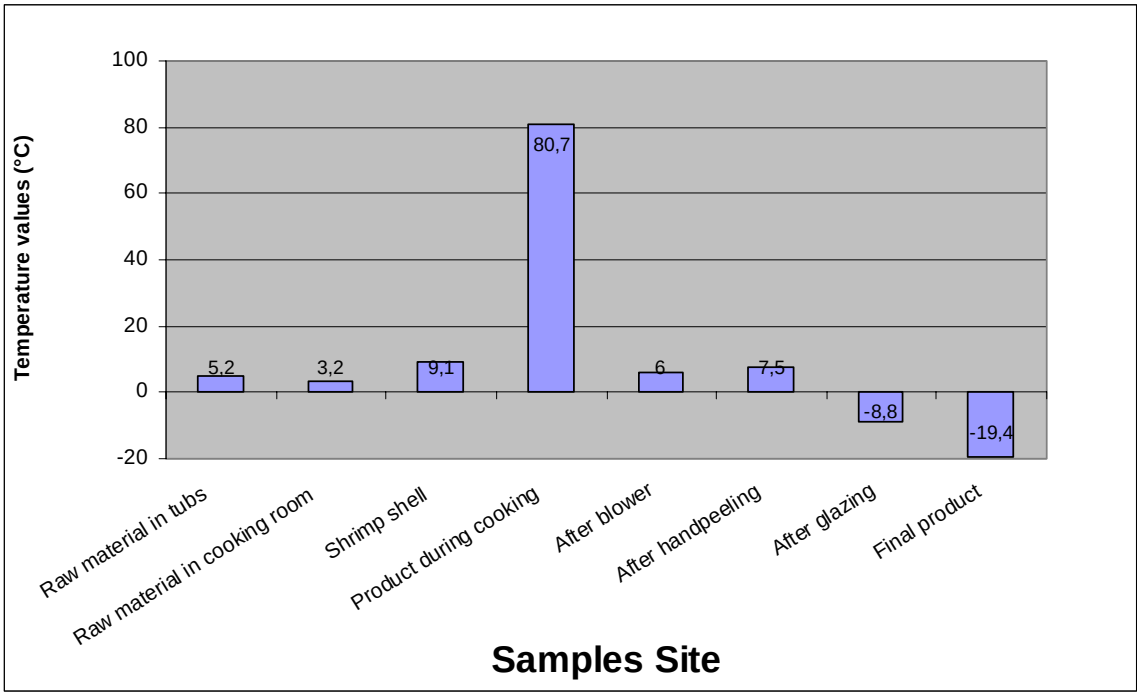


Figure 20: Temperature in the samples at different sampling sites in the processing.

Figure 20 above, shows the temperature at different sampling sites. There is an increase in the temperature during cooking to reduce the number of pathogenic bacteria mainly *Listeria*. In all cases the results of the samples was negative when tested for *Listeria*.

4 CONCLUSIONS

The experiences in the shrimp processing company showed that the quality system that is based on a HACCP system is well documented and implemented. The quality system gives the possibility to ensure food safety. The company has an efficient recall procedure, which is important in case of a problem with the product, as it can help to locate the problem.

The traceability system in this company is based on a good labelling system and record keeping detailing the history of the product. The product can be traced back from the retailer until the catching, using the pallet number to trace the origins of the product. The use of microbiological testing is also an important tool to verify the quality system related to hygiene and the safety of the product and processing line. In case of problems of product contamination the application of traceability is useful to find out what happened with the product during processing.

Understanding how the record keeping regarding traceability works in this company was also a practical experience and useful for fish and seafood processing plants in Cuba. Cuba has a quality system based on HACCP. The experience gained in this study in an Icelandic fish processing company about how the quality system ensures food safety and also how the traceability works in the system, is helpful to promote improvements in the quality system in Cuba.

To be able to implement traceability of fishery products in Cuba before the new regulation on traceability will come into force on 1 January 2005, the main focus will be on improvements of the quality system, in particular regarding some aspects like GMP, GHP and traceability which are part of the prerequisites programmes. The main focus will be on training the people and the quality handbook with detailed procedures about the handling and specifications for the products. The most important factors to ensure traceability of products are: to identify all the links in the processing chain where transactions take place, define the traceable units and label them with unique identifiers. The record keeping will ensure the tracing of the units in the chain.

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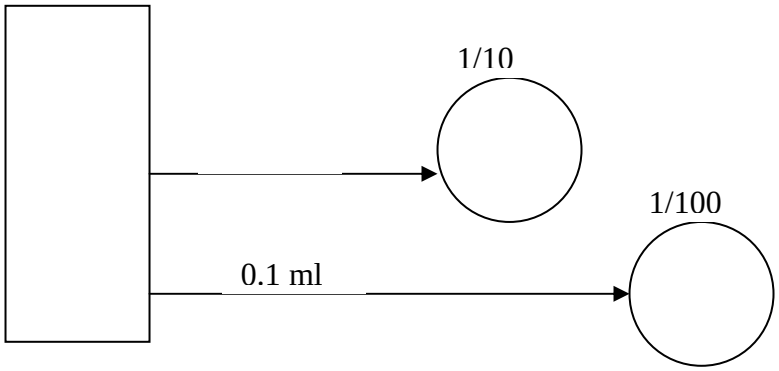
APPENDIX 1: Procedures for analyses

TPC at 30°C

1- Mince the sample.
2- Weigh 25 g of sample.
3- Dilute the sample with 225 g of buffer solution to make 1/10 dilution.
4- 25 g of sample + 225 g of buffer solution have to be blended for 60 s.
5- The dilution sample is transferred with pipettes to the Petri plates as is show in the figure.



6- Melted 45°C agar is poured on the plates and the content mixed.
7- The plates are incubated at 30°C for 48 hours.

For *Listeria*

1- Weigh 25 g of minced sample.
2- Dilute the sample with 225 g of UVM modified *listeria* broth (Enrichment broth)
3- Blend the diluted sample for 60 s.
4- The blended sample is incubated at 30°C for 24 hours.
5- Inoculated into fraser broth (35°C for up to 40 hours).
6- Growth from black tubes is streaked onto Modified Oxford Agar (MOX) (35°C for 48 hours).

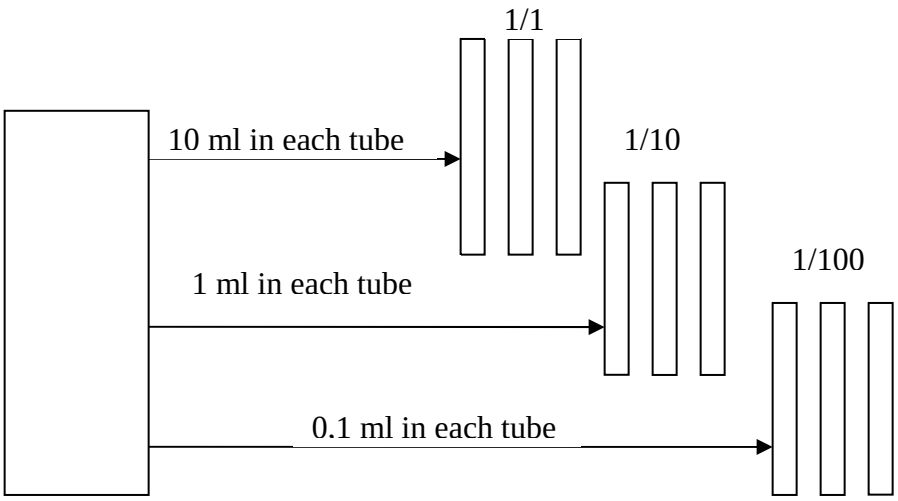
Confirmation tests are done on 5 colonies and include Gram-staining, catalase and motility.

Species identification includes haemolysis on Blood agar and testing on API Listeria (System for the identification of Listeria, bioMérieux SA/France).

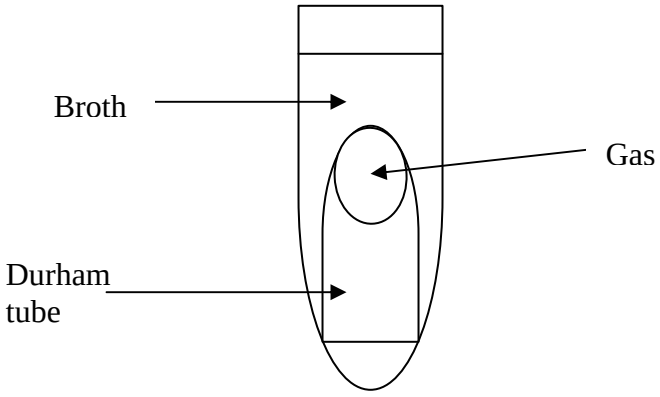
For Total coliforms

1- 25 g of sample + buffer solution (1/10 dilution) is mixed for 60 s.

2- 10, 1 and 0,1 ml of 1/10 dilution are transferred with pipettes to tubes with 10 ml of LST broth.
3- Three tubes are used for each dilution.
4- The first three tubes contain double strength of LST.
The figure show how it's was doing:



The samples are incubated at 35°C for 48 hours.
- Preenrichment is done in Lauryl Sulfate Tryptose (LST) broth
- Confirmed test for total coliforms in Brilliant Green Lactose Bile (BGLB) broth
- Confirmed test for faecal coliforms in EC broth
- All media (LST, BGLB and EC) contain lactose
- Coliforms ferment and produce from it acid and gas
- In all broth tubes are inverted Duram tubes and gas collects in them (See the figure below)

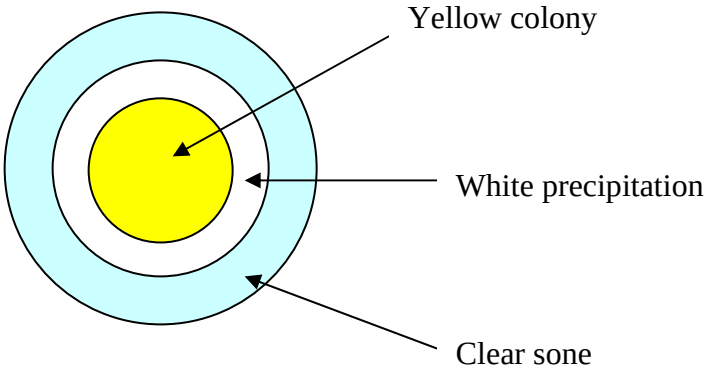


If the result is positive then the positive sample is put in another media

10 ml of BGLB for total coliform and incubated at 35°C for 48 hours. In this growth the coliform less dangerous.
10 ml of EC for faecal coli form and is incubated at 44, 5°C in water bath for 24 hours. The dangerous coliform growth in this media like *E.coli*.
Gas production in BGLB confirms total coliforms and the gas production in EC confirms faecal coliforms.

Staphylococcus aureus

The isolation medium used is Staphylococcus med. No. 110 with egg yolk added.
Incubation temperature is 35°C for 72 hours. Typical colonies are tested for coagulase.



Limits for the final products in Miðfell shrimp company

TVC at 30°C..... < 1000 CFU/g
Total coliforms..... < 10 MNP/g
Faecal coliforms..... < 0,3 MPN/g
Staphylococcus aureus..... < 10/g
Listeria..... 0 in 25 g
Salmonella..... 0 in 25 g
Salt..... 1,5 – 2,2 %

APPENDIX 2 – Product Specification

Iceland Seafood International plc

Product Specification

Species:	PRAWNS	Pack IQF	Internal Code	Spcification No:	176:96
Date:	22.11.02	Specification To Be Replaced, Date	10.12.98	Page 1 of 1	

Standard product
Peeled and cooked prawns.

RECEIVING

Fresh raw material: The prawns have to be fresh with a natural red colour. The prawns may not be older than 6 days from catch. All raw material containers should be labeled with catch date. The raw material must be properly iced (except over the winter season for vessels that discharge on a daily basis), free from foreign objects, chemical and biological pollution. Quantity in containers may not lead to excessive pressure on the raw material. Loading height may not be higher than 60 cm. The raw material must be stored in clean containers.

Frozen raw material: The prawns are to be of a natural colour. The prawns must be processed within 8 months from catch. All raw materials should be labeled with date of catch. The raw material must be free from foreign objects, chemicals and biological pollution. The frozen raw material must be stored in clean containers at a temperature below -18°C.

RAW MATERIAL IN PRODUCTION: Prawn in production may not be older than 6 days from day of catch. Requirements on age of raw material may vary and if so are included in the relevant product description. The prawns must be fresh, with natural colour and odor; samples must be taken for visual and odor inspection. A sample must be taken for cooked flavor inspection if there is any indication of sub-standard material. The raw material must be clean and free from foreign objects, chemical and biological pollution and well iced. The raw material temperature must be between 0°C and 5°C with a target level of <3°C.

COOKING: The in-weighing system must be able to stabilize the flow of prawns that enter the cookers. Stable flow allows the prawns to scatter evenly into cooking and into the machine peelers. The cooking time must be consistent to the size of the prawns processed each time. The core temperature of the prawns must reach at least 72°C for at least 15 seconds, relative to the largest prawn. The accuracy of the temperature probes used must also be taken into account when evaluating the cooking. If any special requirements are for the cooking time/temp. then they are stated in the appropriate product description. **Please note: It can cause a health risk to the consumer if the cooking temperature does not reach 72°C.** Avoid cooking the prawns for too long or at a temperature higher than necessary, it makes the prawns tough. Measure the temperature in a core of a prawn when it comes out of the cooker, do it every 60-min.

Product Specification

Species:	PRAWNS	Pack. IQF	Specification No:	176:96
Date:	22.11.02	Specification To Be Replaced, Date	22.11.02	Page 2 of 4

NB. Always measure the temperature in the largest prawn.

AFTER-PEELING: Even though the flow of prawns through the process is continuos there is always a danger of accumulation on various equipment. It is therefore important that these places be identified and cleaned down regularly during production. Make sure that the prawns scatter evenly on the inspection belt. It is preferred to have the inspection belt fair green.

All shells, legs, hairs and foreign objects must be removed.

If any temporary accumulation of prawns occurs from the inspection table into trays this must be kept to a minimum and cleared at least every hour.

LIGHTING: It is important to have proper lighting for the inspection. Preferred lighting is about 500 lux.

HYGIENE: Prawns are a cooked product that will not be cooked again when it comes to the consumer. It is therefore important that hygiene is kept at a high level. Employees that come into direct contact with the prawns after cooking must wear thin disposable coloured gloves (please note; latex are not allowed) and clean white coats. The protective clothing may only be used in the designated working area; employees must take it off when they leave the working area for coffee breaks or other reasons. Protective clothing for the high-risk area may only be used there and the same thing applies to the low risk area.
All employees must wear hairnets when they are in the working area, no one is allowed to be inside the working area without the proper protective clothing.

Unauthorized or unnecessary passing through the working area should be prohibited at all times. Employees working in the peeling/cooking must take special notice of this, because how close the raw prawns are to the cooked prawns. This applies both during production and cleaning.

STERILIZATION: A sanitizer for hands and gloves must be in place where the employees enter the working area. Nobody is allowed to enter the working area during working hours or after cleaning, without washing and sterilizing his or her hands. All rubber gloves used in the low risk area must be washed with soap and sterilized after work. All chemical used for cleaning/sterilizing must be kept in a separate, locked compartment/ room when not in use.

CHLORINE: The water used in the brine may be mixed with chlorine before adding the salt, the max strength allowed is 1 PPM. Water used to glaze the prawns may also be mixed with chlorine, 1 PPM.

BRINE: When mixing the salt brine it is necessary to register the salt producers lot number. This is required for traceability. The brine is pumped from "low risk" area into "high risk" area. It is therefore necessary to make sure that hygiene rules are observed and that the brine tub is screened off from the main processing environment. It is also necessary to make sure that there is a lid on the tub to prevent the brine from foreign body and dirt. The strength of the brine and the time that the prawns are in the brine should be relative to the fact that the salt content of the prawns must to be between 1,5 and 2,0% (measured with the

Product Specification

Species:	PRAWNS	Pack. IQF	Specification No:	176:96
Date:	22.11.02	Specification To Be Replaced, Date	22.11.02	Page 3 of 4

Volhard method). Measure the salt content of the brine, with a Baumé measuring device, with a 30. min. interval during production. This is done to make sure that the salt content of the brine is within the limits that the production manager has chosen. Add salt into the brine when it is needed. Renew the brine at least once per shift. Chill the brine.

FREEZING: The prawns are IQF. The core temperature of the prawn must drop below -18°C before it comes out of the flow freezer.

GLAZE: The prawns are to be glazed when they come out off the flow freezer. The glazer must be adjusted according to the glaze percentage required in the product description. Measure glaze whenever a sample is taken for count inspection. Confirm that the glaze is according to the requirements in the specification. Measure the glaze with a Codex method.

Codex method

1. Put 1,6 liters of 27°C warm water in a bowl.
2. Weigh 200g of prawns (V0) and put them into the water for 30 sec. Stir the prawns with your hands to prevent it from freezing into clumps.
3. Pour the prawns into a sieve that has a 20 cm diameter with a mesh size of 2.8 mm. Have the sieve stand in a 20° slope for 2 minutes.
4. Remove the prawns from the sieve and weigh them again (V1).
5. Calculate % glaze with the following formula:

$$\% \text{ glaze} = \frac{\text{glazed weight (V0) - de-glazed weight (V1) X 100}}{\text{glazed weight (V0)}}$$

INSPECTION: A product inspection must be conducted for every code in production, at least every 60 min. Permitted maximum number of defects in finished product is 5 defects pr lb. unless otherwise stated in product description. Record the results of the inspections on inspection forms (see guidelines regarding production inspection of prawns), send the white copy to ISI, the red copy with the product to the customer and keep the yellow copy for your files.

CHEMICAL AND-MICROBIOLOGICAL MEASUREMENTS: Sample must be taken for each production date.
Sample size should be minimum 200 g. unless otherwise stated. The sample should be marked with producer, production date and no. and sent at least weekly.
If a sample is not sent directly to a laboratory, Iceland Seafood Int'l should be informed when sent.

Product Specification

Species:	PRAWNS	Pack. IQF		Specification No:	176:96
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LABELING: Each bag should be marked especially with EU-Agreement Number, Julian Code and Best Before Date, or as stated in the product description.

Mark outer cases with a special label for each production number. Check markings; i.e. plant no., day code and best before date before production starts.

COLD STORE: The production should be kept in coldstore where temperature should never be higher than -18°C.

TRANSPORTATION: During loading and transport care must be taken to minimize the time outside the coldstore and that measures are taken to protect the product from rain and sun. The producer must measure temperature in product at time of loading.

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APPENDIX 3: Production Specification

PRODUCTION SPECIFICATION

Spec:	Prawns	Pack: 6x2 kg. 1x12 kg.	Code:	Spec. No.:	10:2003
Date:	23.01.03	Spec. to be replaced, date:	22.12.98	Page 1 of 3	

Product description P349-359, P818-829, P649-659, P800-809

Ref. to General Production Specification for Prawns No. 176:96

Raw material:	See 176:96.
1. Packing:	Bags: 2 kg. for P349-359 and P649-659. carton no: 86 6x2 kg. Pallet standard: no. 58:93 78 cases per pallet. Bags: 12 kg. for P818-829 and P800-809 Carton no: 74 1x12 kg. Pallet standard: Same as for carton no 86. 78 cases per pallet.
2. Marking:	Each master carton is marked. The information includes product number, product description, grade, gross weight including glaze and packaging description. The label should also state EU-Agreement Number, production day and plant number in julien code, and best before end month, year.
3. Best before end:	Best before end is = from production day + 18 months.
4. Distribution and Transportation:	The temperature after freezing must be below -18°C. During transport allowable variation is +3°C.
5. Sample:	After packing a sample must be taken from any bag within the product code for bacterial and chemical inspection. Sample size should be 400g i.e. 200 g. for inspection and 200 g. kept as a back-up sample.
6. Weight::	The pack weight, including glaze, must be the stated weight, ie 2 kg or 12 kg.
7. Count:	Total count of prawns, including glaze and pieces, must be within the stated grade (see table on page 3).
8. Defects:	The prawns are to be free of all shell, legs, feelers and other residues. Note that defects may vary depending on size grading, see table on page 3.

Spec:	Prawns	Pack:	6x2 kg. 1x12 kg.	Code:		Spec. No.:	10:2003
Date:	23.01.03	Spec. to be replaced, date:		22.12.98		Page 2 of 3	

9. Clumps: A maximum amount of clumps is 5% per sample. A clumps is two or three prawns fused together that fall easily apart under pressure of two fingers. Four or more prawns fused together or harder clumps are not allowed.

10. Bits: Please note that in size grade 400/600 and smaller the total count applies, i.e. whole prawns + bits must meet the count.

11. Glaze: Various depending on size grades, see table on page 3.

12. Salt: The target salt level content is between 1,5-2% titrated according to Volhard method. Rejection level is 2.2%.

13. Appearance: The prawns should have a good red/pink colour, or otherwise characteristic for the product, without yellowing or blackening.

14. Texture: After thawing prawns should be firm and succulent typical of good quality frozen product.

15. Flavour/Odour: No sample should be below 3 according to scale below:

	Flavour	Odour
5	Sweet, fresh prawn/shellfish	Very fresh sea/seaweed
4	Slight sweet prawn/shellfish	Fresh normal
3	Neutral	Neutral
2	Slight fishy	Slight ammonium, fishy
1	Distinct fishy, strong after taste	Strong ammonium, even sour or off smell

16. Microbiological standards -
Finished Product

	Good	Accept	Reject
TVC/g 30°C	< 50.000	> 50.000-100.000	> 100.000
Total coliforms MPN/g	<10	10-100	>100
Faecal coliforms MPN/g	<0,3	0,3-1,0	>1,0
Staphylococcus aureus/g	<10	10-50	>50
Listeria in 25 g.	Absent	Absent	Present
Salmonella in 25 g.	Absent	Absent	Present

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APPENDIX 4: Glass Policy

GLASS POLICY

Glass and monitoring of glass in production areas

Monitoring of glass is a large factor in preventive measures of possible foreign bodies in the quality system of the company. The entire production environment has been examined, the location of all glass documented and, were possible, glass been replaced. A glass list has been made of all unreplaceable glass and this list is audited every morning before production starts. If any glass is found to be broken this is documented along with the immediate action.

When equipment is renewed in the plant it is checked to conformance for the above.

Reaction to broken glass.

The following reaction is followed when glass breaks over or near the processing environment. This has been introduced to all members of staff, including maintenance and cleaning crew and is a part of their training:

1. Stop the production immediately and report to the production manager/foreman.
2. Inspect the immediate area, up to 10 meter radius, for glass and remove the glass from the production environment.
3. Remove and discard all products from the immediate area of the glass breakage.
4. Remove and discard all packaging material in and around the glass breakage area and might contain glass splinters.
5. Wash the relevant processing area.
6. Before processing commences a member of the plant management must inspect the relevant area and sign off that the above rules have been followed.

If any member of staff's spectacles break in the processing environment the same rules apply.

All utensils used to clean up the glass are removed from the production area and discarded or cleaned especially. The same applies to the container used for the broken glass. Additionally the boots and other protective clothing used by staff when removing the broken glass and securing the area are cleaned especially.

Any incident as described above is documented a long with the processing area, the production date and the time when production was stopped and when it started up again. A member of the production management must sign this report.

APPENDIX 5: General Rules and Guidelines for Suppliers

GENERAL RULES AND GUIDLINES FOR THE EVALUATION OF SUPPLIERS OF RAW MATERIAL INTO PROCESSING OF COOKED AND PEELED PRAWNS

1. All suppliers must have a licence recognized by the Directorate of Fisheries in Iceland and therefore comply with the relevant laws and regulations of the EU including the EU hygiene directive.

2. That the supplier complies, as a minimum, to all the official demands with regards to production, labelling and sales of seafood according to the appropriate laws and regulations.

3. That the supplier has a documented record of the condition and origin of the raw material and that traceability is in place and secured on all stages.

4. Will have secure access to all information for the relevant material and the authority to audit the material before accepting to verify the compliance to the appropriate conditions.

APPENDIX 6: Hygiene and clothing rules

Hygiene and clothing rules

1. It is strictly forbidden to wear nail polish , rings, earrings and any other jewellery, except for wedding rings.
2. Working shoes, boots, gloves and aprons are always washed with soap and clean water when work is finished. All employees must wash their hands with soap when they enter the work area and after every trip to the toilet. Use brushes rather than paper towels to clean the boots.
3. The employees change protective coats at least twice a week, more often if it is necessary.
4. Smoking, consumption of sweets, food or drinks is only allowed in canteens and private offices. Smoking is not allowed anywhere in the workng area.
5. All glass, including coffee cups and bottles, is forbidden in the working area.
6. The employees personal clothing must be tidy and the protective clothing must cover it well.
7. It is strictly forbidden to leave aprons, gloves or any other protective clothing on the production lines or anywhere in the working area.
8. Chewing gum is absolutely forbidden anywhere on the premises.

How to enter the working area

1. Remove all unauthorised things in the changing room.
2. Put the hair-net on first, make sure that it covers your hair perfectly.
3. Put the protective coat on and button it.
4. Remove your personal shoes and put on factory issued boots.
5. Wash your hands with soap and water.
6. Put on an apron. Put on gloves, if you use gloves, and wash them with soap and water everytime before you enter the work area.
7. Step into the washing tub and you are allowed to enter the work area.

You must wash your hands and gloves with soap and water and step into the tub every time you enter the working area.

Start with no. 1, then no. 2 and work you way to no. 7

APPENDIX 7: Training of Staff

TRAINING OF STAFF.

I have gone over and understood the following:

- ✓ The nature of the production (fully cooked product – high risk product)
- ✓ General house rules:
  - ✓ Use of jewelry
  - ✓ Use of food, drink, alcohol and other intoxicating substances.
  - ✓ Use of foodstuff.
- ✓ Glass policy and rules.
- ✓ Prevention of foreign body contamination
- ✓ Protective clothing including hairnets, disposable gloves, footwear etc.
- ✓ Changing procedures for high/low risk areas.
- ✓ The risk of contamination in handling of high risk product
- ✓ Reason for health supervision of food handlers in high-risk factories.
- ✓ Why the rules are in place.
- ✓ Procedure for return from work after sickness.

_____
Date

_____
Sign.

_____
Supervisor.

APPENDIX 8: Visitor's Questionnaire

VISITOR'S QUESTIONAIRE

NAME.....

ORGANISATION .....

DATE .....

		Yes	No
1.	Have you recently suffered any sickness, diarrhoea or stomach disorder in the last 3 weeks		
2.	Have you been in contact with anyone with the above symptoms		
3.	Have you any history of or contact with Typhoid or Paratyphoid.		
4.	Have you any history of or contact with Hepatitis or Jaundice.		
5.	Have you any history of skin conditions, eczema, dermatitis, boils or septic fingers.		
6.	Have you any history of disease of, or discharges from the ears, nose or eyes		
7.	Have you any history of dental hygiene issues		
8.	Have you any history of bronchitis ad productive cough		
9.	Have you visited any countries outside the EU over the last 3 weeks		

If the answer is yes to any of the above questions you must report this to the Production Manager/Quality Manager before entering the factory.

APPENDIX 9: Calibration form

Calibration form

Number of scale/thermometer:_____

Date	Method	Value	Result	Deviation	Actions	Name

1. **Always calibrate the measuring equipment before use.**
2. Write the date in the first column.
3. Write what method is used for the calibration in column two.
4. Write the value that the measuring equipment is supposed to show, like the weight of the weight in column three.
5. Write the result (reading of the measuring equipment) in column four.
6. Write the difference between the value and the result in column five.
7. Confirm that the measuring equipment has passed the calibration test by writing O.K. in column six, write what actions you took if the equipment did not pass the test.
8. Write the initials of the person that did the calibration in column seven.

APPENDIX 10: Haccp-Safety and Quality points

Haccp – Safety and Quality points – nr.3 **Prawn processing** 11/4/2003

	Production step Hazard	Monitoring frequency (Documentation)	Preventive measures	Parameter range Control limits	Actions	Reference	Operation Responsib.
1 Q	**Receiving** Overall quality of raw material	Temperature rec. Use of ice Sensoric properties - general visual inspection Each lot	Chilling of raw material on board vessel General rules of handling on board	Raw material assessment acceptable or better. Ice visible Temp in raw mat 0-4°C Temp in raw mat 0-7°C	Raw material chilled in iced water , sensoric evaluation. Decomposed raw material destroyed	Raw material purchasing rules	Forman in reception *Production manager*
	Traceability	Day catch labeling All containers	Correct labeling of catch on board vessel	None	Unlabelled raw material evaluated especially and produced with older raw material if necessary	Raw material purchasing rules	Forman in reception *Production manager*
2 Q	**Chiller** Decomposition	Temperature Continuous monitoring of chiller Hourly temp check of raw material	Raw mat well iced. Temp in chiller 0-3°C. Keep door to chiller closed as much as possible. Sanitation according to sanitat plan	Raw material assessment acceptable or better. Ice visible Temp in raw material 0-4°C Temp in raw material 0-7°C	Raw material chilled in iced water, sensoric evaluation. Decomposed raw material destroyed	Specification Product description	Forman in reception *Production manager*
3 S	**Cooking** Survival of listeria	Core temp. of prawn on exit from cooker 1xhour. Temp profile start of each shift and at change of lots	Steam temp and pressure according to procedure. Calibrations of probes. Training of staff.	Profile according to specification but at least over 73°C for at least 15 sec. (must be eq. to 33 sec at 72°C)	If below, line stopped and redirected for re-cooking. Prawn since last check evaluated.	Specification Product description	QC *Production manager*
4 S	**Inspection belt** Foreign body	Continuous checking by staff at inspection belt	Training of staff Correct adjustment of peelers	None	Any non-bycatch foreign body reported to production manager. Bycatch increase – adjust peeling	Specification Product description	Staff at inspection belt *Production manager*
5 Q	**Brine** Concentration of salt in product	Brine system adjusted at start of production	Training of staff Clear instructions	Brine strength 9 – 11%	Brine concentration adjusted	Quality manual Cleaning instructions	QC *Engineer*

(Cont. Appendix 10)

	Production step Hazard	Monitoring frequency Documentation	Preventive measures	Parameter range Control limits	Actions	Reference	Operation Responsib.
6 Q	**Glaze** Weight	Glaze measured acc. to modified Codex. 1x 30-60 min	Equal water pressure. Conveyor speed	Temp in prawn from flow freezer. According to product specification for individual product.	Glaze too low - re-glaze Other - labeled and handled according to rules for non-conforming product	Specification Product descriptions	QC *Production manager*
7 Q	**Product quality** Product inspection	Count Bits Shells By-catch	Adjustment of equipment Training of personnel	According to specifications	Re-label if not according to specification.	Product description	QC *Production manager*
8 Q	**Print/pack** Labeling of bags	Correct and clear information acc to product description	Setting of printer at start of each shift.	None	If not acc to product description then adjust printer and repack.	Product specification Product descriptions	QC *Production manager*
9 S	**Metal detection** Metal	Test of metal detector, using test pieces. 1 x 30 – 60min.	Correctly adjust equipment at beginning of shift. Training of personnel.	Absence of metal in finished product. Limits of detection Ferrous: 2,0 mm Non ferrous: 2.5 mm Stainless steel: 4.0	If test fails reset detector and recheck previous production	Product description Code of practice	QC *Production manager*
10 Q	**Checkweight** Product weight	Weight of bags Continuous	Correctly adjust equipment at beginning of shift. Training of personnel. Calibration	According to product specification and "e" (average weight) regulations.	All bags below weight are rejected and repacked.	Product description	QC *Production manager*
	Microbiological standard	Sample for analysis Daily Results from IFL*	General hygiene rules Training of staff	Microbiological results good Microbiological results acceptable	Product labeled as non-conforming or destroyed	Product description	QC *Production manager*
11 Q	**Packing into cartons** Label	Product- and daycoding inspected Beginning of shift	Training of personnel in pack 2	None	Re-label	Product description	QC *Production manager*
12 Q	**Temp in product**	Temp measured 2x per shift	Temp of product from freezer below -18°C and placing of product as quickly as possible into cold store	Temp in product before entering cold store to be below -18°C	Product separated into cold store and evaluated acc clumping, glaze and temp after 24 hours	Product description	QC *Production manager*

	Production step Hazard	Monitoring frequency Documentation	Preventive measures	Parameter range Control limits	Actions	Reference	Operation Responsib.
13 Q	Cold store Temperature	Continuous recording of temp in cold store	Temp < -22°C Limit time that doors are open. De-ice regularly	Temp <-18°C	Adjust temp in cold store	Quality manual	Foreman at cold store Production manager
14 Q	Transport Temp of product	Temp of product at time of dispatch	Temp < -22°C Limit time that doors are open. De-ice regularly	Temp of product <-20°C	Evaluate with transport company the fitness of the product for transport	QM Transport comp. code of practice	Foreman at cold store Production manager