Quality and Standards in Sardines

Pacific Sardine Association

Manual 2001

Quality and Standards in Sardines Manual 2001

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Executive Summary

"Quality sells first" is a well-known rule in the fishing industry. This means that fishermen and processors are always striving to get and keep quality. Exactly what constitutes quality is sometimes a matter of opinion. This manual attempts to provide some objectives standards by which quality can be measured. Further, it attempts to show how good handling practices can achieve higher quality. None of this is complex, it merely requires an awareness that fish quality deteriorates through time and vigilance is required at every stage of the production and marketing process.

Sardines are delicate and present some unique problems in handling. Their physical characteristics must be understood in designing procedures in ensuring quality. Fishermen have learned about quality in the salmon industry and adopted better handling procedures. This manual builds upon the lessons learned there. The enemies are time and poor handling procedures. But to combat them some measurable standards and procedures should be used by the industry. Foremost is the desire for quality and the market will ensure that those who have a quality product will always be able to sell it at a premium price.

This Manual provides some very specific guidelines and procedures in the handling of sardines and makes recommendations for quality standards. Each vessel and plant will obviously develop their own procedures but they will have a good baseline of knowledge from the work done here. Finally, some recognition must be given to John Lenic of the *FV Ocean Marauder* and Byron Wright of the *FV Prosperity* for their advice and expertise used here for the handling of sardines to achieve the highest quality.

The Pacific Sardine Association wants to actively promote quality standards in the sardine fishery. Any comments on this Manual and any related quality issues would be welcome.

Don Pepper, Executive Director

INTRODUCTION

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Glossary of Terms

CFIA	Canadian Food Inspection Agency
HACCP	Hazard Analysis and Critical Control Point
HEM	Hazardous Extraneous Material
ORGANOLEPTIC	Sensory properties of the food such as odour texture and flavour
QMPR	Quality Management Program Re-engineered
RAP	Regulatory Action Plan
SOP	Standard Operation Procedure
TDU	Tainted, Degraded and Unwholesome

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Objective

The objective of this manual is to increase the awareness of quality problems in the care and handling of sardines. This manual is also a continuation of the Quality Guidelines and Generic HACCP Plan that was prepared by the Pacific Sardine Association in January 2000. This manual is to be used in conjunction with the previous document to develop on vessel and at plant operating procedures. Implementation of the guidelines for handling and processing will result in a product that merits the Pacific Sardine Association "Seal of Quality".

Introduction

The Problem

Sardines that are not handled (properly) at all stages of fishing and processing present a lost opportunity in revenues. Poorly processed sardines from BC would create a market image that would be difficult to overcome. Quality is an issue that must be of concern at all levels to avoid any negative consequences. In addition, fierce competition form US suppliers of sardines at lower prices and higher volumes make it necessary for BC to focus on a higher grade product that can command higher prices and guaranteed sales.

Quality is the avenue to sales in the highly competitive market for sardines. The market for lower quality sardines for tuna farms and bait is large but has many suppliers. BC can compete in this market based upon two factors: large size and higher quality. To compete in the developing food market requires even higher standards of quality. Grading systems that standardize quality attributes have been proven effective in raising revenues for fish products.

The Opportunity

Figure 1 lists the quality attributes that make BC sardines distinctive. These attributes are affected upon the time of year and the area fished. This product can fit into several market niches. California producers supplying the Australian tuna farms receive the lowest prices. These sardines are used as feed. The market currently of interest to BC producers is the tuna bait market. The sardines are used as bait by the tuna longliners. This market requires fish of a certain size and the emphasis is upon quality. For this market BC producers must be aware of product packaging, size and quality. If these are of a high standard, then a premium price is available.

Figure 1

Quality Attributes of Pacific Sardines
Large Size: 150 –225 grams
High Fat Content: < 25%

INTRODUCTION

BC producers are slowly making inroads into the Far East food markets. To enter this market and maintain market share the quality of the sardines must be of the highest attainable. For high quality, high prices are received. To develop this market BC must prove that it has quality standards in place. A consistent supply of high quality sardines commanding the highest prices is the objective for the BC producer.

Quality in Sardines (characteristics)

What is a high quality sardine? Characteristics such as appearance, flavour, odour, texture and freshness are part of the elements that make up a sardine that buyers will pay the highest price for. Each of these characteristics has the problem of being subjective, depending upon individual preferences and perceptions. The challenge is to develop guidelines and standards the clearly state the degree of quality related to each element.

For example, "freshness" relates to the distance between when the sardine is caught and when it reaches the end consumer. What is an acceptable time limit? Much depends upon how the sardine is handled but it is difficult to put a number to "freshness". Most research focuses upon bacterial spoilage, chemical changes and the shelf life of fish. Conversely in Japan and Europe much recent research has been on measuring freshness and quality In Japan the chemical score for freshness is often displayed on the label of the product. The chemical score is a measure of the chemical changes in fish flesh.

Because quality in sardines usually declines as these chemical processes take place it is possible to develop some standards that define quality. Most of them relate to the handling and processing methods and their impact upon the final product. Good techniques result in high quality. High quality can be determined by noting what produces low quality. Low quality is defined by the loss of a number of objective characteristics, mainly deterioration of the flesh. This deterioration begins to show itself externally. The challenge here is for producer to use methods that arrest this decline. Further, producers and consumers must know what constitutes a high quality sardine.

Biology of Sardines

Several aspects of the life history of sardines affect the quality of the product. Genetics controls the size and shape of sardines but oil content is also important. These latter factors are related to maturity. Sardines in BC waters grow in size through the season and increase the oil content of the fish.

Intrinsic Qualities

Intrinsic quality refers to unique characteristics of the species an include such factors as size, colour of skin and flesh, oil content, flesh texture and other physical attributes. Obviously, intrinsic quality will vary with the stage of maturity, age and the season of catch.

Extrinsic Quality

Extrinsic Quality refers to the changes in sardine flesh that take place after the fish is caught and in the processing stage. Certain bacteria changes and chemical changes cannot be stopped but can be slowed by proper and prompt handling and processing. Poor bruising from incorrect pumping, poor processing or contamination result in a product that is unacceptable in the market.

Fish Maturity

Sardines undergo a variety of changes as they mature. By the time they reach BC waters they are about 150 grams and have a little as 12 percent fat. Through the summer as they feed they grow they can reach 225 grams and 25 percent oil content in September. Thus, buyers need to know fish size and oil content. This is necessary because some are for the bait market and others for food.

The Problem of Rigor Mortis.

"Rigor mortis" loosely translated means "stiff when dead". Prior to death a sardine is bright and limber. While alive, the fish controls the breakdown of high-energy compounds and enzyme activity through temperature controls. When the fish dies all these systems collapse. Rigor mortis is the first result. Chemical changes cause contractions of the muscle tissue connected to the skeleton. Now the fish is in rigor. Soon after that, post-rigor mortis begins. The high-energy compounds come with the oxidation of glycogen. This produces lactic acid and this in turn causes the flesh to become acidic as the pH rises. This inhibits bacteria growth for a while but then as the fish comes out of rigor it becomes flaccid. Bacteria increase and spoilage is underway.

Temperature controls the time of pre-rigor and rigor mortis, because it controls the rate of chemical reactions. The higher the temperature, the faster the reaction rates, the faster the sardine deteriorates. Simply put, extending the rigor period is one of the keys to quality. Putting the sardines quickly into RSW and CSW is one sure method.

Even with the best handling techniques, quality deteriorates from the "fresh" state. An understanding of this process and the methods to prevent and slow it are a key to quality.

Causes Of Quality Problems

Physical Appearance

The physical appearance of sardines is important for both the bait and the food market. The external appearance should be free of cuts and damage and this is usually done by the use of a "grading" table where imperfect sardines are discarded. Good pumping or brailing techniques minimize his problem.

Mushy flesh

Mushy flesh is caused from the chemical breakdown from physical damage or enzyme and bacterial action. Mushy flesh affects the texture desired by the sushi trade. In the bait market mushy sardines will not stay on the hook.

Enzyme Action

Enzymes are chemical compounds that act as catalysts in chemical reactions. A general softening of the flesh of the sardine results due to enzyme activity. Proper chilling of the fish will reduce the rate of enzyme activity because enzyme activity increases with increased temperature.

Handling of fish also affects enzyme activity. Disruption of the integrity of the fish due to crushing during pumping and pressure due to weight in the hold increases the rate of enzymatic activity.

Finally, the maturity of the fish will also affect activity rate. Immature sardines become soft almost immediately. Enzyme activity declines with age.

Bacterial Spoilage

Handling and temperature control are also key factors in bacterial spoilage of fish. The bacteria inherent on the skin (exterior) of the fish are dormant until the skin is broken. These bacteria are generally protein-digesting bacteria and will degrade the flesh.

Proper temperature control will slow the rate of bacterial spoilage. As with enzyme reactions, the higher the temperature the faster bacterial populations increase. The bacterial load can also increase due to improper

Q U A L I T Y P R O B L E M S

handling. Bacteria can be added to the product from anything that the fish contacts. Sanitation procedures and personnel training will reduce the risk of bacterial spoilage on board.

Rancidity

The oil content of Sardines varies from 12 to 25% (w/w). Oxidation of oils results in rancidity. Figure 2 lists 4 factors that affect the rate of lipid oxidation. Oxidation reactions will begin soon after the fish is dead. Although affected by temperature, the rate is much slower than bacterial spoilage or enzymatic activity. Fish handling and temperature control practices designed to reduce bacterial spoilage and enzyme activity will also ensure that lipid oxidation is minimized.

Figure 2

Factors Affecting Rate of Lipid Oxidation
Temperature
Sunlight
Oxygen
Iron and Copper Ions

Handling Techniques

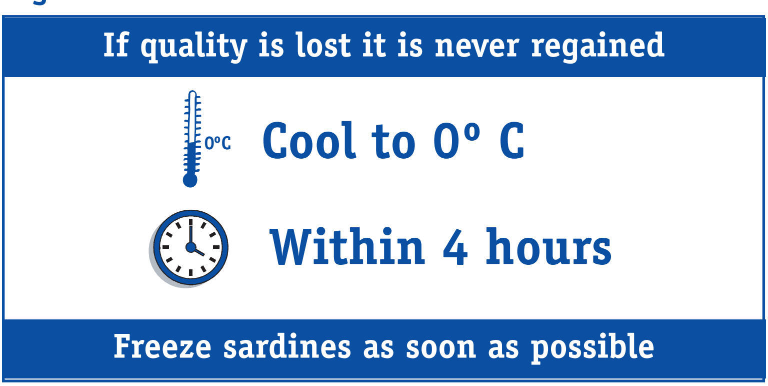
The previous discussion on the causes of quality problems emphasises the importance of temperature control and handling practices throughout the harvesting process. Fishermen and plant personnel must pay attention to the adage " If quality is lost, it is never regained". In the next section, handling techniques are discussed. Both on board vessel and at plant handling procedures are discussed. This information will help the fishermen develop their own practices to ensure adherence to quality standards.

The role of temperature and time

Experiential evidence has demonstrated that sardines of excellent quality can be achieved if the sardines are frozen as soon as possible after catching. With the large distance between the fishing grounds and plant in some cases, extensive care is required. While Frozen-at-Sea (FAS) is the optimum method only a few vessels in BC are capable of this. The Pacific Sardine Association recommends that vessels be equipped with chilling equipment that can cool the sardines to 0°C within 4 hours. Both Refrigerated-Sea-Water (RSW) and Chilled Sea Water (CSW) systems can achieve this cooling rate.

However, key to this is time. The longer fish is retained in less than optimal conditions, the more it deteriorates. The next section of this manual describes the Vessel Chilling Methods and Plant Freezing Methods that are available to the industry to protect against such deterioration.

Figure 3



V E S S E L C H I L L I N G

Vessel Chilling methods

The goal in vessel chilling methods is to reduce the temperature of the fish to 0°C within 4 hours after hauling the fish. Holding temperatures between 31° to 32°F (-0.56° to 0°C) are recommended. The purpose of this is to extend the rigor phase to ensure a sardine of good texture. The Pacific Sardine Association recommends the use of Chilled Sea Water (CSW) or Refrigerated Sea Water (RSW) to accomplish this cooling rate. Proper operation of these systems will ensure fish that meets the PSA Quality Standards. A comparison of these two chilling methods is outlined in Table 1. Important operating considerations for both systems are also discussed.

Table 1

Comparison of Vessel Chilling Methods		
Chilling Methods	Advantages	Disadvantages
Chilled Sea Water (CSW) Sea water chilled with ice and mixed using air, also known as "champagne ice"	• Low labour input needed for fish stowage • Has a simple mechanical system • Fish are maintained at a constant temperature of 31°F in properly designed systems • Cheaper to install and operate than RSW	• Maximum storage time is shorter than that of ice because fish spoil faster • Scale loss can be server in heavy weather • High ice requirement needed to cool both water and fish
Refrigerated Sea Water (RSW) Sea water chilled with on board refrigeration equipment, may have additional salt added to system	• Low labour input needed for fish stowage • No ice requirement and can operate anywhere clean sea water is available • Lower temperature than CSW	• Shorter maximum storage time because fish spoil faster • High initial cost and operating costs • Requires skilled operators • No backup available in case of system failure • Greater temperature fluctuations than CSE

Chilled Sea water (CSW)

A typical CSW system is shown in Plate 1. This chilling method is sometimes called champagne ice because air is used to mix the seawater, ice and fish.

Plate 1

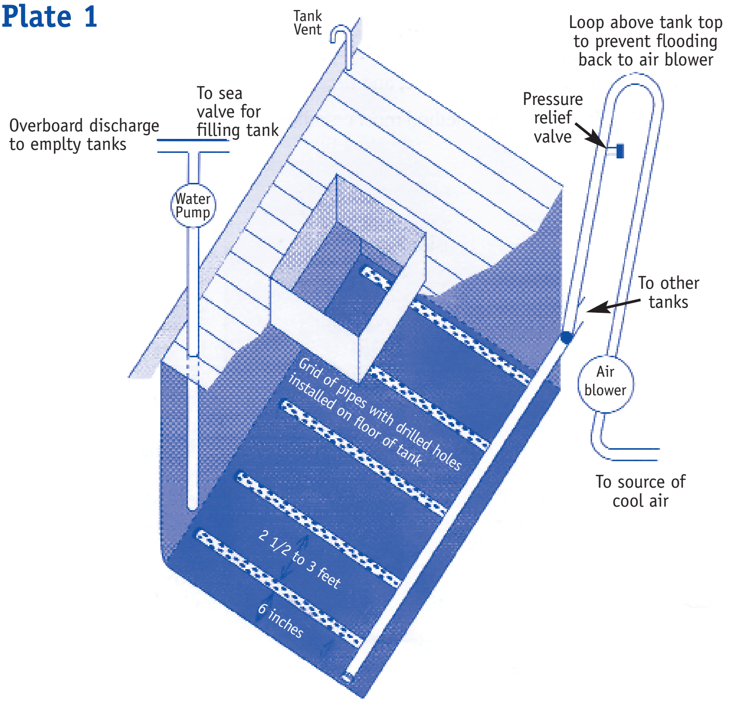


Diagram of a chilled sea water system. Air is bubbled through the holes in the grid of pipes on the floor of the tank to agitate the ice-fish-sea water mixture. Adapted from Kramer (1980).

Successful operation of CSW requires sufficient ice and proper mixing of the ice, seawater and fish. The amount of ice required for a trip is a critical calculation that depends on a number of factors (See Figure X) Running out of ice may result in a lost load of fish.

Variation of temperature is a problem in CSW. Several of operating techniques help to reduce this problem.
These include:

- Chill hold and sea water to 31°F before addition of first lot fish
- Determine optimum loading rate for specific vessel system

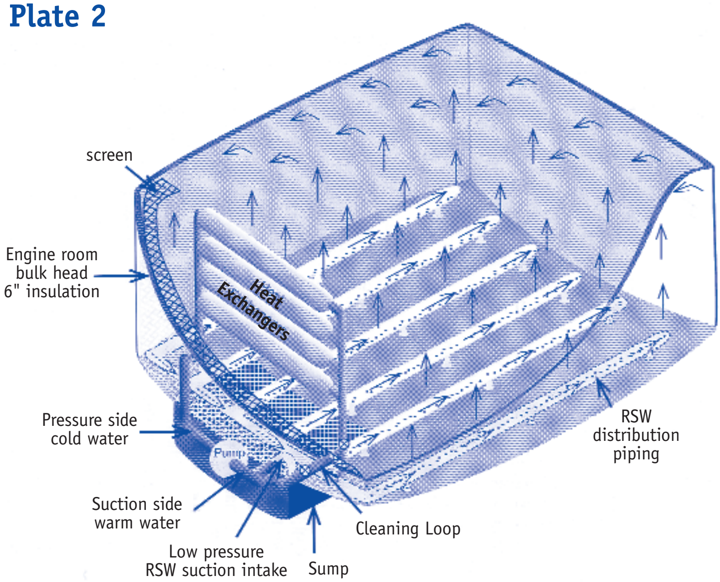
V E S S E L C H I L L I N G

- Prevent warm spots and stratification with good air agitation.
- Continue agitation until desired temperature is reached and cycle accordingly.

Refrigerated Sea water (RSW)

A typical RSW system is shown in Plate 2. Ensuring the vessel has sufficient refrigeration capacity is the most important factor for a RSW system. This is a critical consideration given the distance to sardine fishing grounds and duration of these trips.

Plate 2



Schematic of an upwelling refrigerated sea water (RSW) system. This RSW system will force cold water through the mass of fish, which will provide an even temperature throughout the hold.

The temperature differential between the refrigerant and the seawater controls the rate of heat removal. Cooling rates are initially fast but as the sea water and heat exchanger approach zero the cooling rate will be slower. A vessel design that includes a heat exchanger with the maximum surface area affordable will ensure a cooling rate to 0° in 4 hours.

RSW systems must also consider the salinity of the seawater. Generally, the minimum safe operating temperature to prevent freeze-up of the heat exchanger is 30°F (-1.11°C). Salt may be added to the system to lower the freezing point. Table 2 lists salt requirements to achieve 35ppt (normal seawater salinity).

Table 2

Salinity Conversions to obtain 35 Parts per thousand (ppt) salinity sea water per 1000 cubic feet.

Salometer Degrees	Specific Gravity	% Salt (by weight)	Approximate Salinity (ppt)	Freezing Point	lbs salt to be added to reach 35 ppt (Approximate)
0	1.000	0.0	0.0	32.0	2,220
2	1.004	0.53	5.3	31.5	1,890
4	1.007	1.06	10.6	31.1	1,555
6	1.011	1.56	16.0	30.5	1,220
8	1.015	2.11	21.4	30.0	880
9	1.017	2.33	24.1	29.7	720
10	1.019	2.64	26.8	29.3	540
11	1.021	2.85	29.6	29.1	360
12	1.023	3.17	32.3	28.8	180
13	1.1245	3.38	35.1	28.5	

Temperature fluctuations are a greater problem in RSW systems than in CSW. To ensure adequate cooling and reduced cycling ensure the RSW system is chilled to 0°C before adding any fish. Recording of seawater temperature and temperature fluctuations will provide a history so that RSW operating problems can be rectified.

Critical RSW Design Factors

- **Refrigeration Capacity**
- **Surface Area of Evaporator in heat exchanger**
- **Salinity**

Plant freezing methods

In the previous section the on vessel chilling methods were described. Good handling of fish on vessel is imperative if the processed fish is to have the desired shelf life as a frozen product. Upon receipt at the plant, it is important to freeze the fish as soon as possible.

The initial temperature of the fish entering the freezer is important. The kind of freezer used and its operating temperature are important factors determining the freezing time. The warmer the fish, the longer it will take to freeze and the higher the refrigeration requirement. Other factors like product thickness shape and contact between the fish and the freezing surface also influence freezing time.

In the next section, the plant processing techniques and how they affect finished product quality are discussed

Freezing Rate

Small fish like sardines can be frozen in blocks either in a plate freezer or blast freezer. Fish must be frozen quickly, and the core temperature of the fish block should be reduced to below –20°C within a short period of time. If fish are properly chilled before freezing, both freezing time and refrigeration requirement can be significantly reduced.

Quick freezing is very important in keeping fish quality. Because most water in fish is frozen when the temperature falls from -1 to –5°C (see Figure 1), it is important to lower the fish core temperature through this critical freezing zone (known as the zone of maximum crystallization) as fast as possible, preferably in 3 hours or less. If the temperature reduction rate is slow, the ice crystal formed during this period can grow in size. If the temperature falls more rapidly, more crystals will nucleate, thus limiting the size to which individual crystals may grow. The length of time the fish remain at the critical freezing zone is therefore extremely important because the ice crystal formed within the fish tissue can grow large enough to destroy or alter the cell wall. Fluids from the damaged cells can escape upon thawing, giving rise to drip loss and the soft or spongy flesh texture. Slow freezing over a period of days rather than hours therefore can have detrimental effect on fish quality.

Types of Freezer

Figure 4 describes the three basic methods of freezing available at fish plants: The first two methods are more in common use for small pelagic fish like sardine and herring.

Figure 4

Air Blast Freezer
Freezing in moving air by blowing a stream of cold air over the fish

Plate Freezer
Freezing by direct contact with a refrigerated surface

Immersion Freezing
Freezing by immersion in a low temperature fluid such as carbon dioxide, etc.

Air Blast Freezing

Freezing in the blast freezer is possibly the best choice as it offers more advantages for batch handling. In a correctly operated blast freezer, the air speed over the fish should be everywhere the same to ensure uniform freezing. The air speed should not be less than 2m/s (400 feet /min.). It is important that shelves be sized and located so that all fish put into freezer are exposed to airflow. There should be a minimum plate or shelf separation of about 15-cm (6 inches) to ensure good airflow over the fish. Close stacking should be avoided as it can stop free passage of air between packs and increase freezing time.

Properly sized shelves and located so that all fish put into freezer are exposed to airflow. There should be a minimum plate or shelf separation of about 15-cm (6 inches) to ensure good airflow over the fish. Close stacking should be avoided as it can stop free passage of air between packs and increase freezing time.

Plate 3

An Example of Freezing Curve of Sardine Frozen in Blocks (approx. 10 cm think) by Blast Freezer (Commercial)

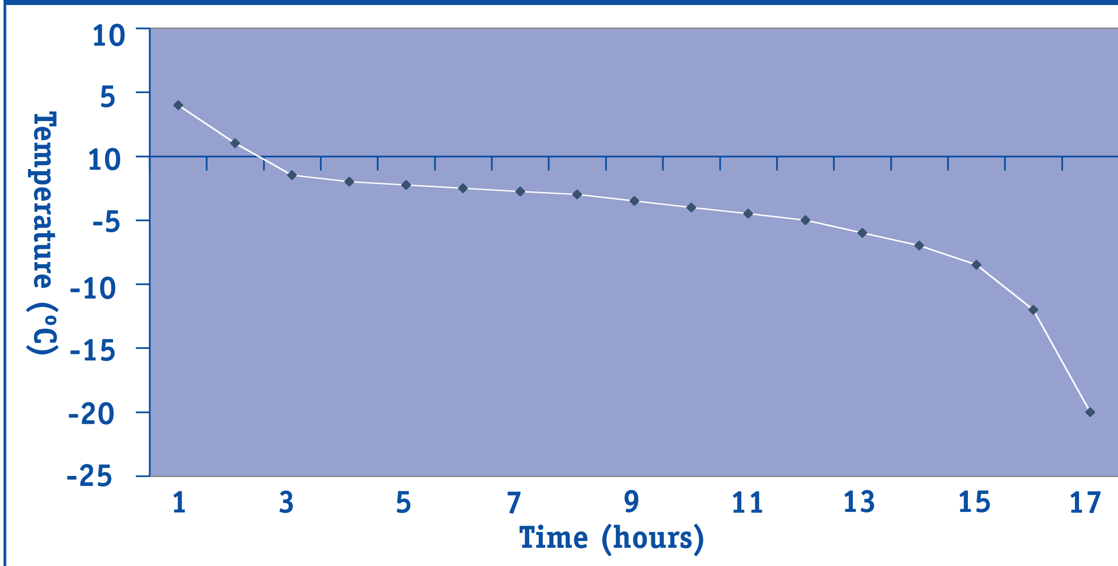


Figure 5

Air Speed
- **Constant speed throughout batch to ensure uniform freezing**
- **Air speed > 2m/s (400 feet /min.)**

Shelves
- **Properly sized and positioned so all fish exposed to air flow**
- **Minimum plate or shelf separation of 15 cm (6 inches)**

Plate Freezer

Plate freezer is probably the most common contact freezer in use for fish. It may be vertical or horizontal. In horizontal freezer, the fish are packed into uniform depth in trays while in vertical freezer the fish can be top-fed directly between the plates. These freezers are good for making blocks of small fish as they can quick-freeze the fish with less power consumption when compared to blast freezer of the same capacity. A wrapped pack of less than 10cm thick with good contact on top and bottom surfaces can be frozen in 2 hours. To maintain good contact between product and plates, the surfaces must be regularly defrosted and cleaned as a small ice bead and light frost can prevent good contact and increase freezing time. The vertical plate freezer is more versatile than the horizontal one since one can easily load and unload fish without the aid of trays or containers.

Operating Temperature and Freezing time

The colder the freezer, the faster the fish will freeze; but as cost increases when the freezer temperature is reduced, a compromise between cost and operating temperature is normally made to obtain the fastest economical freeze. Freezers are usually operated at a few degrees below the required storage temperature. As the recommended storage temperature is –26°C or colder, it is necessary to lower the fish temperature to this value during the freezing process. To achieve this, three conditions are required:

- the temperature of the freezer has to be lower than –30°C
- The average temperature of the surface of the blocks at the end of the freezing process should be close to that of the freezer.

These conditions will ensure a temperature at the centre to about –20°C or lower. Blast freezers usually operate with air temperature below – 30°C while plate freezers at –35 to –40°C.

Treatments after Freezing

As soon as fish are removed from the freezer, they should be wrapped or glazed if they have not been wrapped before freezing to protect fish from dehydration and oxidation. Significant drying can occur in fish unprotected with wrapping within a few days in poor storage. Since good performance in air blast freezer is usually obtained by freezing fish unwrapped in open trays, it is better to freeze fish unwrapped but they should be wrapped as soon as they are removed from the freezer. Freezing in an air blast freezer can result in excessive dehydration due to low relative humidity and high air velocity, it is therefore important to know the fish correct freezing time and to remove fish quickly after complete freezing.

Because uniform glazing is difficult to achieve for blocks of small fish, wrapping is recommended for the sardine blocks, as it would enable better protection. The kind of packaging selected depends on the desired storage life of the products and the affordable cost. The degree of protection against dehydration, oxidation and damage varies with the packaging materials. Among the normal materials used for small fish are polyethylene bags and waxed or plastics coated cartons. Sealed plastic bags with low oxygen permeability is good for fatty fish that are susceptible to oxidation. Paper bags with polyethylene lining are better for handling, as the outer surface is less slippery and the paper can be readily marked to identify the contents of the bag.

Packing and glazing should be done in the cool surroundings and the frozen product should not be exposed to heat or direct sunlight. Fish should be transferred from freezer to cold storage quickly without delay to ensure that fish entering the cold store at the same temperature. This will impose no extra load on the cold storage and little heat will be added to the store that can affect the frozen products already there.

Cold Storage

Cold storage temperature should be low enough to prevent deterioration during the time the fish remain in storage. A temperature of −26°C has been recommended for the safe keeping of fish. The temperature should be kept steady and uniform throughout the store, because any fluctuation would cause drying and increase damage to the fish. Fish transferred from one cold storage to another should be transported in refrigerated vehicles with air temperature maintained below −20°C. Temperature is the most important factor influencing the quality and shelf life of fish held in frozen storage. It has been reported that fish can lose half of their shelf life with each 6°C (10° F) increasing of storage temperature. The expected storage life (quality remain in prime condition) for sardine stored at −26°C is about 6 months, when proper handling and good freezing practice are used. At −10°C, they can lose up to five months of shelf life due to faster rate of deterioration. For fatty fish like sardines that are very susceptible to oxidation rancidity, low storage temperature is necessary in keeping their satisfactory marketing shelf life.

Recommendations and Conclusions

The sardine fishery in BC is in a developing stage and thus the time is opportune for a concurrent development of a standardized quality program. This quality program will ensure that the catching and processing conditions for sardines will provide fish of premium quality to the developing market. The Pacific Sardine Association plans to implement a set of grading guidelines to differentiate various quality features. Finished product that meets the criteria of the program will bear the Quality Seal of the PSA.

Currently, few testing procedures can demonstrate that the handling of fish throughout the process has been adequate to prevent deterioration reactions. The Association has recognized that guidelines that meet or exceed the internationally recognized HACCP guidelines will ensure product that meets the PSA Quality standards. To that end the Association has prepared a *Quality Guidelines and Generic HACCP Plan*.

HACCP relies on documentation and verification activities to demonstrate adherence to defined operating procedures. In the next section of this manual, the Draft Standards are presented. The criteria that will be used to evaluate the vessel and plant are also described.

A P P E N D I X

Appendix

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Draft Standards for the Association Seal

Description

A "seal of quality" implies that the product has been assessed under a set of guidelines or standards established by a regulatory body or by an association of producers. The Pacific Sardine Association is developing a set of standards to ensure a high-quality product. As noted throughout this report, quality is achieved only through rigorous attention to detail at all stages. Preliminary criteria developed entail the following:

This evaluation is summarized and presented in Appendix 1 as Proposed Quality Grades for Pacific Sardines. If the product passes all of the above criteria, the product will be granted the Pacific Sardine Association "Seal Of Quality". This seal can be placed upon the packaging and the product can be marketed as having the seal.

Table 3

Preliminary Criteria to Ensure Quality Standards for Pacific Sardines

The harvester/plant must provide documentation of

A. A vessel quality plan that is
- modelled on HACCP
- has defined standards as to handling, icing and delivery times
- includes an engineer's log of tank temperatures and salinity.

Note: Engineers report required for FAS product

B. Sampling of product by the "clock test" prior to acceptance at a plant.

C. A plant quality plan modelled on HACCP and a CFIA QMP plan.

D. Packaging and labelling that conforms to standards.

E. A visual inspection of the product for the presence of blood, broken fish, and red-eye.

F. Evaluation of freezing (efficiency) process using "drip test" (standard of 1.2%)

G. Bacteria count of test samples

At this time, the Pacific Sardine Association has only proposed grading standards. To promote sardines as a premium product not only for bait but also as a food product requires a clear emphasis upon quality and a guarantee. This guarantee can be achieved through a grading system supplemented with a certificate of adherence to the quality and grading standards.

Outlined below are key operating procedures both on vessel and at plant handling that will ensure the Preliminary Criteria as outlined in Table 1 above are met. These procedures can be summarized as:

- Rapid chilling on board
- Techniques to minimize fish damage
- Importance of refrigeration and freezing throughout the process

HACCP

HACCP programs have become mandatory in many parts of the food industry. All Canadian fish plants that export fish must file a Q-MPr with CFIA. Criticism of HACCP includes its emphasis on paperwork or documentation. Food plants that have implemented HACCP have realized improved performance in areas such as equipment maintenance, number of defects and employee morale. It is for this reason that the Pacific Sardine Association has endorsed the use of HACCP Principles for the development of on vessel and at plant quality programs

HACCP

Hazard Analysis & Critical Control Point

H
A
C
C
P

HACCP

A Systematic & Preventive Method of Ensuring Food Safety

The documentation aspect of HACCP will assist vessels and plants provide Sardines of premium quality to the marketplace. Such documentation will be required to demonstrate that care in handling has occurred throughout the process flow. It is likely to become a requirement of the PSA grading

HACCP is an internationally recognised cost-effective program in food safety. It can be described as a systematic and preventative approach in identifying and controlling potential hazards in every step of the production, processing, and packaging stages at any food processing plant. This includes everything from the receipt of raw materials to processing, quality control etc, all the way through to the final stages including the consumer.

The regulation that all plants exporting to the US have a QMRP plan in place has now filtered down to the vessel and a change in on board recording of activities has become a requirement when off loading at some plants. This change is due to the plants prerequisite program for incoming materials.

This documentation is required for the risk analysis component of the food safety program. The Pacific Sardine Association has chosen to use this systematic approach to the risk analysis as a way to reduce the non food-safety quality issues that are critical to the success of the development of the market, namely deterioration reactions.

HACCP HISTORY

1950's

Dr. W.E. Deming's theories of quality management was a major factor in the upturn of better quality in Japanese products. Deming and others developed total quality management (TQM) systems, an approach to manufacturing improving quality while lowering cost.

1960's

Pillsbury Co. (Dr. H.E. Bauman) approached by NASA, who wanted a "zero defects" program for food safety for the astronauts. The U.S.Army, NASA, and Pillsbury worked in a collaborative effort toward this objective. Pillsbury introduced and adapted HACCP as a system that would utilize operator control and/or continuous monitoring techniques at critical control points (CCP's).

1971

The HACCP principles were publicly introduced at the first Conference for Food Protection in Denver, CO.

1974

FDA used HACCP principles in promulgation of regulations for low-acid canned food.

Early 1980's

Some major food companies were adopting HACCP approach.

1985

The U.S. National Academy of Science recommended the HACCP approach be adopted in food processing establishments to ensure food safety.

1989

The National Advisory Committee on microbiological Criteria for Foods (NACMCF) developed a HACCP document as a guide for maintaining uniformity of the principles and definitions of terminology; NACMCF refined and improved the HACCP concept and published revisions in 1992 and 1997.

More Recently

The International Commission on Microbiological
Specifications for Foods (ICMSF) and the International Association of Milk, Food and Environmental Sanitarians (IAMFES), among others, have recommended the broad application if HACCP principles to food safety. The National Restaurant Association (NRA) developed ServSafe around HACCP principles. USDA has used HACCP principles to establish the framework for science-based reforms of meat and poultry inspection.

Also, in 1997, FDA adopted regulations that mandated the application of HACCP principles to the processing of seafood.

"Food Quality and Safety Systems," 1998.
FOOD AND AGRICULTURE ORGANIZATION (FAO) OF THE UNITED NATIONS

One of the key elements of the CFIA HACCP program is the use of Standard Operation Procedures (SOPs) as a means of formalizing the activities that will ensure food safety. The SOP is also used for training purposes. The Pacific Sardine Association recommends the development of written SOP for onboard vessel and plant activities. These written procedures will demonstrate that the vessel has handled the fish in a manner that prevents deterioration reactions. Example generic SOPs for on vessel and plant activities are presented in Appendix 2.

In the next section of this manual information from the generic HACCP plan will be presented as it relates to meeting the Preliminary Criteria to Ensure Quality Standards for Pacific Sardines

HACCP is an internationally recognised cost-effective program in food safety. It can be described as a systematic and preventative approach in identifying and controlling potential hazards in every step of the production, processing, and packaging stages at any food processing plant. This includes everything from the receipt of raw materials to processing, quality control etc, all the way through to the final stages including the consumer.

The regulation that all plants exporting to the US have a QMRP plan in place has now filtered down to the vessel and a change in on board recording of activities has become a requirement when off loading at some plants. This change is due to the plants prerequisite program for incoming materials.

This documentation is required for the risk analysis component of the food safety program. The Pacific Sardine Association has chosen to use this systematic approach to the risk analysis as a way to reduce the non food-safety quality issues that are critical to the success of the development of the market, namely deterioration reactions.

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Say What We Do

Temperature Control SOP

Storage Temperature
Thermometers
Fish Handling

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Detailed Plant Specifications and standards

The potential hazards identified at each step outlined in Figure 6 are analyzed as part of the plant HACCP plan. It is recommended that plants implement Standard Operating Procedures SOP 's as outlined in Quality Guidelines and Generic HACCP Plan. The SOPs listed in Table 4 discuss the plant handling techniques. These SOPs relate primarily to temperature control and speed in processing to minimize deterioration

Recommended sops for plant
Fish Receiving
Grading
Processing Line Speed
Receipt & Storage of Packaging Materials & Ingredients
Receiving & Storage of Cleaning, Sanitizing and Lubricating Compounds
Labels and Final Product Shipping
Sanitation
Construction & Equipment
Employee Hygiene and Training

Detailed Vessel Specifications and standards

The potential hazards identified at each step outlined in Figure x are analyzed as part of the vessel HACCP plan. It is recommended that vessels implement Standard Operating Procedures SOP 's as outlined in Quality Guidelines and Generic HACCP Plan. The SOPs listed in Table 4 discuss onboard handling techniques. These SOPs relate primarily to temperature control, however sanitation and other record keeping activities that minimize deterioration are also included.

Recommended SOPs for Vessel
On board guidelines
Sardine Chilling Record Keeping

SOPS

Table 4

On Vessel	At Plant
Input Material	Pumping
Receiving of Input Material	Grading
Storage of Input Material	Packaging
Pre-chilling Tanks	Weighing
Sample by Jigging	Racking
Setting	Blast Freezing
Drying Up	Packaging/Glazing
Landing	Labelling
Chilling	Storage
Receiving	Distribution

Measuring Standards

Development of a quality standard requires that an objective measurement of the desired quality attribute be developed. The following tests have been developed by the PSA as part of the grading criteria. Both method and standards are presented for each of the following tests.

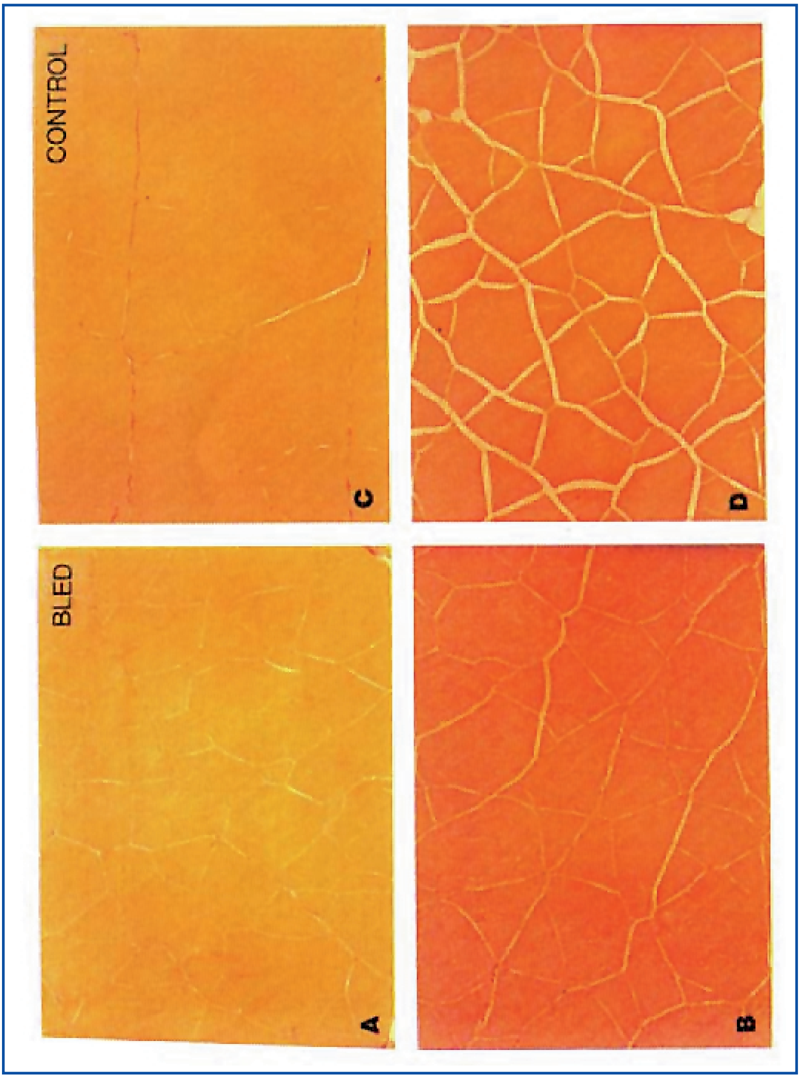
Clock test upon receiving

This diagram shows the effect of bleeding on muscle texture. With bleeding the muscle remain strong. This is shown in Panels A and B. The "Control" pictures show the deterioration of muscle fibre from not bleeding. Sardines are not bled. This is why the muscle and the fish become soft. The distance between the fibres has increased as shown in Panels C and D. The flesh of the fish has become softer.

Purpose:

The clock test is a test that is performed on a sampling of fish at off loading. The position of the fish related to the face of a clock indicates freshness and the impact of muscle weakness from deterioration of flesh. This test is performed in conjunction with the visual inspection

Plate 5



Bled fish in Panels A and B show little loss of connective tissue compare to the Control.

MEASURING STANDARDS

M E A S U R I N G S T A N D A R D S

Method

Perform this test on all fish sampled for TDU at off loading (how many?)

1. Grasp sardine by head

2. Allow sardine to flop to one side

3. Relate the angle of the fish to a clock
   i.e, Straight up = 12 o'clock
   Right angle - 3 o'clock

4. Record

Acceptance Criteria
Clock test between 12 and 3 is acceptable.
Ideally want firm sardine with 12 o'clock result.

Visual inspections

A visual inspection of the fish is done in conjunction with the clock test. A fish of good quality will have clear gills and eyes. There will be no damage to the tails and no evidence of scarring. There will also be no mucous present. Plate 6 shows three sardines of different quality. Exhibit 1 demonstrates a sardine that would meet Premium grade. This fish does not exhibit any evidence of redeye or gill blush

Exhibit 2 is a sardine that demonstrates slight blush on the gills. This fish would not meet Pacific Sardine Association Premium Standard.

A more extreme example of red eye and the development of mucous is shown in **Exhibit 3.**
This sardine would not meet Pacific Sardine Association Premium Standard

Plate 6

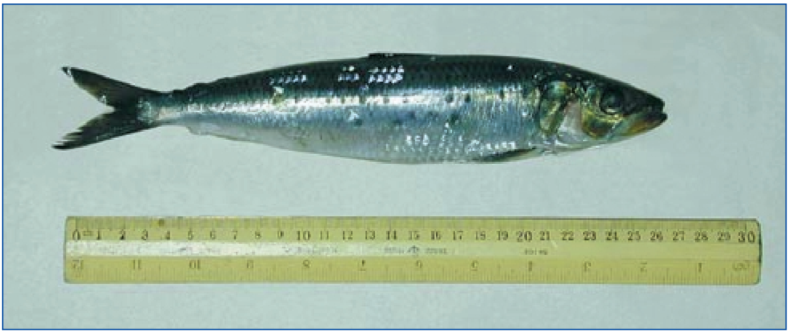


Exhibit 1

Exhibit 2

Exhibit 3

M E A S U R I N G S T A N D A R D S

Drip test sampling

Properly handled frozen sardines will average a drip loss of 1.5 % to 3% (w/w) when thawed. A drip loss of greater than 5% indicates that the fish have not been properly frozen and or stored. Poor handling of frozen product results in changes in the flesh texture, which is evidenced by weight loss on thawing due to loss of fluids.

Purpose: Measure freshness and freezing and cold storage conditions for the Sardine.

Figure 6

Techniques to Reduce Drip Loss

- **Well chill fish after catch**
- **No delay in freezing**
- **Quick freezing to low temperature in correct time**
- **Maintain good storage temperature throughout the chain**
- **Maintain good handling practices and hygienic condition at all times**

Drip Loss Method:

1. Record weight of box of frozen Sardines
2. Allow box of frozen sardines to thaw at room temperature for 24 hours. Catch drip in pan
3. Measure amount of drip loss (weight)
4. Calculate % drip loss

$$\text{Drip Loss} = \frac{(\text{Initial Weight of block of frozen fish}) - (\text{Final Weight of thawed fish}) \times 100}{(\text{Initial Weight of block of frozen fish})}$$

or

$$\text{Drip Loss} = \frac{(\text{Weight of drip from thawed fish}) \times 100}{(\text{Initial Weight of block of frozen fish})}$$

Acceptance Criteria

Less than or equal to 1.5 % drip (w/w)

Bacterial Counts

There is limited use of bacterial counts in the evaluation of sardine quality. Other deterioration reactions would reduce the quality standard of the fish with respect to texture and appearance before the bacterial counts would create a food safety risk. This emphasizes again the importance of handling and temperature control.

The Pacific Sardine Association may require bacterial counts at some point in the future depending on customer requirements. Fish imported to Japan are normally inspected upon arrival to ensure the products meet the quality standards. Inspection for sale purposes is practiced widely and depending on the circumstances can be very detailed. The most common test is sensory assessment but bacteriological and chemical examination is often carried out as required by the Ministry of Health and Welfare. The bacterial counts are considered important indications of fish quality and safety. The microbiological examination of the thawed fish can provide some measures of the initial freshness, the hygienic quality and possible contamination of the fish during storage.

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Required Supporting Documentation

Currently the Seal of Quality program is voluntary and only applies to products marketed for food. Figure 7 lists the documents required by the Pacific Sardine Association as evidence of adherence to the quality program.

Of utmost importance are the various logbooks that provide evidence of handling conditions and temperature control. These records will be verified by the results of the Clock Test and Drip Loss. The Standard Operating Procedures provided in Appendix 2 outline the information to be recorded in the logbooks.

Figure 7

Required Supporting Documentation

- **Observer's set log**
- **Engineer's log**
- **Validator's sheet**
- **Plant QMP certificate or Affidavit of having one**
- **Visual inspection by appropriate body**
- **Clock Test**
- **Drip Loss**
- **Bacteria count on sample**

Appendix 1
Proposed Quality Grades for Pacific Sardines

	Characteristics	Premium	Grade A
Catching	Knotless Bunt	Yes	Yes
	Wet Brailer	Yes	Yes
	Pump	No	Yes
	RSW	Yes	No
	FAS	Yes	No
	Chilled Only (Slush)	No	Yes
Handling/Transport	Landing Time	24 hours	24 hours
	Freezing Time	48 hours	48 hours
	HACCP	Yes	Yes
	TQM	Yes	Yes
	Temperature Control	Less than 0.6° C	Not frozen
Processing	HACCP	Yes	Yes
	TQM	Yes	Yes
	Scale Loss	None	Minimal
	Mucous	Present	Prevent
	Skin	No marks	2 in 100 (2%)
Fish Quality	Gills	Clear	Clear
	Odour	None	None
	Eyes	Clear	Clear
	Scars	None	None
	Tails	No Damage	2 in 100 (2%)
Association	Member in good standing	Yes	Yes
Storage	Temperature	-20 ° C	-20 ° C
Seal	Seal	Yes	Yes