Md. Abdul Hannan · Kazi Ahsan Habib · A. M. Shahabuddin · Md. Ariful Haque · Mohammad Bodrul Munir

Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide

Springer

Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide

Md. Abdul Hannan • Kazi Ahsan Habib •
A. M. Shahabuddin • Md. Ariful Haque •
Mohammad Bodrul Munir

Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide

Springer

Md. Abdul Hannan
Faculty of Fisheries, Aquaculture
and Marine Science
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh

Kazi Ahsan Habib
Faculty of Fisheries, Aquaculture
and Marine Science
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh

A. M. Shahabuddin
Faculty of Fisheries, Aquaculture
and Marine Science
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh

Md. Ariful Haque
Fish and Shellfish Quality Control
W & M Ventures
Khulna, Bangladesh

Mohammad Bodrul Munir
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak (UNIMAS)
Kota Samarahan, Sarawak, Malaysia

ISBN 978-981-19-1565-9 ISBN 978-981-19-1566-6 (eBook)
https://doi.org/10.1007/978-981-19-1566-6

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

Shrimp is a delicious as well as nutritious food item. It is very much popular around the world because of its taste and boneless characteristics. Shrimp industries play a vital role in the field of food security, nutritional requirement, employment generation, and foreign earnings. This book describes the practical situation of postharvest processing, packaging, and inspection of frozen shrimp; their quality control; scope and limitation; business policy; and future potentials of the business. The book highlights the content of receiving of raw materials, their traceability, processing technology, diversifications of products, food grade packaging of final products, value-added products, production supervision, final inspection, laboratory analysis, loading supervision, audit, certification, and payment system of business policy. The book helps to identify knowledge gap in the processing, packaging, and inspection of frozen shrimp, thus leading to minimized hazards. Experts, researchers, academicians, students, advanced learners, and other relevant persons who are engaged in this sector will be benefited using this knowledge. If we can apply this knowledge in the practical field of postharvest processing of shrimp, definitely it will help to produce top-quality products and lead to sustainable seafood business globally.

Dhaka, Bangladesh — Md. Abdul Hannan
Dhaka, Bangladesh — Kazi Ahsan Habib
Dhaka, Bangladesh — A. M. Shahabuddin
Khulna, Bangladesh — Md. Ariful Haque
Kota Samarahan, Sarawak, Malaysia — Mohammad Bodrul Munir

Contents

About the Authors

Md. Abdul Hannan is now serving as an assistant professor in the Dept. of Aquatic Animal Health Management, Faculty of Fisheries, Aquaculture and Marine Science, Sher-e-Bangla Agricultural University, Dhaka–1207, Bangladesh. He is now conducting his PhD research under Dr. Mohammad Bodrul Munir at Universiti Malaysia Sarawak (UNIMAS).

Kazi Ahsan Habib is now serving as a professor and chairman of the Dept. of Fisheries Biology and Genetics, Faculty of Fisheries, Aquaculture and Marine Science, Sher-e-Bangla Agricultural University, Dhaka–1207, Bangladesh.

A. M. Shahabuddin is now serving as a professor and chairman of the Dept. of Aquaculture, Faculty of Fisheries, Aquaculture and Marine Science, Sher-e-Bangla Agricultural University, Dhaka–1207, Bangladesh.

Md. Ariful Haque is now serving as an executive at W and M Ventures (Fish and Shellfish Quality Control), Khulna in Bangladesh.

Mohammad Bodrul Munir is one of the academic faculty members (teaching and research) in the aquatic science program at the Faculty of Resource Science and Technology of Universiti Malaysia Sarawak (UNIMAS) since 2017. He obtained his PhD in aquatic animal nutrition from Universiti Sains Malaysia (USM) in 2016. He has practical experiences in developing guidelines of hazard analysis critical control point (HACCP) for frozen food products.

Abbreviations

AHD	1-Aminohydantoin
AMOZ	3-Amino-5-morpholino-methyl-1,3-oxa-zolidinone
AOZ	3-Amino-2-oxazolidinone
ASC	Aquaculture Stewardship Council
BAP	Best Aquaculture Practices
BRC	British Retail Consortium
BSCI	Business Social Compliance Initiative
BT	Black tiger
CCP	Critical control points
CTS	Cartons
DF	Double-frozen shrimp (frozen two times—frozen raw material)
EAN	European Article Numbering System
ETA	Estimated date of arrival
EU	European Union
FC	Frozen count
FAO	Food and Agriculture Organization
FTA	Foreign Trade Association
FTD	Furaltadone
FZ	Nitrofurazone
FZD	Furazolidone
GMP	Good Manufacturing Practice
GTIN	(Global Trade Item Number)
gsm	Gram per square meter
HACCP	Hazard analysis and critical control point
HDPE	High-density polyethylene
IFS	International Food Standard
INQ	Inquiry
IQF	Individual quick freezing
LC	Letter of credit
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene
MC	Master carton
MSC	Marine Stewardship Council

NFT	Nitrofurantoin
NP	Nitrophenyl
NPAHD	3-(2-Nitrobenzylidenamino)-2,4-imi-dazolidinedione)
NPAOZ	[3-(2-Nitrobenzylidenamino)-2-oxazolidinone]
NPAMOZ	5-(Morpholino methyl)-3-(2-nitrobenzylidenamino)-2-oxazolidinone)
NPSEM	3[(2-Nitrophenyl) methylene]-hydrazine carboxamide
OPP	Orientated polypropylene
Pcs	Pieces
PI	Proforma invoice
PET	Polyethylene terephthalate
RC	Real count
SEM	Semicarbazide
SF	Single frozen shrimp (frozen only one time)
TVBN	Total volatile base nitrogen
UV	Ultraviolet
WHO	World Health Organization

List of Figures

List of Tables

List of Mathematical Calculations

List of Appendices

General Discussion

1

Abstract

Shrimp is an exceptionally nutritious seafood item. It is a high-protein food, low in fats content, and high demand in international seafood markets because of its authentic test. *The chapter of the book summarized the general discussion about shrimp, its importance, source and location of shrimp around the world, world production statistics, international shrimp business policy, export market of shrimp, factors affecting seafood business in international seafood markets, and morphometric identifications and taxonomic classification of commercially important species*. The content of the chapter also helps to know the difference between the most remarkable exportable shrimp species like *Penaeus monodon* and *Penaeus vannamei.*

Keywords

Penaeus monodon · *Penaeus vannamei* · Seafood · Taxonomy · Morphology

1.1 Introduction

Shrimp is one of the most common and popular types of seafood consumed worldwide. Popularization of shrimp is increasing day by day due to its sweet succulent flavor, delicious test, quality nutrients, low fat content, and a rich source of omega-3 fatty acids. Shrimp lipid contains mostly polyunsaturated fatty acid (PUFA), which includes linoleic acid and alpha-linolenic acid that are parent compounds of omega-6 and omega-3 acid that provides a variety of health benefits like retina and brain development (Oksuz et al. 2009). The omega-3 fatty acids help to reduce cholesterol levels in the blood and are thought to reduce the risks of heart attacks, some cancers, and many other diseases (Dore 2012). Omega-3 fatty acids in shrimp also lead to reduce the risk of cardiovascular diseases, overcome weight loss,

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_1

and lower blood pressure. Furthermore, shrimps are a rich source of calcium, iodine, vitamin D, vitamin B_3, zinc, and protein and low in saturated fats.

The shrimp industry was started to develop on a large scale in coastal areas of Southeast Asia in the 1970s. *Penaeus monodon*, *P. vannamei*, *P. orientalis*, *P. merguiensis*, *P. semisulcatus*, *P. indicus*, *Macrobrachium rosenbergii*, *M. monoceros*, *M. nipponense*, etc. are the remarkable species exported worldwide. Among these species *P. monodon and P. vannamei* have the most remarkable contribution in international seafood market. Seafood refers to any form of sea life regarded as food consumed by humans, including fish and shellfish prominently. Shellfish include various species of mollusks, crustaceans, and echinoderms. Edible sea plants such as seaweed and microalgae are also known as seafood widely eaten as sea vegetables around the world. *P. monodon* known as black tiger (BT) is one of the most remarkable exportable items in frozen seafood. It's a unique product because of its authentic test, nutritional content, and regional and global demand in the seafood market. At the beginning of the 1970s, the species *P. monodon* was the preferred species for many years because of its authentic test, but the species was very sensitive to infectious disease. This susceptibility to disease has led to a preference for the farming of *L. vannamei*, which has constituted the largest shrimp industry growth worldwide (Thornber et al. 2020). Note that *P. vannamei* is the most extensively farmed species at current world. Difference between *Penaeus monodon and P. vannamei* is given in the following table (Table 1.1).

Besides consumptions a significant proportion of shrimp is also used as the ingredients of fish feed, fertilizer, medicine, and other purposes. The major shrimp-producing Asian countries are China, India, Bangladesh, Vietnam, Thailand, Indonesia, Malaysia, and the Philippines, whereas majority share comes from China which is around 61% of total Asian shrimp production. Besides China, India contributes 6%, Indonesia contributes 5%, Vietnam contributes 4%, and Bangladesh contributes 3% of total Asian shrimp production. The rest of 21% comes from other Asian countries (Barua and Hossain 2019). The Latin American shrimp-producing countries are Brazil, Ecuador, Mexico, Honduras, Nicaragua, and Peru. The species *P. monodon* is native to Asian countries, but the species *P. vannamei* is native to the Pacific coast of Mexico to Peru. Other vannamei producer countries are China, Thailand, Indonesia, Malaysia, Vietnam, India, the Philippines, Taiwan P.C., Brazil, Ecuador, Mexico, Venezuela, Honduras, Guatemala, Nicaragua, Belize, Pacific Islands, Colombia, Costa Rica, Panama, El Salvador, the United States, Cambodia, Suriname, Saint Kitts, Jamaica, Cuba, Dominican Republic, and Bahamas. Major crustaceans' production in world aquaculture (2010–2018) is given on the following table (Table 1.2; Fig. 1.1).

Millions of million people are engaged in seafood industries as well as the chain of shrimp business and lead their livelihood in different ways like seafood harvesting, transportation, processing, packaging, shipment, restaurants, and retail business.

The existing problems in shrimp business are the scarcity of raw materials, intensification of aquaculture, and uses of heavy antibiotics. Shrimp farmers of third countries are also diverting to other businesses as they didn't get proper

Table 1.1 Difference between *P. monodon and P. vannamei* shrimp

Characteristics	*P. monodon*	*P. vannamei*
Common name	Black tiger shrimp or tiger prawn or giant tiger prawn	Whiteleg shrimp or Pacific whiteleg shrimp
Color	Grayish green/dark greenish/reddish brown	Off-white to greenish-white
Stripes	Back with alternating dark and light transverse stripes	Back with alternating dark and light transverse stripes
Stocking density	Lower	Higher
Production	Lower production	Higher production
Production cycle	Production cycle is longer	Production cycle is shorter
Salinity tolerance	Salinity tolerance higher	Salinity tolerance lower
Temperature tolerant	Temperature range 25–30 °C. Can't grow well at lower temperature	Temperature range 15–35 °C. Can grow in lower temperature
Growth performance	Growth performance slower	Growth performance faster
Size	Larger in size	Smaller in size
FCR	FCR higher	FCR lower
Dietary protein requirements	Dietary protein requirements are higher	Dietary protein requirements are lower
Post-harvest handling	Post-harvest handling can be easier. Quality can be degraded if processing time is very long	Post-harvest handling cannot be easier. Quality can be degraded within very short time
Test	Unique test	Testy but not as black tiger
Price	Higher price in international seafood market	Lower price in international seafood market

remuneration in response to their production cost. In addition, processing industries declared themselves bankrupt frequently making the people unemployed. It's threat for the fisheries sector in near future. So, it is high time to be conscious more about this sector. Besides shrimp, emphasis should be given to other exportable items, i.e., white fish, live fish, smoked fish, dry fish, crab, kuchia, value-added/marinated products, byproducts (head, shell, gut content, fish scale, turtle edge, etc.), and marine resources (seaweeds, octopus, lobster, mollusks, loligo, sepia, cuttlefish, etc.) that are the potential resource for the near future. The government should come forward to manage this industry sustainably. Proper planning, necessary initiatives, and immediate response should be taken immediately to improve our culture technology and development of the new technique to process quality products.

Table 1.2 Major crustaceans' production in world aquaculture (2010–2018)

Types of crustaceans	Year (production in 1000 tonnes)				
	2010	2012	2014	2016	2018
Whiteleg shrimp (*Penaeus vannamei*)	2648.5	3144.9	3595.7	4126	4966.2
Giant tiger prawn (*Penaeus monodon*)	562.9	669.3	701.8	705.9	750.6
Oriental river prawn (*Macrobrachium nipponense*)	193.1	200	204.1	245	237.1
Giant river prawn (*Macrobrachium rosenbergii*)	217.7	216.2	233.7	238.4	234.4
Red swamp crawfish (*Procambarus clarkii*)	596.3	548.7	659.3	894.7	1711.3
Chinese mitten crab (*Eriocheir sinensis*)	572.4	650.7	722.7	748.8	757
Other crustaceans	687.9	586.1	631.1	717.3	729.9
Total	**5478.8**	**6015.9**	**6748.4**	**7676.1**	**9386.5**

FAO (2020)

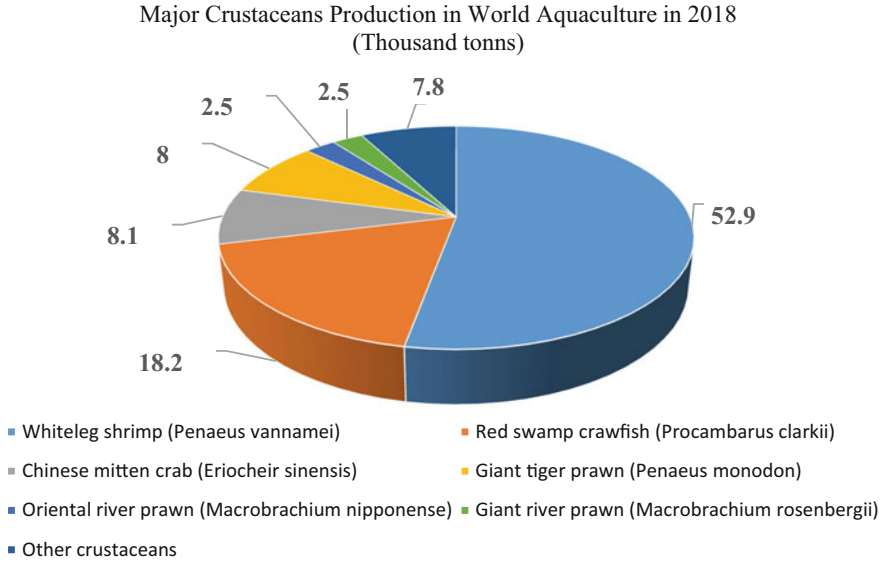


Fig. 1.1 Percentage of major crustaceans' production in world aquaculture (FAO 2020)

1.2 Factors Affecting Seafood Business in International Seafood Market

The shrimp business of the world is affected by a variety of parameters because of global competition. If the respective authorities failed to control these parameters, there is huge chance to collapse the business because the rival countries will take the opportunities. The factors affecting shrimp business in international seafood market are as follows:

- Quality of raw materials (freshness, test, texture, and color).
- Culture technology (either organic or inorganic; either wild catch or cultured, if cultured then it is intensive, semi-intensive, or traditional, etc.).
- Quality of export grade final product (either the country produces top-quality or poor-quality product).
- Competition with other shrimp-producing countries.
- Business policy of different business countries.
- Fluctuation of customer demand in international export market.
- Fluctuation of market price.
- Fluctuation of currency.
- Duration of shipment (either the product is shipped earlier or delay shipment. In the case of delayed shipment and/or non shipment both are dangerous for the international seafood business). Remember that it is very difficult to achieve a quick response from both parties (suppliers and buyers) according to the changing of customer's demand because of long duration of shipment.
- Payment system.
- Marketing chain.
- Generalized System of Preference (GSP) facilities.

Lack of proper knowledge and technology, scarcity of raw materials, lack of well-equipped machineries and laboratories, and lack of well-certified processing industries in third world countries are the common factors that reduce their business day by day. Furthermore, high labor charge and high operational cost are the key factors for developed countries.

1.3 Taxonomic Classification of Shrimp

The term "taxonomy" is derived from Greek words "*taxis*" meaning arrangement and "*nomia*," meaning distribution or method. So, taxonomy is the study of naming, identifying, describing, and classifying organisms which include animals, plants, and microorganisms. Classification can be done through the analysis of morphological, behavioral, genetic, and biochemical characteristics. The following are the taxonomic classification of some important species of exported shrimp.

1. Black tiger/giant tiger shrimp	2. Whiteleg shrimp/Pacific white shrimp
Kingdom: Animalia	Kingdom: Animalia
Phylum: Arthropoda	Phylum: Arthropoda
Subphylum: Crustacea	Subphylum: Crustacea
Class: Malacostraca	Class: Malacostraca
Order: Decapoda	Order: Decapoda
Family: Penaeidae	Family: Penaeidae
Genus: *Penaeus*	Genus: *Litopenaeus*
Species: *P. monodon*	Species: *L. vannamei*

3. Chaka/white shrimp	4. Cat tiger/sea cat
Kingdom: Animalia	Kingdom: Animalia
Phylum: Arthropoda	Phylum: Arthropoda
Subphylum: Crustacea	Subphylum: Crustacea
Class: Malacostraca	Class: Malacostraca
Order: Decapoda	Order: Decapoda
Family: Penaeidae	Family: Penaeidae
Genus: *Fenneropenaeus*	Genus: *Penaeus*
Species: *F. indicus*	Species: *P. semisulcatus*
**Penaeus indicus in previous*	

5. Harina/brown harina	6. Fresh water king prawn/scampi
Kingdom: Animalia	Kingdom: Animalia
Phylum: Arthropoda	Phylum: Arthropoda
Subphylum: Crustacea	Subphylum: Crustacea
Class: Malacostraca	Class: Malacostraca
Order: Decapoda	Order: Decapoda
Family: Penaeidae	Family: Palaemonidae
Genus: *Metapenaeus*	Genus: *Macrobrachium*
Species: *M. monoceros*	Species: *M. rosenbergii*

1.4 Morphometric Identification of Shrimp

Shrimps are laterally compressed crustaceans with a streamlined shape for swimming (Rudloe and Rudloe 2009). It has elongated and slender shaped bodies with long muscular abdomens commonly found in marine, brackish, and freshwater ecosystems both of cold water and warm water regions. The tropical and subtropical regions around the world are most popular for warm water shrimps; however, the

ocean waters of the northwest and northeast regions of the United States and Canada are popular for cold water shrimp. The whole shrimp is divided into two parts:

1. The head
2. The body

The head is fused with a thorax called cephalothorax that is protected by a shell called a carapace. The carapaces of shrimps are more cylindrical, and the shell of carapace is harder and thicker than the shell elsewhere on the shrimp. The gills of the shrimp are located inside the carapace. The front of the carapace which is tapered and curved shape with a serrated edge is called rostrum. The rostrum is a forward extension rigid structure that can be used to attack or as a defense mechanism of shrimp. There are two compound eyes which are attached to the base of the rostrum by movable stalks. These compound eyes are used for detecting movement and vision. The head also consists of two pairs of antennae (one pair is long and another pair is short) and mouth with jaws, mandible and maxilla. The antennae of shrimps are an important organ used as sensors which can help them to feel where they touch and help to assess smell, taste, and suitability of the prey. The antennular appendages are also serving as detectors of chemical, tactile, and vibrational stimuli (Vickery et al. 2012). Again, the body is divided into two parts:

1. Abdomen
2. Tail

The body also consists of six segments. The first five segments each contain a pair of swimming legs, whereas the sixth segment consists of the tail. The tail consists of two pairs of appendages called uropods and the telson. Shrimp can swim forward by paddling their well-developed pleopods (swimmerets) on the underside of their abdomens. They can also move backward very quickly by flipping their tail uropods (Rudloe and Rudloe 2009). The uropods of shrimp function as the steering mechanism during their movement and also take part in raid movement. The female shrimp releases eggs into the water, and the nauplius larvae come up from the eggs and turn into protozoea, zoea, metazoea, mysis, postlarva, and juvenile stages and finally become adult shrimp. The growth of shrimp depends on molting. The growth of shrimp is blocked when the exoskeleton of the shrimp becomes hard and required molting for further growth. Molting is mostly a night event. Molting is essential for faster growth of shrimp but also helps to remove scar, infection, parasites, damaged parts, and limb loss (Panakorn 2018). During the molting process, there is increased respiration and CO_2 production and decreased feeding of shrimp (Corteel and Nauwynck 2010).

See the following morphometric characteristics of shrimp *P. monodon* (Figs. 1.2 and 1.3).

The following are the images of different types of exported shrimp (Figs. 1.4, 1.5, 1.6, 1.7, 1.8, and 1.9).

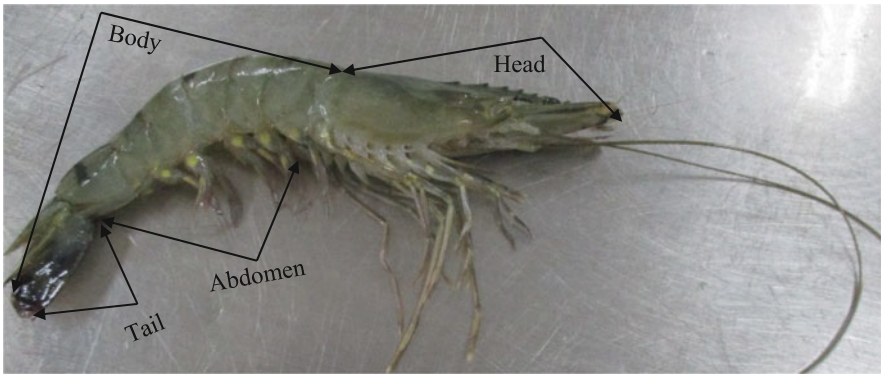


Fig. 1.2 Major divisions of shrimp's body (P. monodon)

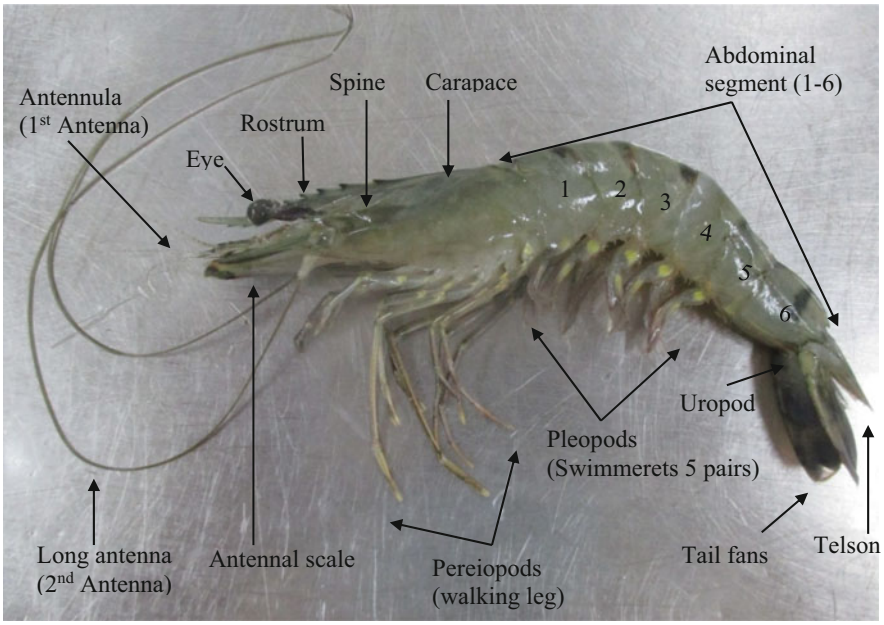


Fig. 1.3 Morphometric characteristics of shrimp *P. monodon*

Fig. 1.4 Black tiger shrimp

Fig. 1.5 Vannamei shrimp

Fig. 1.6 Freshwater shrimp

Fig. 1.7 Harina shrimp

Fig. 1.8 Cat tiger shrimp

Fig. 1.9 Chaka shrimp

References

Barua D, Hossain MS (2019) Environmental impacts of commercial shrimp farming in coastal zone of Bangladesh and approaches for sustainable management. Int J Environ Sci Nat Resour 20(3): 84–92

Corteel M, Nauwynck HJ (2010) The integument of shrimp: cuticle and its moult cycle. The Shrimp Book:73–88

Dore I (ed) (2012) An illustrated guide to shrimp of the world. Springer

FAO (2020) The state of world fisheries and aquaculture 2020. Sustainability in action, Rome. https://doi.org/10.4060/ca9229en

Oksuz A, Ozyilmaz A, Aktas M, Gercek G, Motte J (2009) A comparative study on proximate, mineral and fatty acid compositions of deep seawater rose shrimp (Parapenaeus longirostris, Lucas 1846) and red shrimp (Plesionika martia, A. Milne-Edwards, 1883). J Anim Vet Adv 8(1):183–189

Panakorn S (2018) Managing shrimp moulting. Aquacult Asia Pac 14:18–21

Rudloe J, Rudloe A (2009) Shrimp: The endless quest for pink gold. FT Press

Thornber K, Verner-Jeffreys D, Hinchliffe S, Rahman MM, Bass D, Tyler CR (2020) Evaluating antimicrobial resistance in the global shrimp industry. Rev Aquac 12(2):966–986

Vickery R, Hollowell K, Hughes M (2012) Why have long antennae? Exploring the function of antennal contact in snapping shrimp. Mar Freshw Behav Physiol 45(3):161–176

Product Description

2

Abstract

Product description is a kind of marketing strategy that explains what a product is, what it does, what it can be used for, and what benefits it will provide. The chapter highlights the details of a product description of frozen shrimp like how to write a product description for international business communication, types and diversification (HOSO, PDTO, EZP, PUD, PUDC, PDC, P&D, deep cut, butterfly cut, grill cut, leaf cut, skewer, fantail round, etc.) of frozen shrimp, types of freezing method (IQF, semi-IQF, and block) with flowchart, blanched and cooked shrimp, grading, meaning of grading (what is 16/20 or 21/25, etc.), packing (regular and bulk packing) of shrimp, grading and grading methods (manual and mechanical), uniformity ratio, glazing and hardening, etc. The chapter also helps to know about different types of mathematical calculation like determination of grade with acceptable limit; counting of average pieces; counting of pieces per unit block/bag for semi-IQF, IQF, and block frozen shrimp (both real count and frozen count); standard limit; calculation of individual weight (maximum and minimum) of shrimp for every grade; and determination of glazing % and uniformity ratio with some related exercise.

Keywords

IQF · Semi-IQF · Block · Packing · Grading · Uniformity

2.1 Product Specification

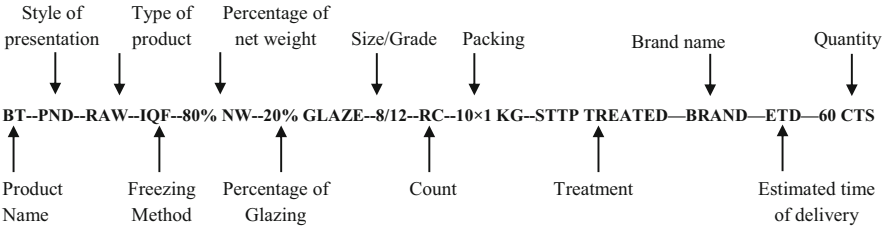
Frozen shrimps are important exportable items of global seafood business, especially the species black tiger shrimp, whiteleg shrimp and freshwater prawn which are utmost remarkable. A variety of diversified shrimp products are processed in the processing industries, whereas the diversification of frozen shrimps comes due to

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_2

competitive seafood business in international seafood market and diversified customer's demand. Diversification of frozen shrimp occurs due to its freezing methods, cutting techniques, processing variations, style of presentation, value addition, and marination techniques. A product description is an important part of the seafood marketing. Generally, a product is a term which refers to an item offered for sale, whereas a product description is a kind of marketing strategy that explains what a product is, what it does, what it can be used for, and what benefits it will provide to its final consumers. The purpose of a product description is to provide necessary information to its customers about the features, ingredients, benefits, and instruction of the frozen products so that they can decide to buy that frozen shrimp. Everyone engaged in this sector should have proper knowledge about the details of product description; otherwise, it will be difficult to continue the business in international seafood market. The following should be covered for a complete description of exported frozen product:

- Name of product (English name and scientific name)
- Ingredients (e.g., 20% water, 80% shrimp, etc.)
- Type of product (raw or blanched or cooked)
- Style of presentation (HOSO or PD or EZP or PUD, etc.)
- Method of freezing (block or IQF or S.IQF)
- Net weight (NW) of frozen product (70% net weight or 80% net weight, etc.)
- Percentage (%) of glaze (30% glaze or 20% glaze or 10% glaze, etc.)
- Size grade of shrimp (2/4 or 8/12 or 13/15 or 16/20 or 200/300, etc.)
- Count of shrimp (frozen count/real count)
- Treatment (treated with approved additives or non-treated)
- Packing (regular packing or bulk packing or special packing)
- Brand name (supplier's brand or buyer's brand, etc.)
- Storage instruction
- Nutritional value
- Origin of product
- Supplier and importer information
- Customer-readable language
- Production date and expiry date
- Price
- Others

In international business world, importers and exporters are not willing to write in details product description during business communication or purchase negotiation. Usually, importers and exporters try to explain the necessary details or information within a single line. Sometimes, all necessary details may not present here, but displaying of all information in packaging unit is mandatory. See the following example of how to explain a specification within a single line during purchase negotiation of frozen shrimp.



[Note: BT = Black Tiger, PND = peeled and deveined, NW = net weight, RC = real count, STTP = sodium tri-polyphosphate, CTS = cartons].

2.2 Types of Frozen Shrimp

Shrimps are highly perishable, so it's important to take necessary steps to keep the shrimp fresh for longest possible time without any kind of quality deterioration. It's not because of freshness only but also the shelf life, test, texture, nutritional quality, and safety requirements. A variety of techniques are practiced in different types of processing industries in the world to keep the products safe, i.e., raw, blanched, cooked, canned, smoked, dried, and other forms of shrimps that are processed and ready to eat. Among the variety of products, this chapter highlights only the frozen shrimp and their product variations. There are three basic types of frozen shrimps, i.e. raw, blanched, and cooked frozen shrimps are commonly processed worldwide. These are as follows.

Raw:	Shrimps are frozen in a natural condition without cooking or blanching. Raw frozen shrimps are fresh, wholesome, hard translucent shells with natural color. M**uscles of raw frozen shrimp are** firm with full of flavor and absent odor. Any kind of discoloration or blackened/reddening edges, limp, slimy, or falling apart are the signs of quality deterioration of raw shrimp.
Blanched:	The word "blanched" means boiling of shrimps in water or stream for a very short time. Shrimps are blanched at a temperature of 65–100 °C for few seconds to a minute (15–60 s) depending on product specification and operation temperature. The raw shrimps changed its color immediately after blanching. Sometimes, blanched shrimps are considered as raw shrimps. Shrimps are transferred to cold water immediately after blanching to stop cooking. Leave the shrimps in water for 3–5 min, or until they cool completely. Stirring is done during cooling process to make sure all shrimps are cooled down properly. Always use an ice bath to cool blanched shrimp to avoid toughness; never allow shrimp to cool in the blanching water. Be careful about time duration; otherwise, shrimps will be cooked instead of blanched. Shrimps are frozen after blanching.
Cooked:	Cooking of shrimp can be done to inactivate the microbial load. The quality and safety of a cooked shrimp depend on cooking method, time duration, and temperature employed. Shrimps are boiled at 85–100 °C temperature for few minutes normally 1–5 min depending on size and type of shrimps. Cooking of shrimp is done using steam cooker. Shrimps are transferred to cold water immediately after cooking. Leave the shrimps in water until they cool completely. Avoid overcooking; otherwise, shrimps become tough and rubbery which leads to nutritional loss.

2.3 Diversification of Shrimp Products

The term "diversified product" refers to product changed or altered or improved or applied any kind of new technologies that makes it different. This is the process of value addition that helps to make opportunities for additional market potential and business expansion. This business strategy is used to increase the sales of products and provide an effective path for faster business growth in an international seafood market although it has some risks. Shrimps in processing industries are made diversified by developing their existing products by means of a variety of techniques such as freezing technique, processing technique, cutting technique, use of additives, marination, etc. Block, semi-IQF, and IQF are different types of freezing techniques that make the product diversified. Raw, blanched, cooked, marination, etc. are different types of processing techniques that make the product diversified. On the other hand, different types of cutting techniques, i.e., regular cut, two-segment cut, three-segment cut, deep cut, butterfly cut, grill cut, leaf cut, skewer, fantail round, etc., made the product diversified. The following are examples of some common diversified products produced worldwide:

- HOSO (head-on shell-on)
- Head-on body peeled or HO-body peeled
- HLSO (headless shell-on)
- PUD (peeled and un-deveined)
- EZP (easy peeled)
- P&D/PD/PND (peeled deveined tail-off)
- PDTO (peeled deveined tail-on)
- PUDC (peeled un-deveined and cooked)
- PDC (peeled deveined and cooked)
- Fantail round
- Peeled deveined tail-off skewer or P&D skewer
- Head-on skewer or HO-skewer
- Butterfly shrimp
- Broken
- Others

[Note that the shrimps that are already peeled, deveined, blanched, or cooked are not as flavorful as a raw fresh, wholesome shell on shrimp.]

The following are the images of some diversified products of frozen shrimp (Figs. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, and 2.9).

[Note: *Fantail round: Head and shell removed except last segment, shell on last segment, and tail fan present.

***Butterfly shrimp:** Peeled and deveined except for the last segment, and split longitudinally through the dorsal axis and make into two sections that remain attached on the ventral side.]

Fig. 2.1 HLSO shrimp

Fig. 2.2 Fantail round shrimp

2.4 Freezing Methods

Freezing is the method of preservation by lowering temperature that inhibits the growth of microorganisms and slows down the chemical changes (enzymatic reaction), resulting in the prevention of food spoilage and foodborne disease and extended shelf life of frozen shrimp. There are three basic types of freezing method used in shrimp processing industries worldwide. These are:

- IQF
- Semi-IQF
- Block

Time and temperature are two important factors for the freezing process. The time of freezing process depends on the following parameters:

Fig. 2.3 PND shrimp

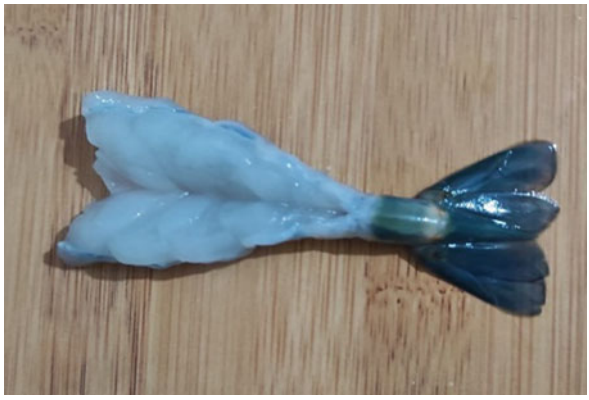


Fig. 2.4 Butterfly shrimp

Fig. 2.5 HO body peeled shrimp

Fig. 2.6 Shushi cut shrimp

Fig. 2.7 HOSO shrimp

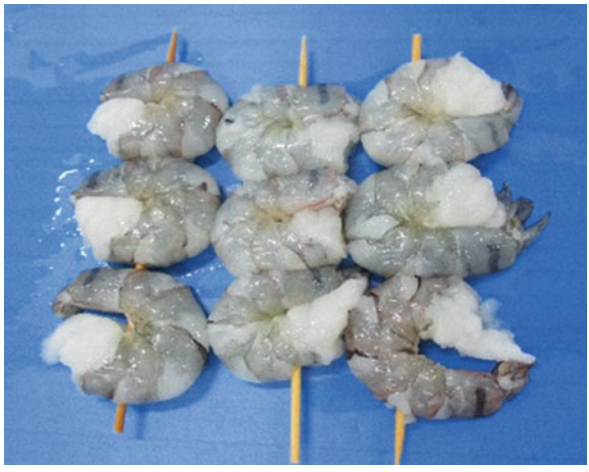


Fig. 2.8 P&D skewer shrimp

Fig. 2.9 HO-skewer shrimp

- Type of freezer and freezing method
- Operating temperature
- Type of product
- Percentage of glaze
- Temperature of product
- Size/grade of product
- Contact area and density of the product
- Thickness of product

[Note: Freezing of seafood products must be appropriated, because it preserves the quality, taste, nutritional value, and shelf life of frozen shrimp.]

2.4.1 Individual Quick Freezing (IQF)

IQF stands for individual quick freezing. Every single (individual) piece of shrimp is coated with water and frozen separately in this technique. The IQF shrimps are frozen at the temperature of −38 to −40 °C until the core temperature of the shrimp reached −18 °C. Spiral freezer is commonly used for IQF products as it freezes very quickly, as quickly as between 15 min and 1 h depending on thickness, size/grade, glaze %, and temperature of shrimps as well as the cooling performance of the machine. The conveyer belt is used to transport shrimp for various steps of IQF technique. Speed of conveyer belt is adjusted so that the products are frozen properly. IQF can be used to freeze raw, blanched, or cooked items of various diversified products. The following parameters should be checked carefully during IQF technique.

- Temperature of the freezer
- Temperature of raw materials (shrimp)
- Core temperature of shrimp

Fig. 2.10 Operation temperature

- Temperature of glazing water
- Percentage (%) of glazing
- Hardening temperature

[Note: The defect clumps arise from here. So attention should be given here to make sure the perfect arrangement of shrimp in conveyer belt and zero clumps in final products.]

The following are the images of different steps of IQF technique (Figs. 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, and 2.18).

In the case of blanched IQF, shrimps are blanched first and then are frozen. Shrimps are blanched to attain an attractive color. It also reduces microbial load and chemical reaction (enzymatic reaction) which can cause quality degradation, i.e., loss of flavor, color, texture, test, etc. Blanch frozen shrimp briefly to kill bacteria on their surface, extend the shelf life, and ensure that they are safe for human consumption. Salt and/or sugar may be added sometimes to the blanching water as per product specifications. It is necessary to blanch different grades of shrimps at different times to make blanched shrimps uniform. Shrimps of different grades are not allowed to be blanched at one time. Remember that blanched time is very short; otherwise, shrimp will be cooked instead of blanched.

In the case of cooked IQF, shrimps are almost same as blanched IQF shrimps except temperature variation. Typically, shrimps are cooked at 90–100 °C temperature. The cooking duration may vary from one to a few minutes depending on product size/grade, cooking methods, and specification. Generally, products are cooked in the cooking chamber by using the stem. The core temperature of the cooked product should be 72 °C. Shrimps of different grades are not allowed to be cooked at one time. Different grades of shrimp required different time and duration for uniform cooking. The following are the images of some blanched IQF and cooked IQF shrimps (Figs. 2.19, 2.20, 2.21, 2.22, 2.23, and 2.24).

2.4.1.1 Now the Question Is Why Shrimps Are Red After Cooking?

Raw shrimps are naturally grayish, but they turn into red when they are cooked. Biochemical reaction is the cause of this change. Chemicals inside the shellfish react

Fig. 2.11 Shrimp at conveyer belt

Fig. 2.12 Shrimp after freezing

Fig. 2.13 Glazing of shrimp

Fig. 2.14 Hardening chamber

Fig. 2.15 Shrimp after hardening

Fig. 2.16 IQF shrimp (BT HLSO-EP)

Fig. 2.17 IQF shrimp (BT P&D)

Fig. 2.18 IQF shrimp (FW HLSO)

to heat and turn its color from grayish to orange/reddish. In raw shrimps the pigment is attached to a certain protein within, but the pigment breaks away and becomes an independent orange/reddish substance when the shrimps are cooked. Raw shrimps are naturally observed grayish due to the accumulation of crustacyanin, a protein-astaxanthin complex that becomes orange with complex dissociation. This dissociation may occur because of heat/cooking (Parisenti et al. 2011).

- **Flowchart of raw/blanched/cooked-IQF shrimps** (Fig. 2.25)

2.4.2 Block Frozen

Block frozen is usually performed by plate freezer. Freezing temperature of block product varied from −38 °C to −40 °C, whereas core temperature of frozen shrimp must be at -18 °C. In case of block freezing, final/export grade shrimps are placed in

Fig. 2.19 Blanched IQF (HLSO EP)

Fig. 2.20 Blanched IQF (P&D)

Fig. 2.21 Blanched IQF (PUD)

Fig. 2.22 Cooked IQF (HOSO)

Fig. 2.23 Cooked IQF (HLSO)

Fig. 2.24 Cooked IQF (PDTO)

freezing pan in a way of systematic arrangement and wrapped with a loose low-density transparent liner polyethylene (LDPE film or HM-HDPE film). Chilled water is poured into the pan at right volume (considering the percentage of glaze as

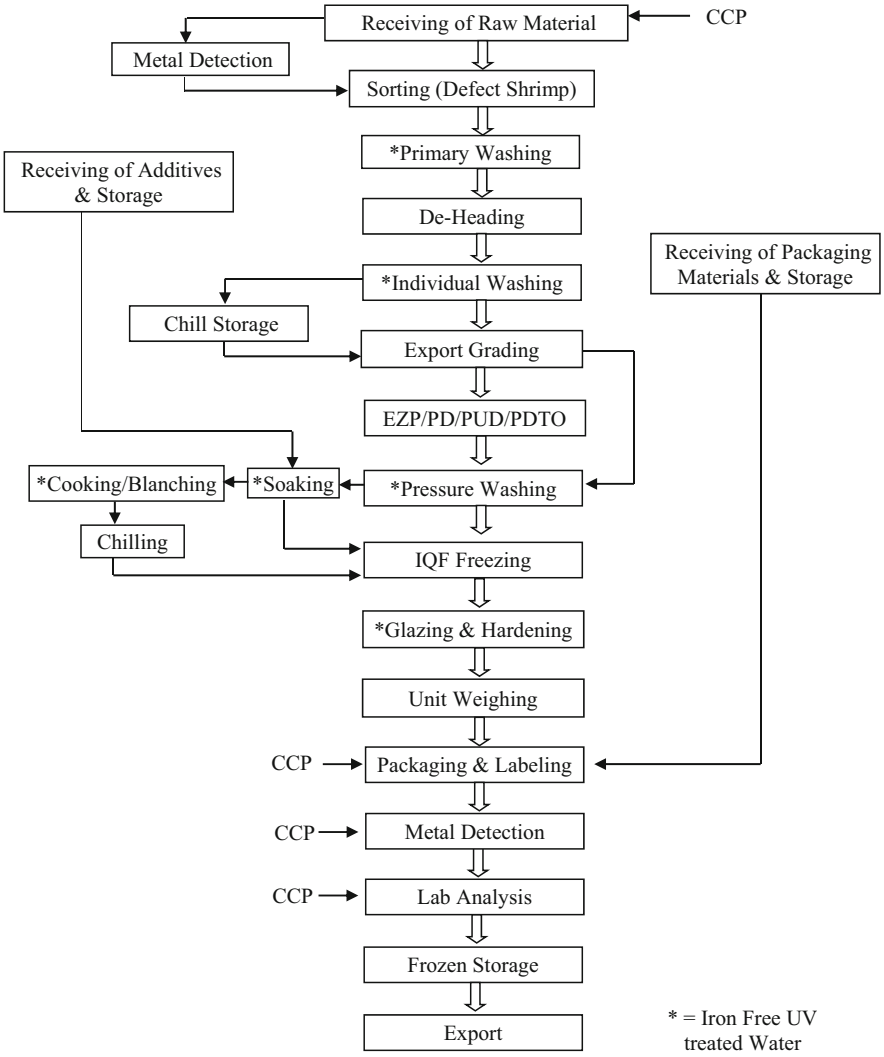


Fig. 2.25 Steps of IQF shrimp

per specification) to fill up the spaces among the shrimps and help to produce uniform block. Finally, the pans are transferred to contact plate freezer covered with a lid. Sometimes a little volume of flake ice is used at the top of the pan to maintain the temperature of the water and forwarded to next step of freezing. In contact plate freezer, shrimps are frozen at -40 °C for several hours (normally 1.5–4 h) depending on the thickness of the slab and the cooling performance of the freezer. Remember that the quicker the freezing, the better the quality of blocked shrimp. The core temperature of the block frozen shrimp should be at least −18 °C. After completion of the freezing process, blocks are brought out from the freezer and

Fig. 2.26 Shrimp arrangement

made separated from the pan using water spray over it. Water should be spread from the back side of the freezing pans to isolate the block from pan. Sometimes the separated blocks are glazed again for its shiny color and smart appearance. Finally, the blocks are sent for final packaging. Packaging materials are prepared previously. The following parameters should be checked properly during the freezing process:

- Temperature of raw materials (shrimp)
- Temperature of water
- Freezer temperature and duration
- Core temperature of shrimp
- Percentage (%) of glaze water
- Proper tagging (lot, size/grade, etc.)

The following are the images of different steps of block frozen shrimp (Figs. 2.26, 2.27, 2.28, 2.29, 2.30, 2.31, 2.32, 2.33, and 2.34).

[Note: Volume of glaze water should be accurate; sometimes excess volume of water are used for block freezing that may create problem in final inspection and weighing in port. Handling of frozen block should be very careful and in hygienic way.]

- **Flowchart of block frozen shrimp** (Fig. 2.35)

2.4.3 Semi-IQF

Semi-IQF is a freezing method which is performed for HOSO shrimps. Semi-IQF is itself a block product, but the difference is that the whole products are not submerged within water like frozen block. In case of semi-IQF products, whole shrimps are not covered with water. Only about 50% shrimps (at the bottom part) are submerged into water, and the rest of the products remains open (not in submerged condition).

Fig. 2.27 Pan with water and ice

Fig. 2.28 Wrapped with poly

Semi-IQF is usually performed by plate/contact freezer. Freezing temperature varied from −38 °C to −40 °C depending on freezer, whereas the core temperature of the semi-IQF shrimp should be at least −18 °C. Freezing duration also depends on product specification and types of freezers. The following parameters should be checked properly during the freezing process.

- Temperature of raw materials (HO shrimp)
- Temperature of water
- Freezer temperature and duration
- Core temperature of shrimp
- Percentage (%) of glaze water
- Proper tagging (lot, size/grade etc.)

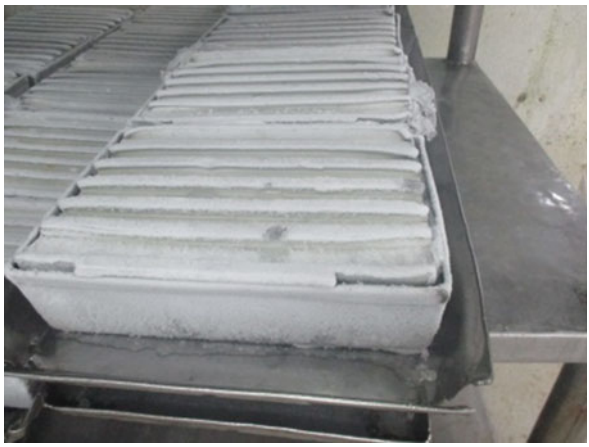


Fig. 2.29 Pan with lid

Fig. 2.30 Freezer (inner view)

Fig. 2.31 Freezer (loading)

Fig. 2.32 Block in pan

Fig. 2.33 Spray to separate block

Fig. 2.34 Final block

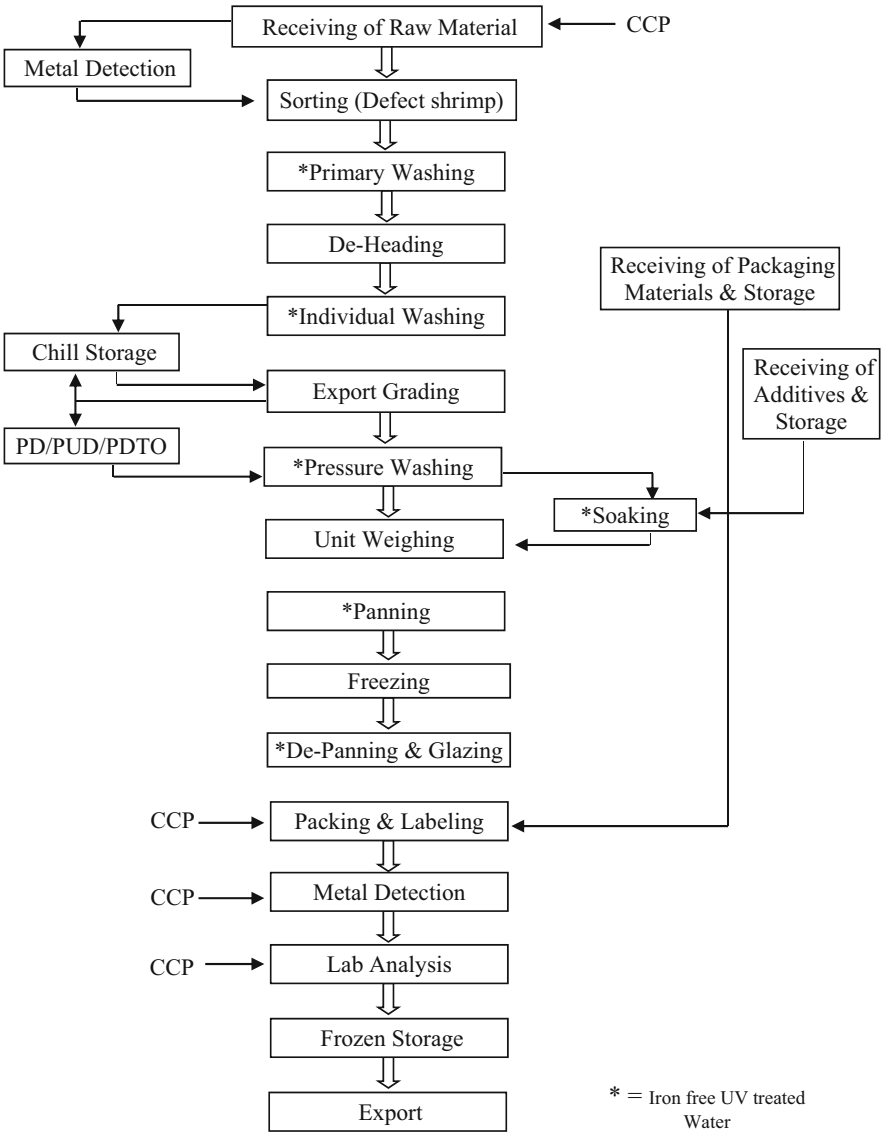


Fig. 2.35 Steps of block frozen shrimp

The following are the images of some semi-IQF shrimp (Figs. 2.36, 2.37, and 2.38).

[Note: Dropping head/lose head, yellow head, black head, discolored, decomposed, broken, and lower grade shrimp have to be removed during processing of semi-IQF shrimp.]

Fig. 2.36 HOSO straight

Fig. 2.37 HO body-peeled-straight

- **Flowchart of HOSO semi-IQF shrimp** (Fig. 2.39)

2.5 Packing of Shrimp

The terms "packing" and "packaging" are often confusing but not exactly of same meaning. Packing is a part of packaging. Packing means the unit volume or quantity of shrimps that are used to pack, whereas packaging is the process of wrapping goods for marketing and shipping. Packing is different for different types of frozen products. Variation of packing depends on its end users, customers' demands, and final destinations. Importers specified their packing variation as per their business strategy. The following are the examples of packing variation of different products.

Fig. 2.38 HOSO-flat

2.5.1 Packing of Block Product

Usually, 6 × 1.8 kg packing is used for block frozen shrimp. Here, 6 × 1.8 kg packing means six inner blocks/boxes are present inside the master carton, whereas the weight of a single block is 1.8 kg (1800 g) and weight of whole master carton is 6 × 1.8 = 10.80 kg. Packing of block frozen shrimp is not a rigid thing; it may vary as per customer's requirements, i.e., 6 × 2 kg, 6 × 1.2 kg, 6 × 1.4 kg, 6 × 1.8 kg, etc. are commonly used packing of block frozen shrimp. Specific freezing pans are used for specific sizes of block. Pan is a metallic structure and mandatory for block frozen shrimp. Pan of different dimensions is used for different packing (Figs. 2.40 and 2.41).

2.5.2 Packing of Semi-IQF Product

In case of Semi-IQF product 10 × 1 kg packing usually used. It means ten inner boxes are present within a master carton, whereas weight of an inner box is 1.0 kg and weight of whole master carton is 10 × 1 = 10.0 kg. Special type of inner box is used for semi-IQF product. The box contains two parts: (1) upper part (top part) and (2) lower part (bottom part). Another special character of semi-IQF box is window. A window is present in every box. Finally, inner box is wrapped with poly paper.

2.5.3 Packing of IQF Product

There are two types of packing that are used for IQF products.

- Regular packing (10 × 1 kg)
- Bulk packing (1 × 10 kg)

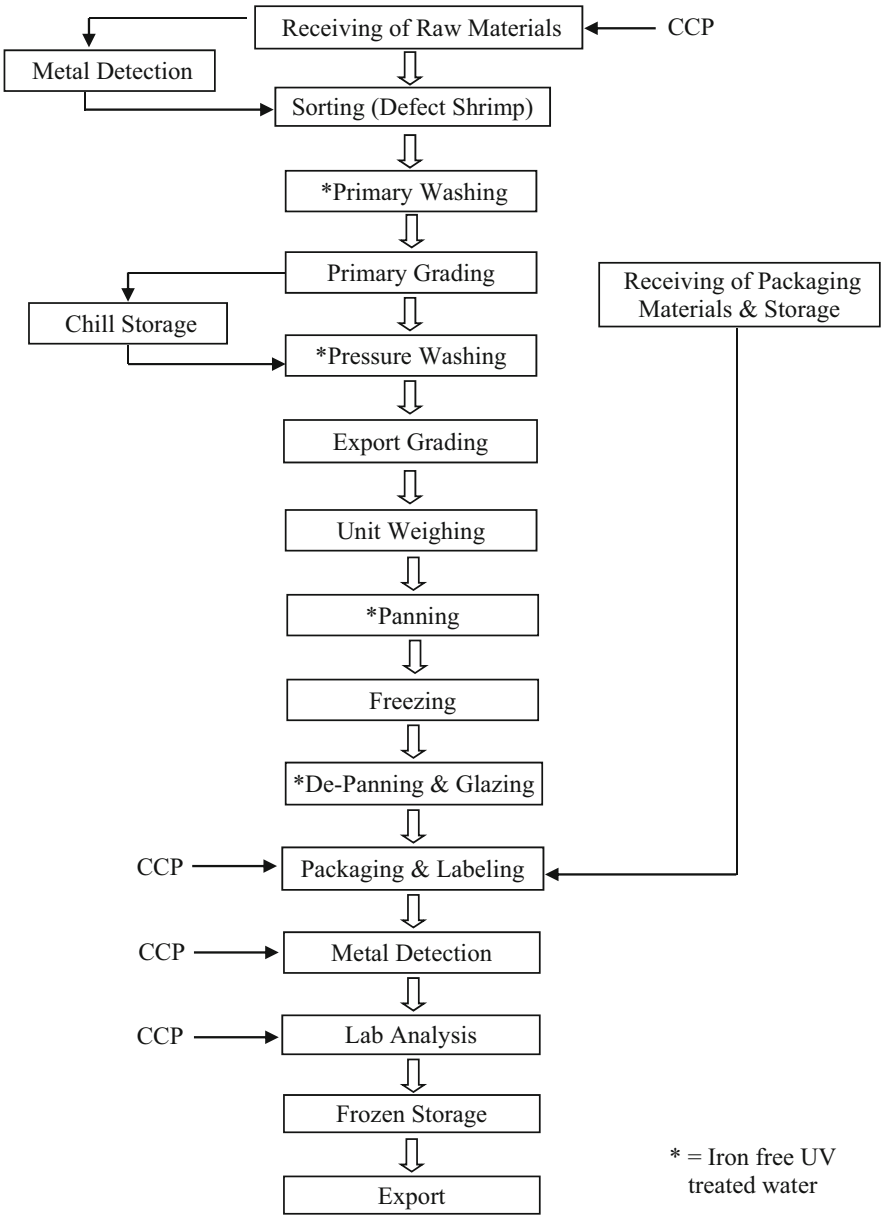


Fig. 2.39 Steps of HOSO semi-IQF shrimp

2.5.3.1 Regular Packing (10 × 1 kg)

Regular packing of shrimp is the most commonly used worldwide. Generally, 10 × 1 kg packing is commonly used regular packing of IQF shrimps. It means ten inner bags (individual bags) are present inside the master carton, whereas the

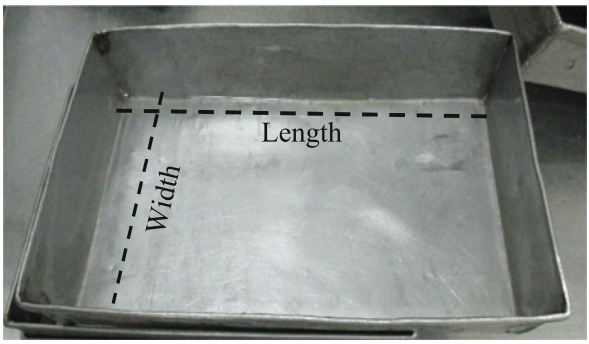


Fig. 2.40 Pan of block frozen shrimp

Fig. 2.41 Arrangement of shrimps in pan

Fig. 2.42 IQF packing (10 × 1 kg) in MC

weight of one bag is 1.0 kg and weight of whole master carton is 10.0 kg (10 × 1 = 10.0 kg). Recommended poly bag and rider/header card are used for IQF packing. Dimension and design of master cartons, poly bags, and rider cards are specified previously. See the following image of regular packing (10 × 1 kg) of IQF shrimp (Figs. 2.42 and 2.43).

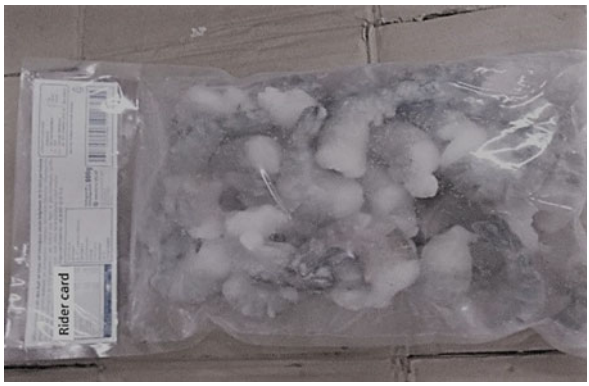


Fig. 2.43 IQF packing (polybag)

2.5.3.2 Bulk Packing (1 × 10 kg)

Bulk packing (1 × 10 kg) is a special type of packing but hardly used in shrimp business. In bulk packing (1 × 10 kg), the whole shrimps are packed in a bulk condition instead of individual IQF packing (10 × 1 kg). It means the whole 10 kg IQF shrimps are packed in a special type of single poly bag instead of individual 1.0 kg poly bag. A plain (not printed) large size of special type of poly bag is used for bulk packing. Suitable dimension of bulk poly bag is 700 × 700 mm ± 20 mm, whereas dimension of individual poly bag is 400 × 250 mm ± 10 mm. Dimension is not a rigid thing; it may vary on client's requirement and specification of the products. There are two types of color (blue and white) bags that are mostly used for bulk packing. Blue color bags are too much appreciated because of their good-looking characteristics. Bulk packing is performed for IQF products only, whereas the shrimps that need to be re-processed further. Re-processing of shrimp is mainly performed as per client requirements and better prices. The following are the images of bulk packing shrimp (Figs. 2.44, 2.45, 2.46, and 2.47).

2.6 Weight Declaration

Weight declaration is a crucial part of international seafood business. It means confirmation of actual weight or net weight of shrimp within the frozen products. Different types of weight are calculated in frozen seafood business, i.e., gross weight, frozen weight, deglazed weight, defrost weight, net weight, etc. Shrimps are biological products and perishable food items that need to be frozen for long-term preservation. It is quite impossible to freeze shrimp without water so that water must be added to shrimp before proceeding to freezing process. Now the question is how much volume of water should be added in frozen shrimp? Actually, percentage of water and percentage of shrimp are pre-determined as per specifications. Percentage of water, i.e., 10%, 20%, 25%, 30%, or 40% water, is mixed with percentage of shrimps, i.e., 90%, 80%, 75%, 70%, or 60% shrimp, respectively, whereas the total volume (water + shrimp) is 100%. Importers fixed up the percentage of water as per

Fig. 2.44 Bulk packing: 1 × 10 kg (open view)

Fig. 2.45 Bulk packing: 1 × 10 kg (inner view)

customers' preference and types of product specification. The price of frozen products can also be calculated based on their actual/net weight of frozen products.

For example, a product of BT is HLSO, raw, block, 80% net weight, 6 × 1.8 kg packing; now calculate the volume of water and net weight of shrimp. Here, net weight of product is 80% and the rest of 20% is water. See the following calculation.

Block product	
80% net weight means = 80% of 1800 g $= \frac{80}{100} \times 1800$ g = 1440 g **Or,** Volume of water = 1800–1440 g = 360 g	Here, Net weight = 80% Packing = 6 × 1.8 kg (means 1800 g/Block) Net weight of product = ? Volume of water = ?
Result: Net weight of shrimp is 1440 g and weight of water is 360 g.	
IQF/semi-IQF product	
Net weight product = 80% of 1000 g $= \frac{80}{100} \times 1000$ g = 800 g **Or,** Volume of water = 1000–800 g = 200 g	Here, Net weight = 80% Packing = 10 × 1 kg (means 1000 g/Box or block) Net weight of product = ? Volume of water = ?
Result: Net weight of shrimp is 800 g and weight of water is 200 g.	

Fig. 2.46 Weighing of bulk packing (1 × 10 kg)

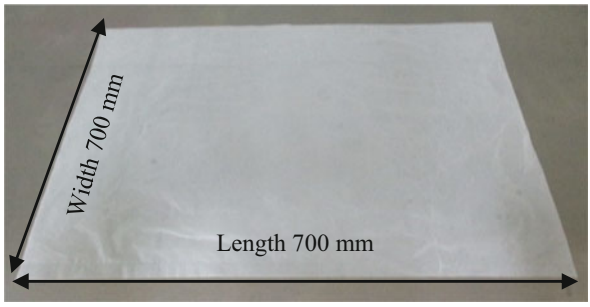


Fig. 2.47 White bag for bulk packing (1 × 10 kg)

[Note: Shortage of weight is a kind of crime. It affects business reputation of the company as well as the whole country. Importers stop buying shrimp from that supplier and even from that country and claim demurrage charge for such types of offense. Sometimes, weight shortage may happen unintentionally during deglazing and storage; that's why some importers put some extra weight to avoid that type of awkward situation.]

2.7 Brand Selection

Brand is a term/name/symbol/design or another feature that distinguishes the products or business organization from its rivals. Brand image is an important fact in business world; it helps to develop business through marketing and advertising. Customers distinguish and choose products based on its brand image. Suppliers and buyers both have their own brand. Selection of brand greatly depends on buyer's instruction: either it is exporters' brand or importers' brand. Buyers select their brand based on market reputation and customer's demand. On the other hand, customers choose their brand based on product quality as well as market reputation of that products.

2.8 Size/Grade of Shrimp

Grading comes from the verb grade; it means "classify or sort." Grading of shrimp is done for the uniform sizes of shrimp. Shrimps are graded according to their weight. Quality grading is very much important to assess the quality of frozen shrimp. It helps to create brand value. If grading is not in proper way, uniformity goes high that may not be accepted by the buyer or may lead the buyer to complain demurrage charge against supplier for improper grading of shrimp. Grading starts from receiving of raw materials and continues in different stages of processing. Proper sanitation, standard chilled temperature, and appropriate grading must be maintained during grading procedure. Sometimes it was observed that professional graders are not willing to wear hand gloves during their grading procedure because it makes their activity slower.

[Note that some processing industries don't have their own professional graders but are performing their grading activities using contractual graders. The contractual graders are now willing to grade shrimp as per specifications. However, suppliers should bear in mind, seafood business in international market greatly depends on good reputation. It will take a long time to recover the reputation if anyone loses it once.]

There are two types of grading that are practiced in shrimp in processing industries. These are as follows.

1. Primary grading:	Primary grading is the first step of grading procedure. Suppliers grade their shrimp during receiving of raw materials at processing industry premises. The shrimps are unloaded from the trawlers or refrigerated vehicle and transported to receiving room for grading. Temperature of the receiving room must be at least 4 °C. Quality control (QC) personnel should check the quality (temperature/disease/softshell/pushed/dart/filth, etc.) of raw materials and discards the products if the products didn't meet the requirements buyer's specifications during primary grading.
2. Final grading or export grading:	Final grading or export grading is performed after soaking (if necessary) of shrimp and before going to freezing process. This is the last stage of grading before packaging. Suppliers follow the international standard of grading procedure for final grading. Quality graders are necessary for this type of grading, and it must be cross-checked by the expert personnel. Uniformity arises from here which is the major concern of importers. So, attention should be very carefully in final stage of grading and need to avoid contractual graders.

- The following gradings are practiced for international shrimp business throughout the world.

• 2/4	• 40/50
• 4/6	• 41/50
• 6/8	• 50/60
• 8/12	• 51/60

(continued)

• 13/15 • 16/20 • 21/25 • 26/30 • 21/30 • 31/35 • 30/40 • 31/40	• 61/70 • 70/90 • 71/90 • 100/200 • 150/250 • 300/500 • U/5 • U/10

- **Now the question is what is the meaning of 16/20? Is there any real meaning?**

Yes, of course it has a real meaning. 16/20 is a range of shrimp. It means 16 to 20 pieces (pcs) of shrimps are present in 454 g (1 *lb)*, whereas 16 pcs/*lb* is the largest grade and 20 pcs/*lb* is the smallest grade of shrimp. Any grades of shrimps within the range of 16–20 are acceptable, but shrimps out of range are not acceptable. See the following example for the clarification:

16 pieces of shrimp per 454 g. [Acceptable]
17 pieces of shrimp per 454 g. [Acceptable]
18 pieces of shrimp per 454 g. [Acceptable]
19 pieces of shrimp per 454 g. [Acceptable]
20 pieces of shrimp per 454 g. [Acceptable]
21 pieces of shrimp per 454 g. [Not Acceptable]
22 pieces of shrimp per 454 g. [Not Acceptable]
23 pieces of shrimp per 454 g. [Not Acceptable]
24 pieces of shrimp per 454 g. [Not Acceptable]

But what will happen if suppliers provide lower than 16 pieces of shrimp per pound? For example, are 15 pcs/*lb*, or 14 pcs/*lb*, or 13 pcs/*lb* shrimp acceptable by the buyer or not? Normally, buyers are not interested to buy these types of grading because the labeling is not matched with declared number of shrimp. As a result, customers think that suppliers betray with them and they are losing some pieces of shrimps. Sometimes buyers may accept it without any hesitation, but suppliers won't provide ever that types of grading because they will sell this higher-graded shrimp with higher price. The following are the images of 16/20 grade shrimp (Fig. 2.48):

[Note: U/10 means there are 10 or less than 10 shrimps present per pound. Remember that 1 pound = 453.59237 g. Normally, suppliers consider it 454 g for easier calculation.]

Processing industries are used to make average pcs/*lb* for the calculation of grading. As per standard protocol, average pcs/*lb* will be 18 {(16 + 20)/2} for 16/20 grade of shrimp, but practically, suppliers perform their grading through a technical way. Suppliers estimate their average grading by counting lower grade of shrimp. It means suppliers calculate their average grade by counting (18 + 22)/2 = 20 pcs/*lb* instead of (16 + 20)/2 = 18 pcs/*lb* for 16/20 grade of shrimp, but total pcs/*lb* will be the same within standard limit. They never exceed 20 pcs/*lb* for 16/20 shrimp. Total pcs/bag will also be within the limit.

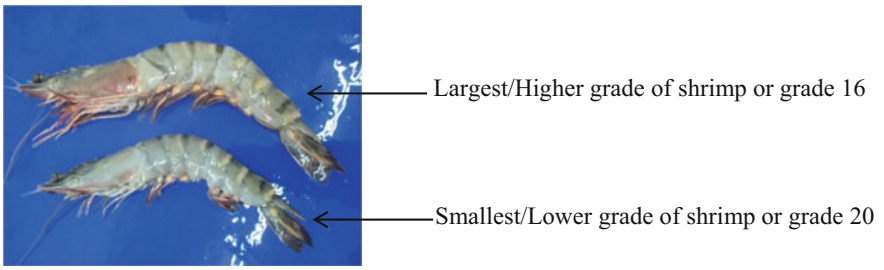


Fig. 2.48 Largest and smallest grades of shrimp

Table 2.1 Calculation of average pieces and grades in shrimp

Export grade	Higher grade + lower grade	Average	Status	Remarks
16/20	16 + 20	= 18 pcs	Standard	Rare practice
	18 + 22	= 20 pcs	Practical	Common practice
	17 + 23	= 20 pcs	Practical	Rare practice

As a result, suppliers are doing 18/22 grade instead of 16/20 grading, but total pcs/bag will be same as standard; just some small pieces are included here. In case of 18/22, lower grade is 22 and higher grade is 18 but average 20 pcs/*lb*. Sometimes some corrupt suppliers use 17/23 grading instead of 16/20 that is alarming for international seafood business. See the following example for more clarification (Table 2.1).

- **The reasons for use of 17/23 or 18/22 grade instead of 16/20**
  - Unavailability of 16/20 grades at that time.
  - Availability of 17/23 or 18/22 grades at the same time.
  - Proper utilization of all sizes of shrimps.
  - For the calculation of total pcs/bag within the limit.
  - Sometimes grading may not be accurate because of manual/hand grading. As 18/22 and 17/23 are very close to 16/20 grade and the possibility of chances of mixing some lower grade shrimp.
  - Sometimes corrupt suppliers intentionally mixed lower grade shrimp with the desired grade shrimp. They did it for selling smaller shrimp at higher price and higher profit. That is, the illegal way sometimes occurs in processing industries. This type of illegal activities must be stopped immediately.

2.8.1 Grading Method

There are two types of grading method that are practiced in processing industries. These are as follows.

Fig. 2.49 Manual grading

1. **Manual Grading**
   Manual grading means grading of shrimp performed by the hand of expert graders. Manual grading is nothing but an assumption of expert grader based on the size and weight of shrimp. Expert graders make grading as per their basic knowledge, experience, and instruction received from the industry. The quality of manual grading depends on the quality and experience of expert graders. Suppliers usually preferred manual grading because manual grading is very fast comparing to mechanical grading. Manual grading sometimes may not be accurate as mechanical grading. Manual grading is also called hand grading.
   The following are the images of grading of shrimp (Figs. 2.49, 2.50, and 2.51).
2. **Mechanical Grading**
   Mechanical grading means grading of shrimp through automatic grading machine. Mechanical grading is also called automatic grading. Grader machine mechanically grades the shrimp by passing them over a series of inclined rollers set to segregate individual shrimp by differences in thickness/weight. As the shrimps cascade through the rollers, the various sizes are diverted by chutes into baskets. The baskets of various sizes of shrimp are placed in separate totes. Mechanical grading is more accurate than manual grading. Processing industries all over the world are now grading their shrimps by using automatic grading machine; however, some still preferred manual grading because mechanical grading is a time-consuming process. Mechanical grading is also a high-speed grading system that is more accurate and can be performed with minimizing operator's workload (Fig. 2.52).

- **Precaution of grading**
  - Manual grading is too fast. It may cause poor grading.
  - Professional graders are mostly illiterate and not aware of quality grading or uniformity.
  - Lack of proper supervision from factory personnel.

Fig. 2.50 Grade of 16/20 (HOSO)

Fig. 2.51 Grade of 6/8 (HLSO)

Fig. 2.52 Grading of shrimp with automatic grading machine

- Be careful in grading when performed by third-party people with a contract basis. They don't have any concerns about quality grading.
- Sometimes graders make rough grading intentionally as per instruction of factory personnel. It may happen because of the scarcity of raw materials, the politics of rivals, or more profit. These types of practices are illegal and must be stopped.

Grading should be supervised very carefully because uniformity arises from here. Uniformity is a too important criterion for shrimp business. If any kinds of anomalies are found in the grading system, necessary steps should be taken immediately to diminish it as early as possible. Importers are more serious about uniformity. If the buyer found abnormal uniformity, it may cause to stop shipment immediately as well as business in the future.

[Note: It is necessary to avoid contract basis grading system. If not possible to avoid contract basis grading system then processing industries should train the professional graders to understand the quality of grading, uniformity, and prospects of grading in these sectors. Only consciousness of expert graders and factory owner can solve this type of problem.]

2.9 Uniformity of Shrimp

Uniformity is the quality or state of being uniform or homogeneity of shrimp. It's related to the grading of shrimp. It means the uniform size as well as uniform weight of shrimp. Uniformity ensures precise pieces and the weight of shrimp. Uniformity is one of the important parts of quality control of shrimp. Uniformity ratio helps buyer to assess the quality of shrimp. The lower uniformity implies good quality product, but higher uniformity implies less quality product. It is expected that the uniformity ratio should not be more than 1.5. The following parameters should be ensured during confirmation of standard grade of uniformity ratio:

- Uniform size of every shrimp.
- Uniform weight of every shrimp. Individual weight of shrimp must be within limit.
- Underweight shrimp should be avoided.
- Overweight shrimp should also be avoided.
- No. of pcs/*lb* or pcs/kg must be within the limit. Never cross the standard limit.
- No. of pcs/bag must also be accurate. Pieces out of limit are strictly prohibited.

The following are the images of some uniform shrimp (Figs. 2.53, 2.54, and 2.55).

- **How Can We Determine Uniformity Ratio?**

The following steps should be followed to determine the uniformity ratio:

Fig. 2.53 Uniformity (HOSO)

Fig. 2.54 Uniformity (HLSO)

Fig. 2.55 Uniformity (PND)

Step 1:	At first, shrimp of upper grade (largest size) and shrimp of lower grade (smallest size) should be separated.
Step 2:	Weight of 10% largest shrimp should be taken and noted down
Step 3:	Weight of 10% smallest shrimp should also be taken and noted down
Step 4:	Divide the weight of 10% largest shrimp by the weight of 10% smallest shrimp for the calculation of uniformity ratio

$$\text{Uniformity Ratio} = \frac{\text{Weight of 10\%largest shrimp (g)}}{\text{Weight of 10\%smallest shrimp (g)}}$$

The tolerance limit of uniformity ratio may vary from product to product and buyer to buyer. Generally, buyer asked to maintain uniformity ratio within 1.20 or 1.30, but it may be accepted till 1.5 based on size and type of products. Sometimes buyer may accept uniformity ratio out of 1.5 for larger grade of shrimp.

[Note: Uniformity ratio should be measured in a deglazed condition, not in defrost condition. Measurement of uniformity ratio in defrost condition is a wrong method. If, someone measures uniformity ratio in defrost condition, soaking gain of the products may be released out, resulting in a shortage of weight and higher uniformity ratio.]

*Calculate and justify uniformity ratio for BT, HLSO-EZP, raw, 8/12, FC, 80% net weight, and 10 × 1 kg IQF products, whereas total pcs/bag is 26, weight of 10% largest shrimp is 106 g, and the weight of 10% smallest shrimp is 82 g

Uniformity Ratio: $= \frac{\text{Weight of 10\%largest shrimp (g)}}{\text{Weight of 10\%smallest shrimp (g)}}$ $= \frac{106}{82}$ $= 1.29$	Here, Total pcs/block = 26 Weight of 10% largest shrimp = 106 g Weight of 10% largest shrimp = 82 g Uniformity ratio = ?

Justification: Now cross-check with standard uniformity ratio. Standard uniformity ratio is 12/8 = 1.50. In this product uniformity ratio is 1.29 that indicates the shrimps are within the limit and uniform in size. If the uniformity ratio observed is within the limit, the product should be accepted; otherwise, product may not be accepted or decision goes to the buyer's opinion (Figs. 2.56 and 2.57).

[Note: Count total pcs per bag first. Suppose it has 26 pcs/bag. 10% of 26 = 2.6 or 3 pcs (0.6 shrimp is not possible). That means 3 largest pcs and 3 smallest pcs should be taken for the calculation of uniformity ratio for this product. Here, the weight of 3 pcs largest shrimp is 106 g and the weight of 3 pcs smallest shrimp is 82 g.]

Perform the following exercises

Exercise 1:	Calculate uniformity ratio, when the weight of 10% largest shrimps is 95 g and weight of 10% smallest shrimps is 72 g.
Exercise 2:	Calculate uniformity ratio and justify for BT, HLSO, raw, 21/25, RC, 80% net weight, 10 × 1 kg IQF shrimps. The individual weight of largest grade and smallest grade shrimp is 22 g and 18 g, respectively. [Hints: Pcs should be standard.]
Exercise 3:	Suppose this is BT, HLSO, raw, 31/40, RC, 70% net weight, 6 × 1.8 kg block products. If total pcs per block is 110, calculate the uniformity ratio and justify it. [Hints: The individual weight of shrimp should be standard.]

(continued)

Fig. 2.56 Weight of 10% smallest shrimp

Fig. 2.57 Weight of 10% largest shrimp

Exercise 4:	Calculate and justify uniformity ratio for BT, HOSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg semi-IQF shrimps, whereas the weight of the largest and smallest shrimp is 99 g and 70 g, respectively.
Exercise 5:	Calculate and justify uniformity ratio for BT, PD, raw, 26/30, FC, 75% net weight, 10 × 1 kg IQF products. [Hints: Everything should be standard and maximum.]

2.10 Count of Shrimp

There are two types of counting system that are practiced in shrimp processing industries. These are:

- Frozen count (FC)
- Real count (RC)

The count of shrimp is very important. The price of shrimp depends on these count variations. The price of the real count is higher than the price of frozen count for same grade of shrimp. The main difference in frozen count and real count is the

variation of individual weight and number of pcs/*lb*. The individual weight of shrimp is lower and the larger number of pcs/*lb* observed is higher in frozen count (FC), whereas vice versa in real count (RC). The details of frozen count and real count are as follows.

2.10.1 Frozen Count (FC)

Simply, frozen count (FC) means frozen weight of shrimp or weighing of shrimp in frozen condition. Frozen count is calculated including the weight of shrimp plus weight of glaze. In frozen counting method, the individual weight of shrimp goes lower and total pcs/*lb* goes higher because the shrimps are weighted with their glazing.

- **Calculation of Pieces (Pcs) for IQF Shrimp (FC)**

*Calculate how many pieces of shrimp will be in a bag for BT, HLSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg IQF products.

Maximum no. of pcs per bag $= \frac{\text{Lowest grade}}{454} \times$ Frozen weight $= \frac{12}{454} \times 1000$ $= 26.43$ or 26 pcs/bag **Again,** Minimum no. of pcs per bag $= \frac{\text{Highest grade}}{454} \times$ Frozen weight $= \frac{8}{454} \times 1000$ $= 17.6$ or 18 pcs/bag (0.6 shrimp is not possible)	Here, Size/grade = 8/12 Lowest grade is = 12 pcs/*lb* Highest grade is = 8 pcs/*lb* Packing =10 × 1 kg Frozen weight = 1000 g 80% Net weight = 800 g 1 *lb* = 454 g Max. Pcs/bag = ? Min. Pcs/bag = ?

Result: Pieces range is 18–26 per bag. It means a maximum of 26 pcs and a minimum of 18 pcs should be presented in a bag for 8/12, FC, 80% net weight, 10x1 kg, IQF products.

Perform the following exercises

Exercise 1:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO-EZP, 13/15, FC, 80% net weight, 10 × 1 kg, IQF products.
Exercise 2:	Calculate how many pcs of shrimp will be in a bag for BT, PD, 16/20, FC, 75% net weight, 10 × 1 kg, IQF products.
Exercise 3:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO, 21/25, FC, 60% net weight, 10 × 1 kg, IQF products.
Exercise 4:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO, PDTO, 31/40, FC, 70% net weight, 10 × 1 kg, IQF products.
Exercise 5:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO, 71/90, FC, 75% net weight, 10 × 1 kg, IQF products.

[Appendix B: Size and weight table]

- **Calculation of Pieces (Pcs) for Semi-IQF Shrimp (FC)**

*Calculate how many pcs of shrimps will be in a box for BT, HOSO, raw, 16/20, FC, 75% net weight, 10 × 1 kg semi-IQF products.

Maximum no. of pcs per box $= \frac{\text{Lowest grade}}{1000} \times$ Frozen weight $= \frac{12}{1000} \times 1000$ $= 12$ pcs/box **Again,** Minimum no. of pcs per box $= \frac{\text{Highest grade}}{1000} \times$ Frozen weight $= \frac{8}{1000} \times 1000$ $= 8$ pcs/box	Here, Size/grade = 8/12 Lowest grade is = 12 pcs/kg Highest grade is = 8 pcs/kg Packing = 10 × 1 kg Frozen weight = 1000 g 75% Net weight = 750 g 1 kg = 1000 g Max. Pcs/box =? Min. Pcs/box = ??

Result: The range of pieces is 8–12 per box or semi-IQF block; it means final grade is same as a grade of requirement. Maximum 12 and minimum 8 pcs can be presented in a box for BT, HOSO, raw, 16/20, FC, 75% net weight, 10 × 1 kg semi-IQF shrimp.

[Note: Calculation of pcs for semi-IQF is different. Here, unit weights are calculated in kg instead of the pound (*lb*) and total pcs/box or semi-IQF block is same as the final grade.]

Perform the following exercises

Exercise 1:	Calculate how many pcs of shrimp will be in a box for BT, HOSO, raw, 13/15, FC, 80% net weight, 10 × 1 kg, semi-IQF products.
Exercise 2:	Calculate how many pcs of shrimp will be in a block for BT, HOSO, raw, 16/20, FC, 75% net weight, 10 × 1 kg, semi-IQF products.
Exercise 3:	Calculate how many pcs of shrimp will have in a box for BT, HOSO, raw, 21/30, FC, 80% net weight, 10 × 1 kg, semi-IQF products.
Exercise 4:	Calculate how many pcs of shrimp will be in a box for BT, HOSO, raw, 40/50, FC, 70% net weight, 10 × 1 kg, semi-IQF products.
Exercise 5:	Calculate how many pcs of shrimp will be in a block for BT, HOSO, raw, 41/50, FC, 60% net weight, 10 × 1 kg, semi-IQF products.

[Appendix B: Size and weight table]

2.10.2 Real Count (RC)

Real count means weighing of shrimp in deglaze condition or weighing of shrimp without considering their glaze. Real count is the method where the individual weight of shrimp is higher and total pcs/*lb* goes lower because glaze is not considered here. It means total pcs of shrimp per unit weight (*lb* or kg) is calculated based on their net weight only. Net weight should be calculated after deglazing/defrosting/thawing of shrimp. The price of real count shrimp is higher.

- **Calculation of Pieces (Pcs) for IQF Shrimp (RC)**

*Calculate how many pcs of shrimps can be present in a bag for BT, HLSO, 8/12, RC, 80% net weight, 10 × 1 kg, IQF products?

Maximum no. of pcs per bag $= \frac{\text{Lowest grade}}{454} \times$ Net weight $= \frac{12}{454} \times 800$ $= 21.14$ or 21 pcs/bag **Again,** Minimum no. of pcs per bag $= \frac{\text{Highest grade}}{454} \times$ Net weight $= \frac{8}{454} \times 800$ $= 14.1$ or 14 pcs/bag (0.1 shrimp is not possible)	Here, Size/grade = 8/12 Lowest grade is = 12 Highest grade is = 8 Packing = 10 × 1 kg Frozen weight = 1000 g 80% Net weight = 800 g 1 *lb* = 454 g Max. Pcs/bag = ? Min. Pcs/bag = ?

Result: Pieces range is 14–21 per bag. It means a maximum of 21 pcs and a minimum of 14 pcs should be presented in a bag for 8/12, RC, 80% net weight, 10x1 kg, IQF products.

Perform the following exercises

Exercise 1:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO-EZP, raw, 13/15, RC, 80% net weight, 10 × 1 kg, IQF products.
Exercise 2:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO, raw, 16/20, RC, 60% net weight, 10 × 1 kg, IQF products.
Exercise 3:	Calculate how many pcs of shrimp will be in a bag for BT, PD, raw, 21/25, RC, 75% net weight, 10 × 1 kg, IQF products.
Exercise 4:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO, raw, 26/30, RC, 78% net weight, 10 × 1 kg, IQF products.
Exercise 5:	Calculate how many pcs of shrimp will be in a bag for BT, HLSO, raw, 71/90, RC, 70% net weight, 10 × 1 kg, IQF products.

[Appendix B: Size and weight table]

- **Calculation of Pieces (Pcs) for Block Frozen Shrimp (RC)**

*Calculate how many pcs of shrimp will be in a block for BT, HLSO, raw, 8/12, RC, 80% net weight, 6 × 1.8 kg block products

Maximum pcs per bag $= \frac{\text{Lowest grade}}{454} \times$ Net weight $= \frac{12}{454} \times 1440$ $= 38.06$ or 38 pcs/block Again, Minimum pcs per bag $= \frac{\text{Highest grade}}{454} \times$ Net weight $= \frac{8}{454} \times 1440$ $= 25.4$ or 25 pcs/block	Here, Size/grade = 8/12 Lowest grade is = 12 Highest grade is = 8 Packing = 6 × 1.8 kg Frozen weight = 1800 g Net weight = 80% = 1800 × 80% = 1440 g 1 *lb* (Pound) = 454 g Max. Pcs/Block =? Min. Pcs/Block = ??

Result: Pieces range is 25–38 per block. It means a maximum of 38 pcs and a minimum of 25 pcs should be presented in a block for 8/12, RC, 80% net weight, 6 × 1.8 kg, block frozen shrimps.

Perform the following exercises

Exercise 1:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 16/20, RC, 70% net weight, 6 × 1.8 kg block frozen shrimp.
Exercise 2:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 21/25, RC, 70% net weight, 6 × 1.8 kg block frozen shrimp.
Exercise 3:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 16/20, RC, 80% net weight, 6 × 1.8 kg block frozen shrimp.
Exercise 4:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 26/30, RC, 80% net weight, 6 × 1.2 kg block frozen shrimp.
Exercise 5:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 16/20, RC, 90% net weight, 6 × 1.8 kg block frozen shrimp.
Exercise 6:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 31/40, RC, 90% net weight, 6 × 1.8 kg block frozen shrimp.
Exercise 7:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 16/20, RC, 100% net weight, 6 × 1.8 kg block frozen shrimp.
Exercise 8:	Calculate how many pcs can be presented in a block for BT, HLSO, raw, 41/50, RC, 100% net weight, 6 × 1.2 kg block frozen shrimp.

[Appendix B: Size and weight table]

2.11 Individual Weight of Shrimp

Individual weight means the weight of every single shrimp. Individual weight of shrimp is fixed and individual shrimp out of limit is not to be accepted anymore. Variation of individual weight shows abnormal uniformity so it must be within limit. Standard individual weight must be met during final grading shrimp. The individual weight of shrimp can be calculated by using following procedure.

- **Calculation of Individual Weight of Frozen Count (FC) Shrimp**

*Calculate the individual weight of shrimp for BT, HLSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg, IQF products?

Min. individual weight of shrimp $= \frac{454}{\text{Lowest grade}} \times \%$ of net weight $= \frac{454}{12} \times 80\%$ $= \frac{454}{12} \times 0.8$ $= 30.3$ g or 30 g **Again,** Max. individual weight of shrimp $= \frac{454}{\text{Lowest grade}} \times \%$ of net weight $= \frac{454}{8} \times 80\%$ $= \frac{454}{8} \times 0.8$ $= 45.4$ g or 45 g	Here, Size/grade = 8/12 Lowest grade is = 12 pcs/*lb* Highest grade is = 8 pcs/*lb* Packing = 10 × 1 kg Net weight = 80% 1 *lb* (pound) = 454 g Max. Individual weight = ? Min. Individual weight = ?

Result: The range of individual weight of shrimp is 30–45 g. It means the minimum individual weight of shrimp will be 30 g and the maximum individual weight of shrimp will be 45 g for BT, HLSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg IQF products. Shrimps out of this limit are not accepted.

Perform the following exercise

Exercise 1:	Calculate the individual weight of shrimp for BT, HLSO-EZP, 13/15, FC, 80% net weight, 10 × 1 kg, IQF products.
Exercise 2:	Calculate the individual weight of shrimp for BT, HLSO, 16/20, FC, 70% net weight, 10 × 1 kg, IQF products.
Exercise 3:	Calculate the individual weight of shrimp for BT, PD, 21/25, FC, 75% net weight, 10 × 1 kg, IQF products.
Exercise 4:	Calculate the individual weight of shrimp for BT, PDTO, 26/30, FC, 78% net weight, 10 × 1 kg, IQF products.
Exercise 5:	Calculate the individual weight of shrimp for BT, P&D, 61/70, FC, 90% net weight, 6 × 2 kg, IQF products.

[Appendix B: Size and weight table]

- **Calculation of Individual Weight of Real Count (RC) Shrimp**

*Calculate the individual weight of shrimp for BT, HLSO, raw, 8/12, RC, 80% net weight, 10 × 1 kg IQF products?

Minimum weight of shrimp $= \frac{454}{\text{Lowest grade}}$ $= \frac{454}{12}$ $= 37.8$ g or 38 g **Again,** Maximum weight of shrimp $= \frac{454}{\text{Lowest grade}}$ $= \frac{454}{8}$ $= 56.8$ g or 57 g	Here, Size/grade = 8/12 Lowest grade is = 12 pcs/*lb* Highest grade is = 8 pcs/*lb* Packing = 10 × 1 kg Net weight = 80% 1 *lb* (pound) = 454 g Max. Individual weight = ? Min. Individual weight = ?

Result: The range of individual weight of shrimp is 38–57 g. It means the minimum individual weight of shrimp will be 38 g and the maximum individual weight of shrimp will be 57 g for BT, HLSO, raw, 8/12, RC, 80% net weight, 10x1 kg IQF products. Shrimps out of this limit are not accepted.

Perform the following exercise

Exercise 1:	Calculate the individual weight of shrimp for BT, HLSO-EZP, raw, 13/15, RC, 80% net weight, 10 × 1 kg, IQF products.
Exercise 2:	Calculate the individual weight of shrimp for BT, HLSO, raw, 26/30, RC, 75% net weight, 10 × 1 kg, IQF products.
Exercise 3:	Calculate the individual weight of shrimp for BT, PD, raw, 21/25, RC, 70% net weight, 6 × 1.8 kg, block products. [Hints: Same as IQF product]
Exercise 4:	Calculate the individual weight of shrimp for BT, HLSO, raw, 71/90, RC, 80% net weight, 6 × 1.8 kg, block products. [Hints: Same as IQF product]

(continued)

Exercise 5:	Calculate the individual weight of shrimp for BT, HLSO, raw, 16/20, RC, 100% net weight, 6 × 1.2 kg, block products? [Hints: As same as IQF product]
Exercise 6:	Calculate the individual weight of shrimp for BT, HLSO, raw, 8/12, RC, 90% net weight, 6 × 1.4 kg, block products? [Hints: As same as IQF product]

[Appendix B: Size and weight table]

- **Calculation of Individual Weight of Semi-IQF Shrimp (FC)**

*Calculate individual weight of shrimp for BT, HOSO, Raw, 8/12, FC, 20% glaze, 10 × 1 kg, Semi-IQF products

Minimum weight of shrimp $= \frac{1000}{\text{Lowest grade}} \times \%$ of net weight $= \frac{1000}{12} \times 80\%$ $= \frac{1000}{12} \times 0.8$ $= 66.7$ g or 67 g **Again,** Maximum weight of shrimp $= \frac{1000}{\text{Lowest grade}} \times \%$ of net weight $= \frac{1000}{8} \times 80\%$ $= \frac{1000}{8} \times 0.8$ $= 100$ g	Here, Size/grade = 8/12 Lowest grade is = 12 pcs/kg Highest grade is = 8 pcs/kg Net weight = 80% Packing = 10 × 1 kg 1 kg = 1000 g Max. individual weight = ? Min. individual weight = ?

Result: The range of individual weight of shrimp is 67–100 g. It means the minimum individual weight of shrimp is 67 g and the maximum individual weight of shrimp is 100 g for BT, HOSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg semi-IQF products. Shrimps out of this limit are not accepted.

Perform the following exercise

Exercise 1:	Calculate the individual weight of shrimp for BT, HOSO, raw, 13/15, FC, 20% glaze, 10 × 1 kg, semi-IQF products.
Exercise 2:	Calculate the individual weight of shrimp for BT, HOSO, raw, 16/20, FC, 25% glaze, 10 × 1 kg, semi-IQF products.
Exercise 3:	Calculate the individual weight of shrimp for BT, HOSO, raw, 16/20, FC, 22% glaze, 10 × 1 kg, semi-IQF products.
Exercise 4:	Calculate the individual weight of shrimp for BT, HOSO, raw, 21/30, FC, 30% glaze, 10 × 1 kg, semi-IQF products.
Exercise 5	Calculate the individual weight of shrimp for BT, HOSO, raw, 31/40, FC, 40% glaze, 10 × 1 kg, semi-IQF products.

[Appendix B: Size and weight table]

2.12 Glazing and Hardening of Shrimp

Glazing is a protective layer of ice that is added to the surface of frozen shrimp. Shrimps are glazed automatically through brushing water, immersion/dipping them into water, or spraying water over them that helps to preserve the freshness of frozen shrimps. Potable water or potable water with approved additives should be added for appropriate glazing. After glazing, shrimps are shifted to hardening chamber for hardening of glaze. Hardening is performed to secure the glazing of shrimp. Glazing and hardening are a significant issue for IQF products. The percentage of glaze depends on buyer requirements. The following things should be checked during glazing of shrimp:

- Temperature of product (shrimp)
- Source of glaze water
- Temperature of glaze water
- Surface area of the product means size/grade of shrimp
- Percentage of glaze
- Duration of glazing
- Temperature of hardening chamber and duration

The following are the images of glazing and hardening of shrimp (Figs. 2.58, 2.59, and 2.60).

- **Importance of Glazing**

  Glazing is important for the following reasons:

- Acts like packaging aid and minimizes the risk of contact with the air
- Reduces oxidation and minimizes rancidity
- Protects from surface dehydration
- Protects from discoloration and decomposition
- Protects against temperature fluctuations and freeze burn during storage and transport
- Preserves freshness, improves quality, and extends the shelf life of the product

In recent years processing industries are interested to use edible coatings from polysaccharides, proteins, and lipids to extend shelf life of food products (Sun 2005).

Fig. 2.58 Glazing

Fig. 2.59 Glazing

- **How can we determine the percentage (%) of glazing?**

The following steps are used to determine the percentage glazing:

Step 1:	Weight of frozen shrimp (frozen weight) should be taken first
Step 2:	Sufficient water should be taken for deglazing of shrimp or standard water volume is eight times of frozen sample
Step 3:	Leave the shrimp in water until the ice melted. Remember that shrimp should be deglazed without defrosting the shrimp itself
Step 4:	Temperature should be maintained at 20 °C ± 5 °C for 20 s to 2 min depending on glazing percentage, type, and the size of product
Step 5:	Weight of deglazed shrimp (deglazed weight) should be taken
Step 6:	Calculate the percentage (%) of glazing using the following formula:

Fig. 2.60 Hardening

$$\%\text{ofGlaze} = \frac{\text{Frozen weight} - \text{Deglazed weight}}{\text{Frozen weight}} \times 100$$

*Calculate the percentage of glazing for BT, HLSO-EZP, 8/12, 80% net weight, RC, 10 × 1 kg packing IQF products where frozen weight is 1000 g and deglazed weight is 810 g.

$\%\text{of Glazing} = \frac{\text{Frozen weight} - \text{Deglazed weight}}{\text{Frozen weight}} \times 100$ $= \frac{1000-810}{1000} \times 100$ $= \frac{190}{1000} \times 100$ $= 19$	Here, Frozen weight = 1000 g Deglazed weight = 810 g % of glazing = ?

Result: Percentage (%) of glazing is 19 or 19%. It means percentage (%) of glaze is 19 and percentage (%) of deglaze shrimp is 81. Moreover, the weight of glaze is 190 g, whereas the weight of deglaze shrimp is 810 g for this product.

Perform the following exercise

Exercise 1:	Calculate the percentage of glazing for BT, HLSO, IQF, 6/8, FC, 75% NW, 10 × 1 kg packing, where frozen weight is 1060 g and deglazed weight is 768 g
Exercise 2:	Calculate the percentage of glazing for BT, HLSO, IQF, 13/15, RC, 80% NW, 10 × 1 kg packing, where frozen weight is 1020 g and deglazed weight is 808 g
Exercise 3:	Calculate the percentage of glazing for FW, P & D, IQF, 16/20, RC, 80% NW, 10 × 1 kg packing, where frozen weight is 1038 g and deglazed weight is 815 g
Exercise 4:	Suppose a product of BT, HLSO, IQF, 21/25, FC, 70% NW, 10 × 1 kg packing, where 60% shrimps are the largest grade and the rest of shrimps are the lowest grade. Deglazed weight of the largest shrimp and smallest shrimp is 15 g and 12 g, respectively. Frozen weight is 1030 g. Now calculate the % of glazing

- **Precaution of deglazed weight**
  - Glaze should be removed properly.
  - Soaking gain should not be removed.
  - Measurement of weight should be more accurate.
  - Chilled water should be used for deglazing of process. Use of hot water is not a standard procedure.
  - Never let the sample long time in water for removing of glaze; otherwise, it will be defrosted instead of deglazed.
  - Special care should be taken for small size shrimp. It has the tendency to defrost within a very short time.

References

Parisenti J, Henrique L, Mourino JLB, do Nascimento Vieira F, Buglione CC, Maraschim M (2011) Effect of background color on shrimp pigmentation. Bol Inst Pesca 37(2):177–182

Sun DW (2005) Handbook of frozen food processing and packaging. CRC Press

Processing of Shrimp

3

Abstract

The term "processing" means to perform a series of mechanical or chemical operations in order to preserve something. Shrimp is a perishable food item, and it is necessary to process it for long-term preservation as well as convenient transportation. Shelf life of perishable products is limited in the presence of air and atmospheric oxygen, which can lead to the growth of aerobic spoilage microorganisms (standard shelf life of frozen shrimp is 2 years). Preservation techniques are designed to inhibit or reduce the changes of metabolic activities in shrimp and stop quality deterioration. A variety of techniques like lowering of temperature, control of water activity, stop/reduction of microbial loads, etc. are used in shrimp processing industries for long-term preservation of frozen shrimp. Besides, uses of additives in frozen shrimp also prolong its shelf life. The chapter highlighted the topics on receiving of raw materials, sensory assessment of raw materials (smell, odor, color, texture and test), color separation, de-heading and de-heading process (manual and mechanical), peeling and deveining process, washing, chilling, chilled storage of frozen shrimp, etc.

Keywords

Sensory assessment · Color separation · De-heading · Deveining

A variety of techniques and chemicals are used in shrimp processing industries for long-term preservation. The details of processing of shrimp are described below.

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_3

3.1 Receiving of Raw Materials

Processing of shrimp starts with the receiving of raw materials. The quality of final product greatly depends on quality of raw materials. So, receiving of raw material is an important part of processing industries. Fish should be washed and cleaned properly before handling in the factory. Washing should be done by using WHO standard potable water. Generally, ground water (around 1000 ft deep) is used in processing industries treated with UV radiation after removing of iron and dirt. The raw shrimps are washed thoroughly at receiving point to remove the filth, mud, sand, and other unwanted materials. Washing also helps to reduce bacterial contamination. Every processing should have its own water treatment facilities. Raw materials must be received with standard protocol and necessary documents. Receiving staff is responsible for receiving of raw materials and inside arrangements of the raw material. The following things should be checked and recorded during receiving raw materials:

- Traceability tag.
- Traceability certificates.
- Receiving date, time, code no., batch no., lot no., etc.
- Suppliers' guarantee letter.
- Icing ratio.
- Melting ice water.
- Physical appearances (bad smell, color, muscle texture, freshness, etc.).
- Temperature of raw materials. Temperature of the raw materials must be kept at 4 °C or below.
- Mode of transportation.
- Duration of transportation.

[Note that it's a mandatory requirement for shrimp processing industries to maintain proper hygienic condition of the raw materials, labor, and receiving room as well.]

3.2 Sensory Assessment

Sensory evaluation comprises a set of techniques for accurate measurement of human responses to foodstuffs. A sensory evaluation has been defined as a scientific method used to evoke, measure, analyze, and interpret those responses to products as perceived through the senses of sight, smell, touch, taste, and hearing (Lawless and Heymann 1998; Stone and Sidel 1993). Lawless and Heymann (2010) state that sensory evaluation comprises a set of techniques for accurate measurement of human responses to foods and minimizes the potentially biasing effects of brand identity and other information influences on consumer perception.

Sensory assessment is also known as organoleptic analysis. Organoleptic or sensory assessment involves the employment of one or more physical senses or

Table 3.1 Organoleptic quality assessment technique of raw shrimp (qualitative method)

Parameters	Characteristics								Status
Color	Excellent	√	Good		Normal		Poor		Approved √
Smell	Excellent	√	Good		Normal		Poor		Rejected
Texture	Excellent		Good	√	Normal		Poor		
Appearance	Excellent		Good	√	Normal		Poor		
Freshness	Excellent		Good	√	Normal		Poor		
Cook condition	Excellent		Good	√	Normal		Poor		

subjective evidence and rating of the food product (Kanduri and Eckhardt 2008). Generally, the characteristics such as general appearance, freshness, smell, color, texture, and test are assessed in the sensory evaluation of shrimp. The preliminary judgment of quality assessment is the best practice for the quality control process in shrimp industries. Sensory characteristics can be performed by using trained or experienced panelists. It's better to separate the participants during sensory assessment; otherwise, it may reflect one's judgment to others. Trained experts or experienced panelists can consistently recognize the quality of shrimp. The assessors must be trained enough and have clear and descriptive guidelines of the sensory evaluation procedure to get a good result. In the case of sensory assessment, any kind of inconsistency if found the shrimps may not be accepted by the importers. Raw shrimps should be natural, fresh, lively, and free of order, defects and disease. The characteristics of sensory assessment procedure of fresh shrimp are as follows (Table 3.1):

Appearance:	It looks like a natural or glittering/shiny appearance.
Smell/ flavor:	Smell/flavor shall be typical/natural of freshly harvested shrimp and must be free from bad/foreign smells or off-flavor.
Odor:	Obnoxious odor or odor of spoilage or decomposition is not accepted. Some other forms of odor such as sour, musty, putrid, ammonia, fuel, etc. are not acceptable. Slight, moderate, marked, severe, etc. are the intensity of odor.
Color:	Color of shrimp will be natural. It should be checked in daylight or colorless light.
Texture:	Texture will be typical. Texture is checked by holding shrimp in hands and applying pressure on its mussels. The ideal characteristics of fresh raw shrimp are firm, succulent, not softy, or mushy.
Taste:	Taste will be typical or sweet with a slight saltiness, fresh, and no off-flavor.

Sometimes importers suggested putting into a grade instead of tick mark (√) for organoleptic judgment. Average grades of all parameters are used to evaluate the quality of the product. Different buyers have different grading systems. See the following grading system for your reference (Table 3.2).

[Note: Sampling of three bags is not a standard procedure; it's an example. Selection of bags (no. of bags) depends on buyer requirement. The standard procedure is to select random 1% or 2% of total products but must be at least two bags for every single item is used for organoleptic assessment.]

Table 3.2 Organoleptic quality assessment technique of raw shrimp (grading method)

Characteristics	Bag 1	Bag 2	Bag 3	Average	Status	Grades
Color	1	2	4	2.3	Approved	*Excellent = 4 *Good = 3 *Normal = 2 *Poor = 1
Smell	1	1	3	1.7	☐	
Texture	2	2	3	2.3	Rejected	
Appearance	2	1	4	2.3	√	
Freshness	1	1	3	1.7		
Cook condition	2	2	4	2.2		
Total				2.2		

- **The following parameters should be taken into consideration during organoleptic assessment of shrimp:**
  - The sensory assessment area should be free of distractions from other types of analyses.
  - The working area should be free from foreign odors or smells.
  - Avoid ventilation. Room with proper ventilation removes product odors.
  - Assessment should be separated for different participants. One person's reaction may affect another's judgment.
  - Lighting should be uniform, as near natural light as possible, and not influence the appearance of the product being tested.
  - Product should be tested usually at room temperature.
  - Assessment can be done in only one species or product at a time.
  - Expert personnel should take a periodic break during the assessment. (Kanduri and Eckhardt 2008)

3.3 Color Separation

Color separation means uniformity of color. It's very important for quality products. Color separation helps products to look good and increase their value. A variety of colors are observed in natural shrimp, but customers are not aware of it. They don't have in-depth knowledge about color variation and mixed color production. The color of same species of shrimp may vary because of different types of habitats, aquatic environments, waters, soil types, and diets. A variety of colors may present in fresh raw shrimp. Suppliers should make color separation because different color in same block or bag may confuse the customers. Shrimp without color separation is considered as a defect. If a customer found the product without color separation, he/she may think that his/her purchased shrimp is not a quality product or it's a combination of quality and quality-less products. That's why mixed color production makes a bad impression on the client or customers. On the other hand, if the customer found the product as uniform color, he/she may treat it as natural color. The

Fig. 3.1 Natural color of black tiger shrimp

process of color separation is not a difficult task. Processing industries at present are doing their production maintaining color separation, but still now a great number of industries are doing their production without color separation. Color separation should be the mandatory process for all processing industries. Sometimes buyer confirms the color separation deal before going to make a contract. The following are the images of some color variation of black tiger shrimp (*P. monodon*) (Fig. 3.1).

The following are the images of color variation of freshwater shrimp (*M. rosenbergii*) (Figs. 3.2, 3.3, and 3.4).

Fig. 3.2 Mixed color shrimp

Fig. 3.3 Color variation

3.4 De-heading of Shrimp

The term "de-heading" means "removing the head from its body." The head (cephalothorax) of shrimp contains several organs rich in various digestive enzymes, which could lead to rapid deterioration in shrimp (Kanduri and Eckhardt 2008). It is necessary to remove the head (cephalothorax) region for long-term preservation of shrimp. Shrimps are immediately taken into the de-heading room after primary washing. The de-heading table must be clean and hygienic. Quality of the product is being damaged from here because of improper de-heading. A great chance of cross-contamination may also happen during the de-heading operation. The term "de-heading" is also known as "be-heading." The following should be checked very carefully during the de-heading process:

Fig. 3.4 Uniformity of color

- Temperature of raw materials
- Temperature of chill water
- Proper de-heading
- Proper washing
- Defects of de-heading (i.e., hanging meat)
- Waste disposal system

3.4.1 De-heading Method

The de-heading of shrimps can be performed in two ways. These are as follows:

1. Manual de-heading
2. Mechanical de-heading

3.4.1.1 Manual De-heading

Manual de-heading is usually performed by the hand of expert personnel. No machineries are used in the manual de-heading process. The manual de-heading process is still practiced in most of the developing countries because of the availability of skilled and cheap labors and faster work with higher yield at short time. De-heading is done by squeezing the shrimp head from its tail section by using thumb and fingers of the expert personnel. The following are the steps of de-heading process in shrimp.

Fig. 3.5 Grabbing of shrimp

Fig. 3.6 Twisting of shrimp

Step 1:	First, grab the shrimp (body) firmly in your dominant hand.
Step 2:	Grip the shrimp head firmly with the other hand.
Step 3:	Twist off the shrimp properly in one quick movement to separate the head from its body. Twisting helps to remove the head from the juncture.
Step 4:	Remove the head and pull out digestive tract and other organs with de-heading.
Step 5:	Dispose of the heads (separate basket), and rinse the de-heading shrimp in chilled water.

The following are the images of de-heading process of black tiger shrimp (Figs. 3.5, 3.6, and 3.7).

[Note: De-heading should be done separately for every single shrimp. Please pick the shrimp up one at a time; don't try to grab a handful all at once. Use of hand gloves must be during de-heading process. Use of long hand gloves is better.]

Some of the processing industries are doing the de-heading process by using some techniques. At first, they separate carapace (shell of head) from the head and

Fig. 3.7 Separation of head

Fig. 3.8 Grabbing of shrimp

then remove all organs from the region. After removing carapace and organs, shrimps are sent for washing. In this process, a certain portion of neck meat is present in hanging condition after de-heading of shrimp. Such type of de-heading process helps suppliers to avoid weight loss. Yes, of course, it's not the standard process, but some buyers may not have any objections about the process. Importers allow some percentage (%) of shrimp containing hanging meat/neck meat. Actually, it's not a serious problem and not hazardous for human consumption, but it's better to avoid hanging meat in final product. Suppliers should keep in mind that the world is more competitive and it's about quality issue. A quality product increases your brand value as well as increases sales. The following are the images of de-heading steps of black tiger shrimp (Figs. 3.8, 3.9, 3.10, 3.11, 3.12, and 3.13).

3.4.1.2 Mechanical De-heading

Mechanical de-heading means de-heading of shrimp by using instruments. Mechanical de-heading systems consist of a flat knife, which cuts off the head after correctly

Fig. 3.9 Removing carapace

Fig. 3.10 Removing of carapace

Fig. 3.11 Removing of organs

Fig. 3.12 Resulting neck meat

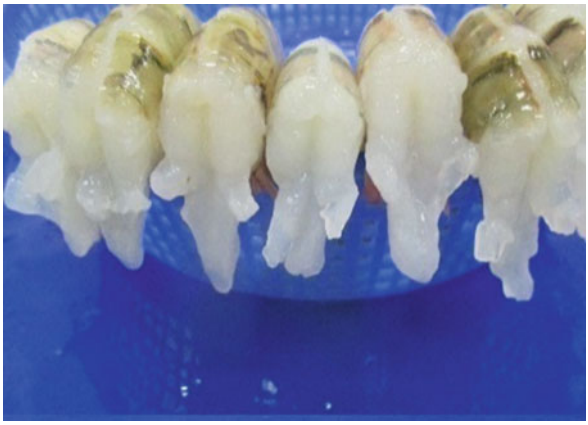


Fig. 3.13 Neck meat after washing

positioning the shrimp. Mechanical de-heading is more accurate but a slow process. Chances of de-heading defects are very low in mechanical de-heading system if machineries are functionally well. Headless shell-on (HLSO) shrimps are washed individually with running chilled water during or after de-heading process.

- **Precaution of de-heading process**

The quality of shrimp greatly depends on proper de-heading process. Quality damaged mostly depends on improper de-heading procedure. The following points should be considered carefully during the de-heading process:

- De-heading table and utensils must be clean, hygienic, and free from contamination.
- De-heading method must be in hygienic condition.

- Sometimes workers are not willing to wear hand gloves. It makes the process slower. Please be careful about it. It is a must to wear hand gloves during the de-heading process.
- Be careful about the defect hanging meat. Hanging meat out of the limit may not be accepted.
- After de-heading, shrimps need to be pressure washed individually. There is a great chance of microbial contamination. Ensure running treated chilled water for washing of de-heading shrimp.
- Rinse shrimp with water properly; ensure no carryover head fragments (shell, leg, organs, etc.) in final products.

3.5 Peeling of Shrimp

"Peeling" refers to removing of shell from meat. Peeling can be done manually and mechanically. Manual peeling makes the process faster, but there is a chance to arise defects from here. Still now processing industries in developing countries are doing their peeling using manual/hand peeling technique. The following are the steps of manual/hand pilling.

Step 1:	Grab the shrimp first
Step 2:	Pull off their legs
Step 3:	Open the shell along the inner curve of the body. Use your thumbs to crack the shell open along the underside where the shell is softer and easy to open
Step 4:	Pull off the shell to remove it
Step 5:	Finally, pull off the tail segment by squeezing the shell and separate from the meat

In the mechanical process, headless shell-on (HLSO) shrimps are conveyed onto a series of inclined spinning rollers where the shell of every single shrimp is cracked/split and peeled and passes through the rollers and then a series of cleaning sluices that lead to the deveining process. Peeling machines are now available commercially that can handle a large volume of shrimp. All the processes are automatically controlled using software.

- **Precaution of peeling**
  - Wearing of hand gloves is a must.
  - Peeling table and the knife must be clean, hygienic, and free from contamination.
  - Washing of shrimp should be done separately. Washing together may increase the chances of cross-contamination.
  - Chilled water should be used during washing.
  - Ensure no carryover shell and leg fragments in final products.

- The process peeling is the vital source of bacterial contamination, particularly hand peeling. Workers must wash their hands frequently, and all working surfaces must be kept clean and hygienic.
- Shrimp must be kept cool throughout the process.

[Note: Thawed frozen shrimps are much easier to peel than fresh raw shrimps. Peeling of raw shrimps becomes easier after 1–2 days of chilled storage, but peeling of raw fresh shrimps led to produce top quality end products].

3.6 Deveining of Shrimp

The peeled shrimps are then transferred to the next step of deveining process. The digestive tract of shrimp is called vein that runs down the dorsal side near the surface. The vein looks like a long, gritty string and has bitter taste when consumed. It is necessary to remove the vein from shrimps because it contains a lot of microorganisms that may not be suitable for human consumption. The vein of shrimp is usually filled with food, sand, and dart. Shrimps are fed anything that fell down the bottom of the pond like debris, algae, dead and living plants, worms, insects, larvae, fish, snails, and even dead and live shrimp. Shrimps are called scavengers. Removal of vein improves the quality of shrimp.

In deveining process, shrimps are cut along the body length of the dorsal side (outer curve of the shrimp's body), and vein is gently pulled up to bring it out properly. It's fairly elastic and doesn't break usually but sometimes may happen due to unconscious pulling. Once the vein does break, keep pulling until removing it properly.

The removal of the intestine can be performed by different methods:

1. The first one is called cut-deveined, which entails cutting the shrimp's back and pulling out the intestine.
2. The second one is called pin-deveined, which consists of the removing of intestine with a needle.

Deveining can be performed for both peeled and deveined (P&D) and easy peeled (EZP) shrimp. Quality of shrimp depends on cutting, peeling, deveining, and washing procedure. Improper cut, deep cut, partial vein, whole vein, etc. are the defects that arise from here. The tolerance level of the vein is zero if found in the final product and may not be accepted by the importers who may complain of demurrage against the defects. Deveining can be done either using machinery or manually. Suppliers of developing countries usually follow the manual process. Manual process is easy and not time-consuming. The following are the images of deveining technique (Fig. 3.14, 3.15, 3.16, 3.17, 3.18, and 3.19).

- **Precaution of deveining**
  - Ensure no vein or no fragments of the vein. Vein must be zero in final products.

Fig. 3.14 Cutting (EZP)

Fig. 3.15 Cutting (EZP)

- Washing of shrimp should be done individually. Avoid batch washing to protect cross-contamination.
- Peeling table and utensils must be clean, hygienic, and free from contamination.
- Run your knife gently. A shallow cut is fine; deep cut needs to be avoided. "Deep cut" is considered as defect.
- Deveining table and knife should be washed periodically.
- The deveining process must be in a hygienic way.

Fig. 3.16 Cutting (EZP)

Fig. 3.17 Deveining of shrimp

3.7 Washing of Shrimp

Washing is performed in various stages of processing. UV-treated chilled running water should be used in different processing steps. The recommended chilling temperature is 4 °C but no longer than 10 °C. Water velocity, water temperature, and water treatment should be checked frequently. Washing water must be UV-treated, potable, and hygienic. Table with pressure wash is good for washing. Pressure wash is used to remove the filth, shell, leg, and microorganisms. It is also called filth wash.

Fig. 3.18 Deveining of shrimp

Fig. 3.19 Shrimp after deveining

The following are the images of different types of washing tables (Figs. 3.20, 3.21, and 3.22).

3.8 Chilled Storage of Shrimp

Suppliers store raw materials in chill room for temporary preservation. The duration of chilled storage of shrimp is very short normally few hours to days. Normally shrimps are stored directly in the hygienic floor maintaining proper icing ratio, but it should be better to store shrimp in plastic baskets instead of flooring. In chilled storage, suppliers use flake ice at a ratio of 1:1 for maintaining good quality product. Icing should be done layer by layer. Flake ice should be manufactured with properly

Fig. 3.20 Table of pressure wash

Fig. 3.21 Washing table

treated potable water. Water source and flake ice must be free from all source of contamination (microbial, chemical, heavy metals), dart, filth, and external materials. Every industry must have facilities for flake ice plant of their own testing facilities. Chilled storage is necessary only at that time when suppliers received a large volume of raw materials than their production capacity. Chilled storage also helps in easy peeling and deveining process (Figs. 3.23, 3.24, and 3.25).

- **Precaution of chilled storage**
  - The icing ratio must be appropriate.
  - Icing should be done in different layers (top and the bottom layer is a must). Avoid icing of shrimp only the top of the basket.

Fig. 3.22 Washing table

Fig. 3.23 Preparation of flake ice

- Storage of shrimp should be done in the basket. Never store shrimp directly on the floor of a chilled storage room.
- Ensure proper tagging during chilled storage.
- Don't store shrimps in chilled storage for a long time.
- Reuse of flake ice is strictly restricted.

Fig. 3.24 Collection of flake ice

Fig. 3.25 Chill storage of shrimp

References

Kanduri L, Eckhardt RA (2008) Food safety in shrimp processing: a handbook for shrimp processors, importers, exporters and retailers. Wiley

Lawless HT, Heymann H (2010) Sensory evaluation of food: principles and practices, vol 2. Springer, New York

Lawless HT, Heymann H (1998) Sensory evaluation of food principles and practices, 2nd edn

Stone H, Sidel JL (1993) Sensory evaluation practices, 2nd edn. Academic, San Diego

Food Additives and Soaking

4

Abstract

Additives are the substances that are added in food to enhance/improve its freshness, appearance, color, flavor, texture, and test. The chapter includes the topics of food additives, categories of additives, uses of food additives, types of additives (organic and inorganic), numbers or E-numbering system, their active substances, EU approved additives, soaking gain, soaking method, additives in value-added products, etc. The chapter also helps to know the calculation of soaking gain (%) of different types of shrimp products with related exercise.

Keywords

Food additives · Soaking · E-Numbers

4.1 Food Additives

Additives are the substances that are added in food to enhance/improve its freshness, appearance, color, flavor, texture, and test. It also helps to preserve nutrient content, safety requirements, and long-term preservation. Use of food additives in shrimp is a major concern because of potential health effects on the human body. Additives must be approved by the importing countries, and illegal/banned additives are not allowed in foods. International standard and guidelines should be followed strictly during use of additives in food. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) is the international body responsible for evaluating the safety of food additives. The use of additives in food completely depends on the buyer's requirement. There are a variety of additives available in the market. These additives are divided into several categories, i.e., acidity regulators, antioxidants, glazing agents, food preservatives, etc. Some additives are used in specific reasons, but

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_4

some additives have more than one function. The following are the categories of food additives.

Acidity regulators:	Acidity regulators are substances that control the acidity or alkalinity of foodstuff.
Antioxidants:	Antioxidants are used as a food to prevent oxidation process.
Emulsifiers:	Use to keep food safer for longer. Emulsifiers allow water and oils to remain mixed together in an emulsion.
Flavor enhancers:	Flavor enhancers used in food to enhance their existing/natural flavors.
Stabilizers:	Help to control physicochemical state of foodstuff and keep the texture firm in shrimp.
Sweeteners:	Sweeteners are added to foods for flavoring agents, also for the taste.
Fortifying agents:	Fortifying agents are used for increasing of nutritional value.
Glazing agents:	Glazing agents are used for the shiny appearance of shrimp. They are also used as a protective coat of shrimp.
Preservatives;	Preservatives are used to prevent or inhibit spoilage of food due to fungi, bacteria, and other microorganisms.

Uses of food additives are common in seafood industries. Stabilizer, emulsifiers, and antioxidants are the most commonly used in shrimp processing industries as per the instruction of the buyers. Uses of others are very low or occasionally.

4.2 Soaking of Shrimp

Soaking means dipping of shrimp into a solution. The solution may contain a mixture of salt, water, and food additives that may help to retain moisture in shrimp and enhance its flavor, color, texture, and test. Different additives are used for different purposes. Soaking is an important part of shrimp processing, but soaking must be in an appropriate way. Percentage of additives, types of additives, soaking procedure, soaking duration, etc. should be followed strictly as per international standard. Uses of additives balance between protein and moisture that result in preferred texture and palatability in tests. Phosphates, non-phosphate, and antioxidants are the most commonly used food additives in shrimp industries. Phosphate and non-phosphate are known as MRAs (moisture retention agents). Fresh seafood with high nutritional value has a limited shelf life, which can be extended by cold storage. Shrimps soaked in food additives have the following functions:

- Help to increase water retention capacity and reduce thaw-drip loss
- Help to increase freezing capacity
- Help to enhance the general appearance and maintain freshness
- Help to improve its consistency, texture, color, and other sensory properties
- Help to improve its taste

- Help to prevent oxidation
- Help to preserve nutrients
- Help to reduce cook and cool losses
- Help to prevent melanosis
- Help to increase weight (weight gain) of shrimp

[Note: Different additives are used for different purposes. Sometimes single additive can perform different functions.]

4.2.1 Soaking Method

The standard soaking method should be maintained properly to ensure quality products. It is essential to handle this stage very carefully. Normally, around 2% additives and 2% salt and water are used for standard soaking (little bit variation may be considerably based on product type and specifications). Chilled water must be confirmed during the soaking process. It's better to maintain the temperature at 4 °C, and soaking duration should be a maximum of 1.5–2 h. Temperature should be checked very carefully and frequently for both soaking water and soaked shrimp itself. Ice should be added if temperature fluctuates during soaking procedure. There are two types of soaking method practiced in shrimp processing industries. These are as follows:

1. Paddler method: Manual process
2. Stirring method: Mechanical process

The following are the images of soaking methods of shrimp (Figs. 4.1, 4.2, and 4.3).

The following parameters should be considered during the soaking of shrimp:

Fig. 4.1 Preparation of additives

Fig. 4.2 Soaking (stirring method)

Fig. 4.3 Soaking (paddler method)

Table 4.1 Permitted food additives currently used in shrimp processing industries

Type of additives	Name of additives	Country of origin
Phosphate (STTP)	Blue sowrd/kdm	China
	Carfosel	Belgium
	Xingfa	China
Non-phosphate (NP)	NP-1^{+}	Thailand
Antioxidant	Sodium metabisulfite (sulfite)	China

- Size/grade and type of shrimp
- Method of soaking
- Percentage of additives and water
- Duration of soaking
- Temperature of soaking water
- Temperature of soaked shrimp (Table 4.1)

4.2.2 Determination of Soaking Gain (%)

Soaking gain can be calculated by using the following formula:

$$\%\text{of soaking gain} = \frac{\text{Weight of shrimp after soaking gain} - \text{Weight of shrimp before soaking}}{\text{Weight of shrimp before soaking}} \times 100$$

Kingwascharapong and Benjakul (2016).

[Note: Weight of shrimp after soaking gain should be taken very carefully; let the shrimp drain out the additives first, and then weight should be taken.]

*Calculate the percentage (%) of soaking gain for BT, PND, raw, 8/12, FC, 20% glaze, 10 × 1 kg shrimp where initial weight (before soaking) of shrimp is 324 g/*lb* and final weight (after soaking) is 364 g/*lb*.

$\%\text{ of soaking gain} = \frac{\text{Weight of shrimp after soaking gain} - \text{Weight of shrimp before soaking}}{\text{Weight of shrimp before soaking}} \times 100$ $= \frac{364-324}{324} \times 100$ $= 12.3\%$	Here, Initial weight = 324 g Final weight = 364 g Soaking gain (%) = ?

Result: Soaking gain of shrimp is 12.3% for BT, PND, raw, 8/12, FC, 20% glaze, 10 × 1 kg products (Table 4.2).

Perform the following exercises

Exercise 1:	Calculate the percentage (%) of soaking gain for BT, PND, raw, 16/20, FC, 20% glaze, 10 × 1 kg shrimp where initial weight (before soaking) of shrimp is 324 g/*lb* and final weight (after soaking) is 36 g/*lb*.
Exercise 2:	Calculate the percentage (%) of soaking gain for BT, HLSO-EZP, raw, 13/15, RC, 25% glaze, 10 × 1 kg shrimp where initial weight (before soaking) of shrimp is 445 g/*lb* and final weight (after soaking) is 458 g/*lb*.
Exercise 3:	Calculate the percentage (%) of soaking gain for BT, PDTO, raw, 21/25, FC, 25% glaze, 10 × 1 kg shrimp where individual weight (before soaking) of shrimp is 13 g and final weight (after soaking) is 14 g.

Table 4.2 Estimation of soaking gain (%) at different types of frozen product (shrimp)

	Type of products		
Parameters	HLSO	HLSO-EZP	PDTO/PND
Soaking method	Paddler, stirring	Paddler	Stirring
Temperature	6 °C	6 °C	6 °C
Soaking time	1.5–2 h	1.5–2 h	1.5–2 h
Gain	2–4%	4–8%	12–16%
pH	7.0	7.0	7.0
Ingredients	STPP (2%), UV treated water, salt (2%), flake ice, raw materials		

Fig. 4.4 Temp. of soaking water

[Note: Little bit variations are appreciated. Percentage of soaking gain depends on various factors, i.e., size/grade, soaking duration, soaking method, soaking temperature, and types and percentage of additives used.]

The following parameters should be checked and recorded during the soaking process.

- Starting time and ending time
- Soaking method
- Temperature of soaking water
- Temperature of soaked shrimp
- Name of additives
- Origin of additives
- Brand of additives
- % of additive added
- % of soaking gain

The following are the image of different stages of soaking process (Figs. 4.4, 4.5, 4.6, 4.7, 4.8, and 4.9).

- **Precaution of soaking**
  - The temperature of soaking water and soaked shrimp can never exceed 6 °C; 4 °C is standard. The temperature should be checked frequently. If the temperature is found higher, ice should be added immediately.
  - Additives must be approved by the importers. Banned additives are strictly prohibited.
  - The percentage of additives should be added by following international standard or specifications. It must be within the limit. The addition of excess additives is strongly prohibited.
  - Soaking duration should be within limit. Generally, 2 h soaking duration is standard but may vary from product to products as per specifications. Oversoaking is strongly prohibited; it's a crime.
  - The whole process must be in a hygienic way.

Fig. 4.5 Temp. of soaking of shrimp

Fig. 4.6 Appearance of soaked shrimp

Fig. 4.7 Texture and smell of soaked shrimp

Fig. 4.8 Soaking of shrimp with additives

Fig. 4.9 Soaking of shrimp with additives

4.3 Numbers or E-Numbers

A variety of food additives are available in the market. All additives are assigned under a unique numbering system expressed as "Numbers" or "E-numbers." This numbering system is now internationally adopted by Codex Alimentarius Commission. In Europe, additives are marked as "E-numbers," but countries outside Europe marked them by the numbers only. It means same additives are used with the same numbering system in the world, but in Europe they just use "E" prefix before the numbering system, where "E" stands for "Europe." For example, in Europe people know "diphosphate" as "E450," but outside Europe people know "diphosphate" as "450." "E numbers" or "Numbers" are commonly found on food labels. See the following table (Table 4.3) of most commonly used additives in shrimp processing industries.

[Note: Examples are based on EU, because EU is the largest seafood market for shrimp.]

Table 4.3 Most commonly used additives in shrimp processing industries

Treatment	E-Number	Active substances	Purpose	Status
Phosphate	E450	**Diphosphates**: 1. Disodium diphosphate 2. Trisodium diphosphate 3. Tetrasodium diphosphate 4. Dipotassium diphosphate 5. Tetrapotassium diphosphate 6. Dicalcium diphosphate 7. Calcium dihydrogen diphosphate	Emulsifier	EU Approved
	E451	**Triphosphates:** 1. Penta sodium triphosphate 2. Penta potassium triphosphate	Emulsifier	
	E452	**Polyphosphates:** 1. Sodium polyphosphates 2. Potassium polyphosphates 3. Sodium calcium polyphosphate 4. Calcium polyphosphates	Emulsifier	
Non-phosphate	E331	**Sodium citrates**: 1. Monosodium citrate 2. Disodium citrate 3. Trisodium citrate	Acidity regulator	
	E332	**Potassium citrates:** 1. Monopotassium citrate 2. Tripotassium citrate	Acidity regulator	
	E333	**Calcium citrates:** 1. Monocalcium citrate 2. Dicalcium citrate 3. Tricalcium citrate	Acidity regulator, firming agent, sequestrate	
Antioxidant	E223	**Sulfites:** Sodium metabisulfite	Antimicrobial, antioxidant, food preservative	

Reference

Kingwascharapong P, Benjakul S (2016) Effect of strong alkaline solutions on yield and characteristics of Pacific white shrimp (Litopenaeus vannamei). Int Food Res J 23(3): 1136–1144

Defects of Shrimp

5

Abstract

Defect means a shortcoming or fault, or imperfection. Shrimps with any kind of deviation, or out of specifications, are considered as defects. Product with defects is not accepted by the buyer anymore. Defect in final products should be zero. The chapter highlighted different types of defects (attached shell, bad smell, black spot, discoloration, melanosis, soft shell, vein, clumping, dehydration/freeze burn, black gill, black head, odor, decomposition, foreign matter, dropping head, deep cut, broken pieces, etc.), their descriptions, and causes/origin of defects. The chapter also helps to know about the tolerance limit of the defects and defect (%) calculation process.

Keywords

Clumps · Dehydration · Decomposition · Discoloration · Vein

5.1 Defects of Shrimp

Defect means a shortcoming or fault, or imperfection. Shrimps with any kind of deviation, or out of specifications, are considered as defects. Based on severity, defects may be categorized in the following three ways.

1. Critical defects:	Critical defects are considered as serious injuries, may cause rejection of the container without any hesitation, i.e., decomposed shrimp. Critical defects have zero tolerance in limit.
2. Major defects:	Major defects are also considered as serious injuries, may cause rejection of the container, i.e., bad smell/odor, discoloration, etc. The defects also have zero tolerance limit.
3. Minor defects:	Minor defects are considered as defects but have some flexibility. Importer may accept the products if the defect remains within the limit. Minor defects may

(continued)

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_5

	also cause rejection of the container if the defects cross its standard limit. Attached shell, shell broken, back broken, tail broken, etc. are considered minor defects.

The following are the list of defects found in export grade frozen shrimp.

• Attached leg	• Foreign matter
• Attached shell	• Hanging meat
• Bad smell	• Head discoloration
• Black spot	• Improper peeling
• Black head	• Loose head/dropping head
• Black gill	• Melanosis
• Broken pieces	• Non-uniformity
• Broken shell	• Odor/extraneous odor
• Broken tail	• Soft shell
• Clumps	• Spot on shell
• Deep cut	• Spot on meat
• Dehydration/freeze burn	• Uncut
• Discoloration	• Vein
• Decomposition	• Wrong cut

5.2 Description of Defects in Shrimp

Attached legs:	Sometimes swimming legs are attached to final products. It's a result of improper peeling/cleaning.
Black spot:	Black spot is a disease. Disease-infected shrimps are totally unaccepted. Sometimes spot found in fresh shrimp rather than black spot disease that may be accepted but discarded is better.
Broken shrimp:	Any visible breakage of shrimp observed in the final product is considered as the defect "broken shrimp." Shell broken, back broken, tail broken, broken pieces, etc. are the examples of broken shrimp.
Clump:	Clump is a cluster of shrimps. The cluster of two or more than two pieces of IQF shrimps is known as clamping/clamp shrimp. Clumping is found only in IQF shrimp.
Decomposition:	Any kind of deterioration in shrimp and shrimp products which means the breakdown of texture causing a persistent and distinct objectionable flavor or odor is called decomposition.
Dehydration:	Dehydration is the loss of moisture from frozen shrimp. This may occur if the products are not properly glazed, packaged, or stored. Deep dehydration adversely affects the appearance and surface texture of the product and is commonly known as "freezer burn." As a symptom of dehydration, a white or yellow dry area appears on the surface of the shrimp which penetrates below the surface. For non-peeled shrimp, the shell should be removed to check the dehydration in flesh.
Discoloration:	Any deviation of color (red, orange, yellow) which is different from natural color is considered as the defect "discoloration." Besides shell, muscle of discolor shrimp also turns into red/orange/yellow color.

(continued)

Foreign matter:	Any kinds of substances/objects which are not derived from the product are considered as foreign matter. Foreign matters are not allowed in export grade shrimp.
Hanging meat:	Hanging meat is the result of improper de-heading. Some meat remains in hanging position in the juncture point of shrimp after removing of the head. It may increase some weight.
Melanosis:	Any kind of black coloration or black pigment that is present on shrimp's body is considered as melanosis. It is also called black coloration.
Odor/bad smell:	Smell should be typical for raw fresh shrimp. If found any kind of foreign smell, bad smell, smell of spoilage, or objectionable flavor/smell are considered as odor.
Soft shell:	It means softness condition of the shell. It is very easy to identify the soft-shell shrimp by touching of its body. It's just like a feeling of soft shell.
Uncut:	No cut observed in the dorsal side of shrimp body.
Wrong cut:	Shrimp is cut in the wrong way. Shrimp should be cut as per buyer requirement. Cutting variations are not allowed without prior approval.
Vein:	Vein is nothing but intestinal tract of shrimp. A black threadlike intestinal tract present on the dorsal side of shrimp. In case of deveined product, buyer asked to remove the vein completely as it may contain harmful microorganisms. Vein or parts of vein that are observed in final product are considered as defect called "vein." It's a result of improper deveining process.

The following are the images of shrimp with their defects (Figs. 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16, 5.17, 5.18, 5.19, 5.20, 5.21, 5.22, 5.23, 5.24, 5.25, 5.26, and 5.27).

Perform the following exercise

Exercise 1:	Make a list of defects for block, IQF, and semi-IQF products.
Exercise 2:	Make a list of defects for HLSO, PND, PDTO, PUD, EZP, and HOSO shrimp.
Exercise 3:	Make a list of critical, major, and minor defects.

5.3 Causes of Defects

Causes of defects in shrimp are as follows:

- Improper transportation of shrimp
- Receiving of poor-quality raw materials (disease infected, jelly/iron/water pushed shrimp, etc.)
- Improper handling of shrimp
- Improper icing of shrimp
- Long-term storage
- Thawing and reprocessing of shrimp
- Improper processing of shrimp (improper grading, beheading, cutting, peeling, deveining, freezing, glazing, packaging, storage, etc.)

Fig. 5.1 Loose/dropping head

Fig. 5.2 Tail broken

Fig. 5.3 Black gill

Fig. 5.4 Broken/damage

Fig. 5.5 Head discoloration

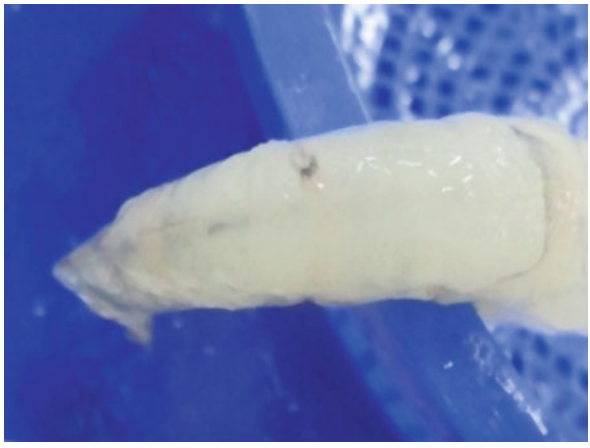


Fig. 5.6 Uncut (PND shrimp)

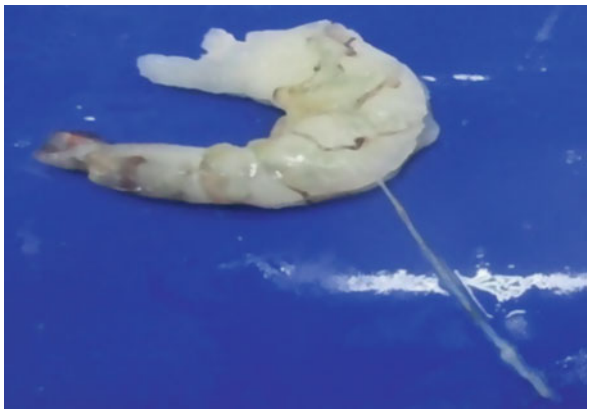


Fig. 5.7 Vein

Fig. 5.8 Wrong cut

Fig. 5.9 Deep cut

Fig. 5.10 Clumps

Fig. 5.11 Shell broken

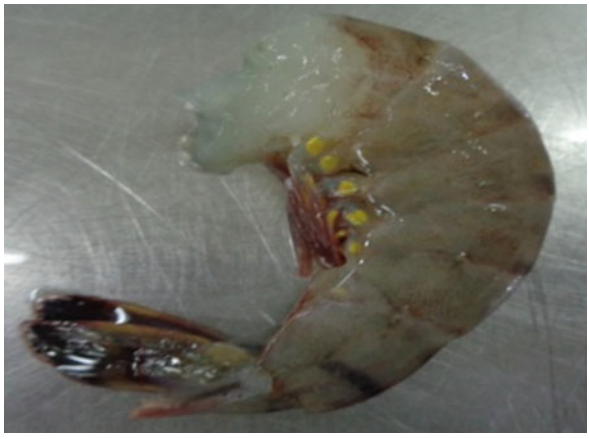


Fig. 5.12 Soft shell

Fig. 5.13 Necrosis

Fig. 5.14 Hanging meat

Fig. 5.15 Back broken

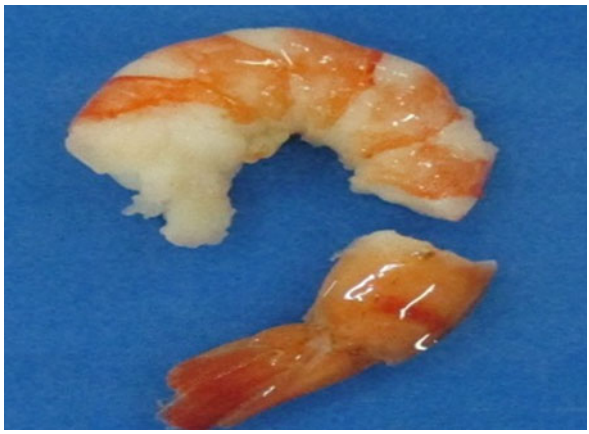


Fig. 5.16 Broken shrimp

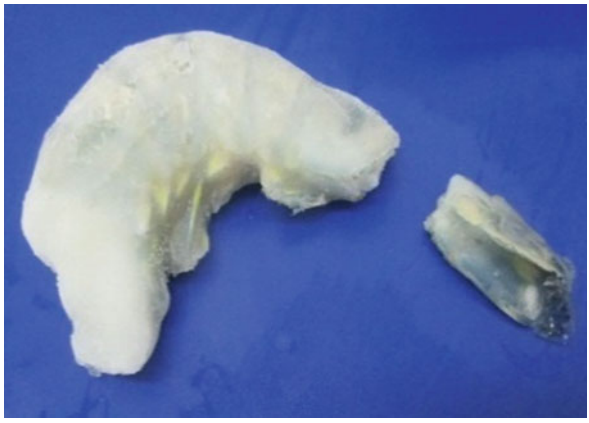


Fig. 5.17 Tail broken

Fig. 5.18 Broken pieces

Fig. 5.19 Decomposed shrimp

Fig. 5.20 Discoloration (FW)

Fig. 5.21 Discoloration (BT)

Fig. 5.22 Improper peeling

Fig. 5.23 Melanosis

- Improper functioning of equipment
- Fluctuation of temperature
- Improper sanitation in the working environment
- Lack of trained personnel
- Careless/unconsciousness of the workers
- Unwillingness of the suppliers

5.3.1 Calculation of Defects (%)

The products with any kind of defects are not accepted by the buyers, so that it is necessary to find out the percentage of defects in final products. There are two methods that are practiced for the counting of defect by percentage like calculation of defects by means of (1) weight and (2) pieces. Calculation of defects (%) by

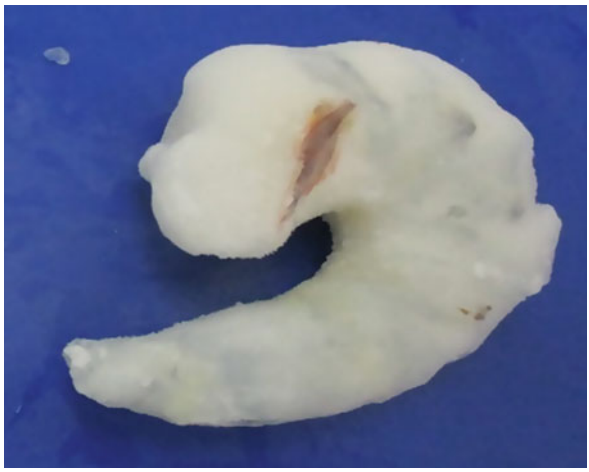


Fig. 5.24 Attached foreign matter

Fig. 5.25 Attached shell

Fig. 5.26 Attached shell

Fig. 5.27 Attached organ

means of weight is more accurate although some importers choose the calculation method by pieces. Both of these two methods are given below.

1. **Calculation of defects (by means of weight)**

$$\% \text{ of broken shrimp} = \frac{\text{Weight of broken shrimp per unit}}{\text{Actual (thawed) weight of shrimp per unit}} \times 100$$

$$\% \text{ of vein} = \frac{\text{Weight.of veined shrimp per unit}}{\text{Actual (thawed) weight of shrimp per unit}} \times 100$$

$$\% \text{ of hanging meat} = \frac{\text{Weight of hanging meat shrimp per unit}}{\text{Actual (thawed) weight of shrimp per unit}} \times 100$$

$$\% \text{ of soft shell} = \frac{\text{Weight of soft shell shrimp per unit}}{\text{Actual (thawed) weight of shrimp per unit}} \times 100$$

*Suppose you have observed 90 g veined shrimp in a bag of BT, PND, 8/12, RC, 80% NW, 10 × 1 kg, IQF products. Calculate the percentage of veined shrimp.

$$\% \text{ of vein} = \frac{\text{Weight of veined shrimp per unit}}{\text{Actual (thawed) weight of shrimp per unit}} \times 100$$

$$= \frac{90}{800} \times 100$$

$$= 11.25\%$$

Here,
Weight of veined shrimp = 90 g
Actual weight of shrimp = 800 g

Result: Percentage of veined shrimp of this unit bag is 11.25.

Or,

2. **Calculation of defects (by means of pieces)**

$$\% \text{ of broken shrimp} = \frac{\text{No.of broken shrimp per unit}}{\text{Total no.of shrimp per unit}} \times 100$$

$$\% \text{ of vein} = \frac{\text{No.of veined shrimp per unit}}{\text{Total no.of shrimp per unit}} \times 100$$

$$\% \text{ of hanging meat} = \frac{\text{No.of hanging meat shrimp per unit}}{\text{Total no.of shrimp per unit}} \times 100$$

$$\% \text{ of sot shell} = \frac{\text{No.of soft shell shrimp per unit}}{\text{Total no.of shrimp per unit}} \times 100$$

*Suppose you have observed 2 pcs of veined shrimp in BT, PND, 8/12, RC, 80% NW, 10 × 1 kg, IQF products. Total pcs per bag is 21. Calculate the percentage of veined shrimp.

$\%\ \text{of vein} = \frac{\text{No.of veined shrimp per unit}}{\text{Total no.of shrimp per unit}} \times 100$ $= \frac{2}{21} \times 100$ $= 9.5\%$	Here, No. of veined shrimp = 2 pcs Total pcs of shrimp/bag = 21 pcs
Result: Percentage of veined shrimp of this bag is 9.5.	

Perform the following exercise

Exercise 1:	Suppose you have observed 60 g discolored shrimp in a bag of BT, HLSO, raw, 16/20, FC, 80% NW, 10 × 1 kg, IQF products. Calculate percentage of discolored shrimp.
Exercise 2:	Suppose you have observed 98 g soft shell in a block of BT, HLSO, raw, 31/40, RC, 100% NW, 6 × 1.8 kg block product. Calculate the percentage of soft shell.
Exercise 3:	Suppose you have observed 3 pcs of loose head shrimp in a block of BT, HOSO, 21/30, FC, 80% NW, 10 × 1 kg S.IQF products. Calculate the percentage of shrimp containing the loose head.
Exercise 4:	Suppose you have observed 5 soft shells in a block of BT, HLSO, raw, 31/40, RC, 100% NW, 6 × 1.8 kg block product. Calculate the percentage of soft shell. [Hints: Consider minimum no. of pcs per block].

Traceability in Shrimp

6

Abstract

Traceability is a record-keeping system of forward and backward. From stocking of shrimp to final consumption, all stages of food chain information should be kept recorded. The chapter highlighted the details of traceability, its importance, traceability in culture system, traceability in depot, and traceability in processing plants and shipment. Traceability system in food chain helps to trace hazards and guide to resolve it at any stages of their value chain.

Keywords

Culture area · Depot · Processing industry

6.1 Traceability

Traceability is the capability to trace something from production to consumption that interprets the history of origin, supply chain, and processing details and distribution of an item throughout the documentation procedure. Traceability is one of the most critical requirements in information systems and the supply chain risk management for both global food safety and quality assurance. The detailed record-keeping process throughout the whole value chain process helps to increase supply chain visibility, improves quality control system of foodstuff, and reduces risks. Traceability is important to ensure both food safety and consumer confidence (Pouliot and Sumner 2013).

Golan et al. (2004) state that traceability refers to the ability to identify the source of food. Traceability is "one step backward and one step forward" record-keeping system that helps to identify the product has been supplied throughout the supply chain and ensure food safety, quality, and product labeling (Pouliot and Sumner 2013; Marucheck et al. 2011).

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_6

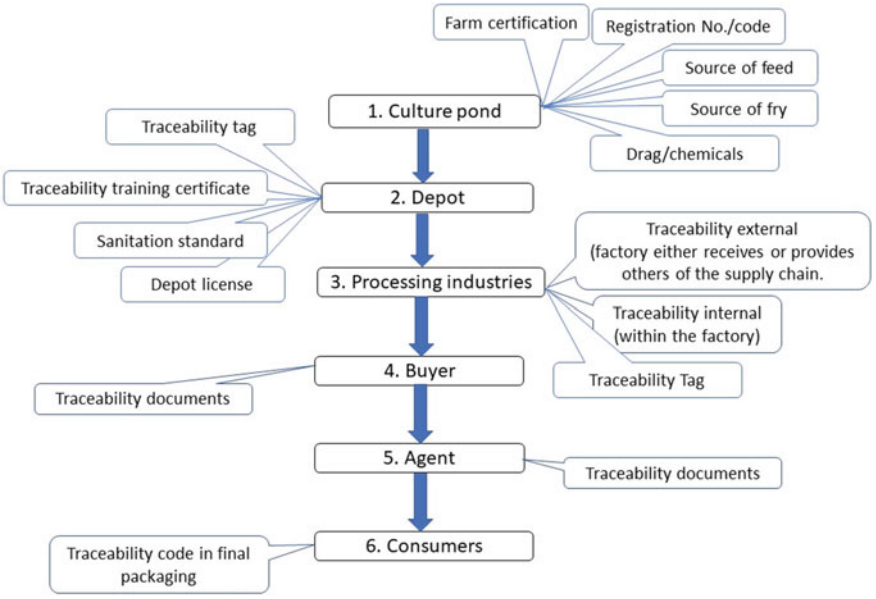
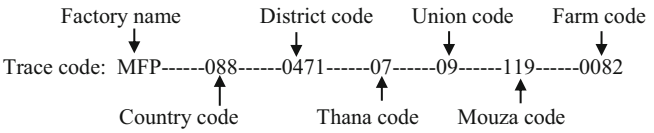


Fig. 6.1 Flowchart of traceability

Codex Alimentarius Commission of the FAO stated that "the traceability is the ability to follow the movement of food through specified stage(s) of production, processing and distribution" (Nowsad 2007).

According to the EU Commission Regulation (*EC No. 178/2002)*, "traceability is the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution" (Nowsad 2007).

In order to maintain traceability, all shrimp farms need to be registered first. After successful registration a trace code is assigned for every registered farm. Trace code helps to identify the origin of product from any stage of its culture to final consumption. Trace code should be mentioned in the packaging of exported items. See the following example of traceability coding system used in frozen shrimp.



A traceability flowchart is given below with the details of traceability system (Fig. 6.1).

6.1.1 Importance of Traceability

Traceability is a mandatory process for all kinds of food businesses. The strong monitoring system must be enforced in food processing industries so that it is possible to trace or recall food at any step of its origin to final consumption. This traceability system helps suppliers to determine the problem and also helps to take the necessary steps to solve the problems accordingly. Importance of traceability is as follows:

- Traceability increases supply chain visibility.
- Traceability identifies the risk and hazards from the entire supply chain.
- Traceability helps to identify the origin of the fault.
- Traceability improves quality control systems of the products.
- Traceability helps to recall suspected food items from the whole supply chain.
- Traceability helps to resolve the identified hazards.
- Traceability assures food safety in all steps of the supply chain.
- Traceability confirms the quality of food and food products.
- Traceability helps to protect criminal actions.
- Traceability ensures consumer protection.
- Traceability increases product value and assure better price.
- Traceability collects and records all necessary information.
- Traceability helps to lead sustainable business with reputation.
- Traceability helps in risk management.

6.1.2 Traceability in Culture Area

Traceability should be started from culture pond of shrimp. Farmers must submit their culture record details in depot/purchaser/processing industries during the selling of their shrimp. Traceability in culture area helps to confirm the quality of raw materials. Remember that quality raw materials lead to produce quality final products. The following record should be maintained by the farmer during the culture period.

Trace code:	Every farmer should have a registered trace code for their identifications. Shrimp-producing countries are already taken action to register shrimp farms and send them a trace code accordingly. Farmers who are not registered yet must enclose their trace code immediately. Note that without registered/certified farms, purchase of raw materials (shrimp) is not allowed.
Origin of seed/fry:	Name of hatchery and suppliers (seed/fry) should be recorded. Fry should be collected from the restarted registered hatchery also.
Culture area and method:	Culture area and culture method should be well recorded. It helps to know either the product is organic or inorganic or the product is wild catch/extensive/semi-intensive/intensive product.

(continued)

Feed:	Record properly if feed used in cultured farm, i.e., origin of feed, feed ingredients, protein %, brand, feeding rates, feeding frequency, etc., should be recorded properly.
Fertilizer:	Record properly if fertilizer is used, i.e., name of fertilizer, origin, brand, doses, frequency, reasons, etc.
Chemicals:	Record properly if chemicals are used, i.e., name of chemicals, date of use, origin, dose, frequency, reason, etc.
Disease treatment:	Record properly if performed disease treatment. Keep record of the following if shrimps are treated for disease infestation, i.e., name of the disease, occurrence time, chemicals and/or drugs used for treatment, doses, frequency, etc.. Uses of antibiotics are strongly prohibited, but if used then you need to confirm withdrawal period.
Date of stocking:	Date of stocking should be recorded.
Date of harvesting:	Date of harvesting should also be recorded.

6.1.3 Traceability in Depot

It is necessary to collect the abovementioned information from farmers. Farmers have to provide all necessary information or documents along with their raw materials. Depot should confirm the sanitation procedure, icing ratio, and standard packaging during storage or transportation. Icing ratio has to be calculated considering the size/grade of raw materials, transportation distance, weather condition, environmental temperature, etc. Collection of shrimp and storage time should be very short. Long-term storage of shrimp in depot is strongly avoided. Depot should supply the following documents to processing industries:

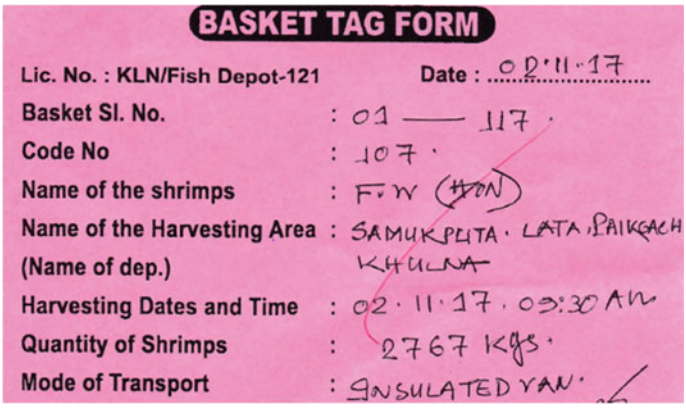
- Basket tag (tag contains information details, i.e., name of depot owner, trace code, batch no., quantity, receiving date and time, etc.)
- Challan/memo
- Depot license
- Acknowledgment of free of metals/chemicals/jelly/push, etc. in shrimp
- Document details of culture history received from the farmers

6.1.4 Traceability in Processing Industry

Processing industries have to maintain traceability both external and internal. In case of external traceability, processing industries have to maintain record for both case of receiving or providing others of the supply chain. Traceability in processing industries starts with receiving of raw materials. Factory personnel should check the following parameters very carefully during the receiving of raw materials. Factory personnel marked the raw materials with new identification no. (i.e., batch no./lot no.) and continued the following steps based on that batch no./lot

no. Following parameters should be checked very carefully during receiving of raw materials (Figs. 6.2 and 6.3):

- Is basket tag present or not?
- Is raw material well packed or not?
- Is icing ratio appropriate or not?
- Is hygienic condition good or not?
- Is quality of raw materials good or not?
- Does it come from the previously selected farms or not?
- All necessary documents are present or not?


BASKET TAG FORM

Lic. No. : KLN/Fish Depot-121 Date : 02·11·17

Basket Sl. No. : 01 —— 117.

Code No : 107.

Name of the shrimps : F.W (HON)

Name of the Harvesting Area : SAMUKPUTA. LATA, PAIKGACH

(Name of dep.) KHULNA

Harvesting Dates and Time : 02.11.17. 05:30 AM

Quantity of Shrimps : 2767 Kgs.

Mode of Transport : INSULATED VAN.

Fig. 6.2 Basket tag (depot)

Fig. 6.3 Basket tag (suppliers)

Traceability helps to increase transparency and accountability in the seafood supply chain by ensuring proper information about the products. Traceability in shrimp processing industries is divided into categories:

1. Internal
2. External

Internal traceability starts with receiving of raw materials. In every stage of shrimp processing industry, traceability is maintained strictly, i.e., receiving of raw materials, lot no., uses of additives, soaking time, microbial, chemicals, heavy metals, storage, as well as shipped products are recorded well. In case of external traceability, the record-keeping is done for both cases either receiving or providing others or shipped within the supply chain. Remember that the traceability documents are shipped to buyer along with the final products. It should be necessary to preserve the traceability documents for few years if the products are shipped already.

References

Golan EH, Krissoff B, Kuchler F, Calvin L, Nelson KE, Price GK (2004) Traceability in the US food supply: economic theory and industry studies (No. 1473-2016-120760)

Marucheck A, Greis N, Mena C, Cai L (2011) Product safety and security in the global supply chain: Issues, challenges and research opportunities. J Oper Manag 29(7–8):707–720

Nowsad AKM (2007) Participatory training of trainers: a new approach applied in fish processing. Bangladesh Fisheries Research Forum. 329 p

Pouliot S, Sumner DA (2013) Traceability, recalls, industry reputation and product safety. Eur Rev Agric Econ 40(1):121–142

Plant Sanitation and Hygiene

7

Abstract

Sanitation is the act of hygiene and prevention of contamination by maintenance of sanitary conditions. Sanitation of shrimp processing industries is a mandatory requirement for all. Every step of processing of shrimp must follow the sanitation standard for quality food production by avoiding foodborne contamination in human. The chapter of the book highlighted the details in sanitation guidelines for processing industries, uses of chlorine solution with different doses for different uses, and their precaution. The chapter also explains WHO guidelines for washing hand.

Keywords

Sanitizers · Chlorine · Hand wash

7.1 Sanitation

Sanitation is the act of hygiene and prevention of contamination by maintenance of sanitary conditions. The aim of plant sanitation and hygiene is to provide clean environment during transportation, processing, and storage of shrimp and stop transmission of disease-causing microorganisms from food materials to human. The word cleaning means removing of physical or solid particles that are loose or adhering to a surface, but the word sanitation means not only removing of physical or solid particles but also removing of microorganisms. Sanitation is a mandatory issue for seafood industries. The application of sanitizer helps to keep our product safe and wholesome and increase their maximum shelf life through reduction of contamination and spoilage. Factory personnel should monitor sanitation procedures regularly and must report findings to respective authorities. The buyer or buyer representative checks the sanitation procedure considering it as a major issue. It's the

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_7

key indicator of business performance. Every personnel must maintain sanitation procedures before going to visit the factory area. It's a mandatory process not only for quality personnel and laborers but also for all sorts of staffs, visitors, managers, owners, buyers, and others who wish to visit processing industries.

7.2 Sanitation Guideline for Processing Industries

The following guidelines of sanitation procedure are maintained in processing industries:

- Wear apron, mask, gumboot, headgear, and hand gloves.
- Wash hands properly with liquid soap/hand wash, and dip hands and legs in chlorinated water before entering into the industry.
- In every hour of interval, workers must wash their hands with chlorinated water.
- Chemicals, i.e., perfume, nail polish, lipstick, etc., are not allowed inside the industry.
- Ornaments or metals, i.e., ring, earrings, nose pin, necklace, bangles, etc., are strictly prohibited inside the industry.
- Uses of mobile phones are not allowed.
- Staffs suffering from the disease are not allowed.
- Eating of foods is strictly prohibited inside the industry.
- Broken, damaged, contaminated, disease-infected products are not allowed for processing.
- Waste of shrimps, i.e., legs, shell, vein, meat, etc., are kept in the selected basket and removed instantly after being filled up.
- Washing of shrimps should be done individually instead of batch wash.
- All equipment, i.e., processing table, stand, basket, bowl, knife, belt, water tank, floor, wall, etc., must be washed properly with detergent and sanitizer at the end of the shift and before starting of next shift.

7.3 Doses of Sanitizers

The most widespread disinfectants are chlorine, ozone, iodine, hydrogen peroxide, formalin, UV light, etc. Among the disinfectants chlorine is one of the most effective and widely used in shrimp processing industries because of its high effectiveness, availability with different forms, inexpensiveness in cost, not being affected by hard water, and easy monitoring of residual levels. Chlorine is a disinfectant used to disinfect the hands and feet of the quality personnel, laborers, and visitors who have to enter into the processing industry. Chlorine solution is also used to sanitize the

Table 7.1 Doses of chlorine solution that are practiced in shrimp processing industries

Scope of treatment	Standard of solution (ppm)
Hand dip	20–50
First foot dip	150–200
Second foot dip	150–200
Floor sanitization	150–200
Equipment's and utensils' sanitization	150–200

equipment, floors, and walls of the processing industry. Chlorine solution can be prepared from belching powder (Table 7.1).

[Note: Chlorine solution should be replaced at 2 h intervals for foot dip, 1 h interval for hand dip, and 1 h interval for equipment and utensils' sanitization].

- **Precaution for chlorinated solution**
  - Keep the solution in closed condition. Never keep it open; it may reduce its reactivity.
  - Mark the solution with a proper identification tag.
  - Attention should be given on the expiry date.
  - Don't dip hand for a long time. It may have an irritating and corrosive action.
  - Don't drink chlorinated water.
  - Keep the solution away from food staff and preserve at a safe location.
  - If sometimes in eyes, wash with pure water properly, and take suggestions from the doctor.

7.4 Guidelines for Washing Hand

The following are the images of hand washing procedure in processing industries (Fig. 7.1).

[Note: Rinse well under running water, and make sure all traces of soap are removed. Remove rings and watches before washing your hands, or ensure you move the rings to wash under them.]

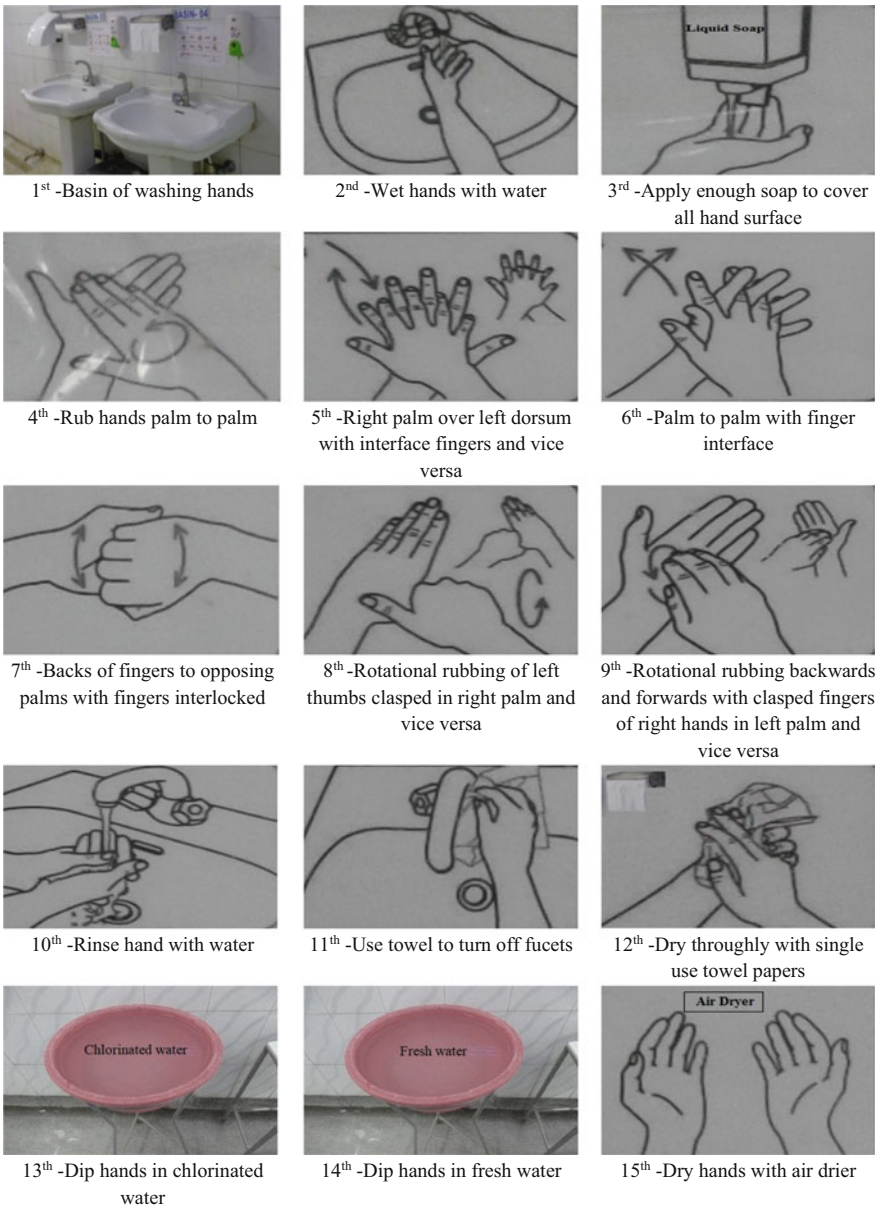


Fig. 7.1 Hand washing procedure in processing industries (WHO 2009)

Reference

WHO (2009) WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland. https://www.ncbi.nlm.nih.gov/books/NBK144035/figure/partii_ranking.f2/?report=objectonly

Packaging, Labeling, and Storage

8

Abstract

Packaging is an unavoidable function for all kinds of foodstuff, but special care should be taken for frozen shrimp because final products of frozen shrimp are transported in frozen condition (−18 °C) in all aspects of their cycle. Packaging means wrapping of goods. The chapter highlighted the details of packaging and packaging materials; description of artwork/label and rider card; properties of inner bag, inner box, and master cartons; specification of bag, box, and master cartons (components, flute, flute height, flute type, mount paper, etc.), and information on MC sticker, rider card, its dimension, pallet (US and Euro pallet), palatalization, metal detection, barcode scanning, and frozen storage. Storage monitoring, storage loss, and defects of packaging are also included in this chapter. Different types of calculation like calculation of pallet, area of pallet, no. of cartons per pallet, no. of cartons per layer, no. of layers per pallet, and air gap determination are specified clearly in this chapter with some related exercise.

Keywords

Artwork · Rider card · Master cartons · Pallet · Metal detection

8.1 Packaging

Packaging means wrapping of goods. It serves a great role in food and food products, especially for frozen products. Everything from packaging materials, labeling information, packaging design, color, to logo should be accurate as per buyer's instruction and must satisfy the international packaging law. Packaging should be more attractive to look at, which helps to promote sales and marketing and make a brand image worldwide. Remember that packaging of frozen products must be waterproof. The purposes of the packaging of frozen shrimp are as follows**:**

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_8

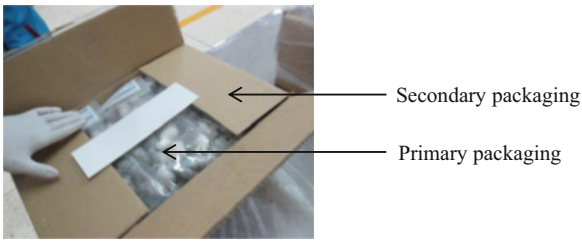


Fig. 8.1 Primary and secondary packaging of frozen shrimp

- Ease handling
- Identify product
- Protect from heat, light, air, and moisture
- Keep safe from contamination
- Make convenient storage and transportation
- Help in advertisement and communication
- Promote sales and marketing
- Make a brand image worldwide

Packaging is an important part of shrimp business. Shrimps are sent for final packaging after completion of production process. There are two types of packaging that are in practice in seafood business (Fig. 8.1).

(a) Primary packaging:	Primary packaging means inner packaging, i.e., packaging of inner box or bag.
(b) Secondary packaging:	Secondary packaging means outer packaging, i.e., packaging of master carton.

Packaging is performed immediately after final processing of shrimp. In some exceptional cases, temporary packaging can be performed immediately after final processing of shrimp. It happens when packaging materials are not available in processing industry or packaging company fails to supply packaging materials on time. Final packaging can be done again after receiving of final packaging materials. Labeling of packaging must be accurate, because any kinds of deviations or wrong packaging may stop the shipment. On the contrary, importers may claim demurrage to suppliers for their mislabeling or late shipment. Goods are packed as per buyer instruction. If buyer has any special instruction, it must be followed during final packaging. Keep in mind that packaging and labeling must be 100% accurate and as per international packaging law. The following parameters should be checked very carefully during final packaging:

- Are color, logo, and other design okay as per buyer instruction?
- Is dimension perfect as per buyer's instruction or not?
- Is labeling okay or not?
- Is labeling visible enough to read or not?

- Is there any mislabeling in master carton, inner bag, or box or rider card or not?
- Is barcode scanning properly or not?
- Is there any mismatch with barcode or not?
- Is sealing perfect or not?
- Is there any damaged master carton or not?
- Is master carton strong enough to protect frozen shrimp or not?
- Is there any damage inner box or bag or not?

8.2 Packaging Materials of Frozen Shrimp

Packaging materials are major concern of frozen products because of dealings with food-grade items and chances of cross-contamination. Packaging materials of frozen products are also important for the transportation of long distances and long-term storage. Remember that the shelf life of frozen shrimp is around 2 years. Now, the question is what would be the packaging materials of frozen shrimp?

The following are the characteristics of package materials of frozen shrimp:

- Packaging materials should be available and cost-effective.
- Package materials should be convenient for the size, shape, and type of frozen shrimp.
- Package materials should be potable and durable for longtime preservation.
- Package materials should be convenient for frozen storage and long transportation.
- Package materials should be convenient for easy handling and processing.
- Package materials should be suitable for printing and labeling and good looking.
- Package materials should be strong enough to protect heavy weight of frozen shrimp.
- Package materials should be safe to use and free from chances of cross-contamination.
- Package materials should be recyclable and biodegradable.

8.3 Description of Artwork/Label

The artwork is a vital part of the packaging. A full set of packaging is called artwork. It is also called label. Artwork includes the design and dimension of the master carton, inner box, inner bag, sticker, rider/header card, and others. Standard packaging law should be followed during the preparation of artwork. All information present on artwork must be accurate and authentic. The preparation of artwork is a mandatory process for all seafood businesses. Suppliers prepared their artwork upon approval of the importers. See the following characteristics of an ideal artwork.

(a) PO No.:	PO number means purchased order number. It's an identification number of the purchased consignment. The buyers marked their purchased consignment as PO number for their convenience. The buyers provide their purchase reference (PO) number after confirmation of the purchase negotiation. PO number must be mentioned on artwork/label. It helps to identify and track the consignment very easily. PO number is also known as reference number.
(b) Lot No.:	Lot number means the identification number of the raw materials or shipped products. Lot number should be mentioned in artwork for identification of the source of raw materials.
(c) Art. No./Article No.:	Art. no./article no. is the identification mark of the product. Different article numbers are assigned for different items of products of the consignment. Different Art. nos. are assigned for different types of products. For example, BTI-2020 is the article no. of black tiger, HLSO-EZP 16/20 IQF shrimp and BTB-2020 for BT-HLSO 16/20 block shrimp. Every buyer has his or her own product identification system that is marked as article number. It helps the buyer to manage his or her product within a variety of items. Art no./article number has to be mentioned on artwork/label.
(d) Factory approval No.:	Every factory has to take an approval number from the responsible authority of the country. The factory approval number is the only identifying mark that is present on retail items of frozen foods. For example, KLN-77 is the EU approval number for Atlas Sea Food Ltd., Khulna, Bangladesh, one of the renowned shrimp-processing industries of Bangladesh. Factory approval number must be mentioned on artwork.
(e) Name of product:	Product name has to be mentioned on artwork/label, i.e., black tiger shrimp or giant freshwater shrimp or cat tiger shrimp or harina shrimp or vannamei shrimp, etc.
(f) Scientific name:	Scientific name must be mentioned on artwork/label, i.e., *Penaeus monodon* is scientific of black tiger shrimp or *Litopenaeus vannamei for vannamei shrimp or Macrobrachium rosenbergii for giant freshwater prawn.*
(g) Production description:	Production description has to be mentioned on artwork/label, i.e., head-on shell-on raw semi-IQF shrimp or head-less shell-on cooked IQF shrimp.
(h) Size/grade of shrimp:	Size/grade of shrimp has to be mentioned on artwork/label, i.e., 8/12, 13/15, 16/20, etc.
(i) Count of shrimp:	Count of shrimp has to be mentioned on artwork/label, i.e., either the shrimp is real count or frozen count.
(j) Production method:	Production method should be mentioned on artwork/label, i.e., marine catch or catch in freshwater or farmed or aquaculture product.
(k) Name of fishing gear:	Name of fishing gear has to be mentioned on artwork/label for wild catch, i.e., trawl net.
(l) Frozen weight:	Frozen weight has to be mentioned on the artwork, i.e., 1000 g for frozen IQF shrimp or 1800 g for block shrimp, etc.
(m) Net weight:	Net weight has to be mentioned on the artwork/label, i.e., net weight 800 g for 10 × 1 kg 80% NW, IQF shrimp.

(continued)

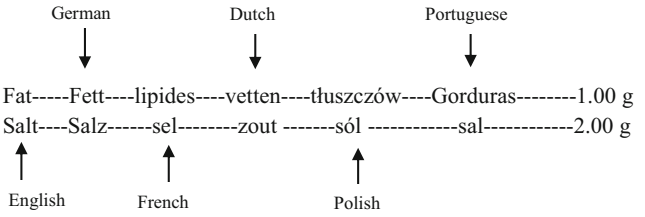
(n) Production date:	Production date has to be mentioned on artwork/label, i.e., production date is 31.12.2021.
(o) Freezing date:	Freezing date has to be mentioned on artwork/label, i.e., freezing date is 31.12.2021. Normally production date and freezing date are the same because products are frozen after production.
(p) Best before date/best before end:	Best before date has to be mentioned on artwork/label. Best before date is also known as best before end. Best before date is around 2 years for frozen shrimp, i.e., 30.12.2023.
(q) Ingredients:	Ingredients should be mentioned on artwork for clear identification of the product, i.e., shrimp (%), water (%), salt (%), STTP (%), etc.
(r) E-Numbers:	Name of additives or its assigned E-numbers have to be mentioned on artwork/label. Additive's name or E-numbers help consumers to choose their desired products, i.e., E450, E451, and E452 are the E-numbers of phosphate treatment.
(s) Barcode:	Barcode of the product has to be mentioned on artwork/label both of inner bag or master carton. It must be visible clearly and readable by the barcode scanner.
(t) Name and address of the importer:	Name and address of the importer must be mentioned on artwork.
(u) Brand name	Brand information text/logo should be mentioned on artwork.
(v) Frozen instructions:	Instructions of conservation and storage of frozen seafood should be mentioned on artwork. The following are the instructions of frozen shrimp.

Product name	Star marks	Temperature	Storage time
Black tiger shrimp	No star	Refrigerator	1 day
Black tiger shrimp	One star/*	−6 °C	1 week
Black tiger shrimp	Two stars/**	−12 °C	1 month
Black tiger shrimp	Three star/***	−18 °C	2 years

(w) Nutritional content:	Tested nutritional values of the frozen shrimp should be displayed on artwork. It helps consumers to know details of nutritional content of the product. Nutritional values are calculated per 100 g of sample. See the following example for more details:

Nutritional value per 100 g:	
Energy	= 320/72 kj/kcal
Fat	= 1.00 g
Carbohydrates	= 0.00 g
Proteins	= 16.0 g
Salt	= 2.00 g
Minerals	= 0.50 g

(x) Language:	Different languages are displayed on artwork so that consumers of different countries of different languages can get a better idea about the product and product instructions before consumption. How many languages will be presented on the artwork/label depends on which country the products will be shipped. See the following example of different languages.



(y) Special instruction:	:	If the buyers have special instruction or special character (brand name, logo, certification logo, etc.) that may be displayed on the artwork/label.

8.4 Inner Bag/Polybag (IQF)

Polybags are used for inner packaging of IQF products. Style, dimension, and design of polybag may vary from product to product, buyer to buyer, country to country, etc. It's totally dependent on buyer's requirements. Different types of polybags are used in seafood business worldwide. There are three types of polybags that are used commonly in shrimp processing industries around the world like:

- Plain bag with rider card
- Preprinted bag with rider card
- Preprinted bag without rider card

Preprinted bag with rider card is the mostly used for IQF shrimp packaging. It is the easiest way of packaging and handling information. Normally, information of polybag and information of rider can be divided in two parts. These are as follows.

1. Fixed information:	Product name, scientific name, freezing instructions, nutritional content, etc. are considered as fixed information.
2. Variable information:	Factory approval no., production date, freezing date, expiry date, size, count, etc. are considered as variable information because it may change time to time.

Fixed information is displayed on polybag and variable information goes to rider card. Sometimes all information goes to rider card, and polybag is used only for

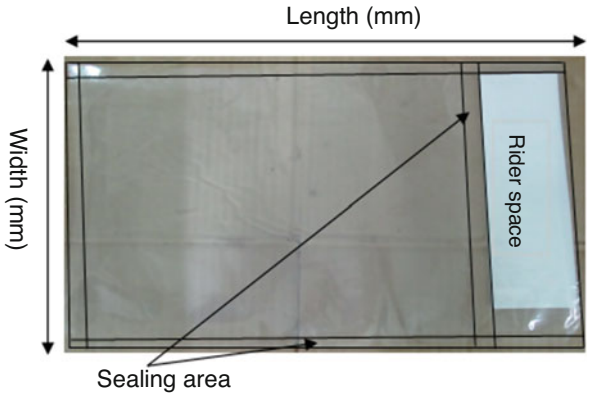


Fig. 8.2 Design of a polybag

attractive design and packaging. The following is the design and dimension of a sample polybag of IQF shrimp (Figs. 8.2 and 8.3).

8.4.1 Properties of Inner Bag/Polybag

Everything from packaging materials, style, design, font, color, logo, information, to dimension must be accurate and approved by the buyers and also satisfy the international packaging law. The cylinder is the essential equipment for the printing of polybag. The preparation of cylinders depends on dimension, design, and color variation of a polybag. Note that a variety of cylinders are required to complete a multicolor bag. The cause is that one cylinder is required to print one color, but if a bag has five colors, it requires five cylinders to complete the polybag. Once a cylinder is being completed, it can be continued year after year. The following are the properties of inner bag/polybag:

- Inner bag should be constructed with double line poly paper.
- Polyethylene terephthalate (PET), low-density polyethylene (LDPE), high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), orientated polypropylene (OPP), NYLON, etc. are the raw materials for polybags. Note that raw materials of inner polybags must be with permitted materials.
- Raw materials should be safe and free from contamination and have no health hazards.
- Polybag should be flexible and strong enough to protect the frozen products.
- Thickness of the liner poly paper should be around 100–120 micron.
- Weight of polybag should be around 15–30 g.
- Air should not be allowed inside the polybag.
- A small size punch should be done on polybag to avoid air inside the polybag.
- If there any special mark (ASC, BAP, HACCP, Halal, etc.) that may be inserted on the polybag.
- A packaging approval certificate should be provided by the packaging company.

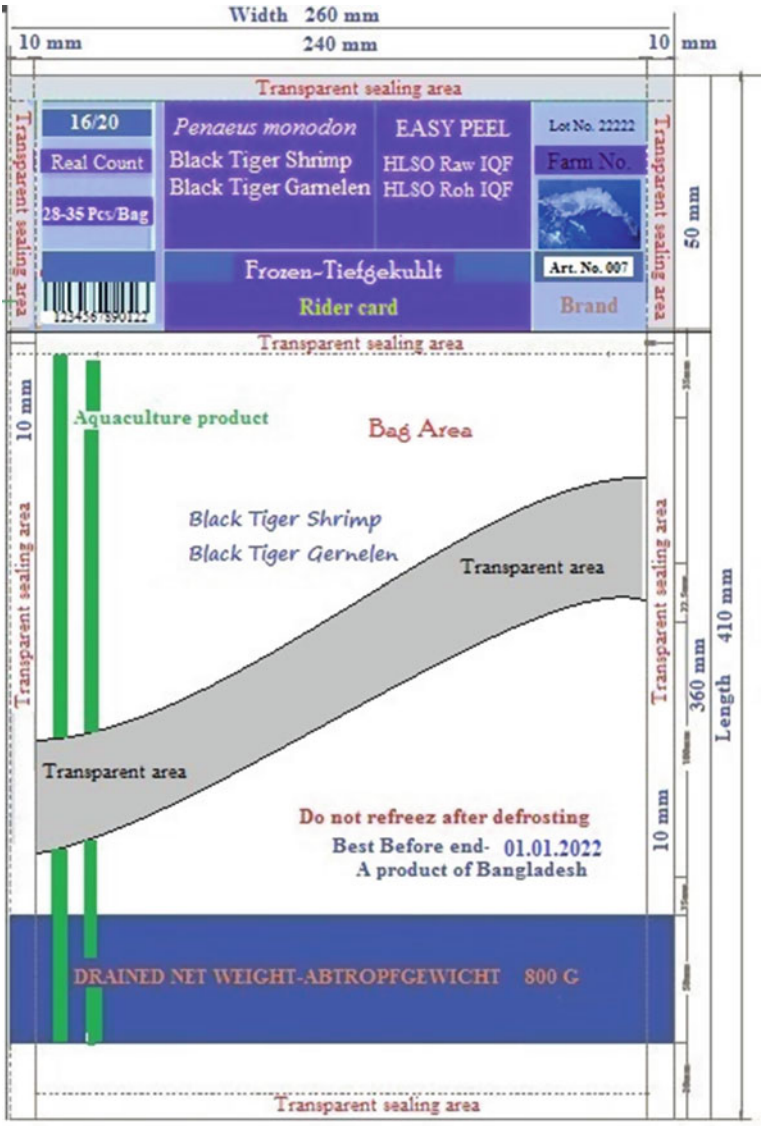


Fig. 8.3 Details design and dimension of a polybag

- **Dimension (s)**

Dimension (s) of polybag depends on size, shape, type, and volume of product. It also depends on size of master carton. The dimension of master carton, polybag, and rider card is given below for your reference (Table 8.1).

[Note: Dimension is not a rigid thing. It may vary buyer to buyer and country to country as per requirement]

Table 8.1 Dimension of master carton, polybag, and rider card

Types of products	Length (mm)	Width (mm)	Height (mm)	Remarks
Rider card	220 ± 10	60 ± 10	–	1 rider card/bag
Inner bag	410 ± 10	260 ± 10	–	1 kg product/bag
Master carton	380 ± 10	280 ± 10	230 ± 10	10 inner bag/MC

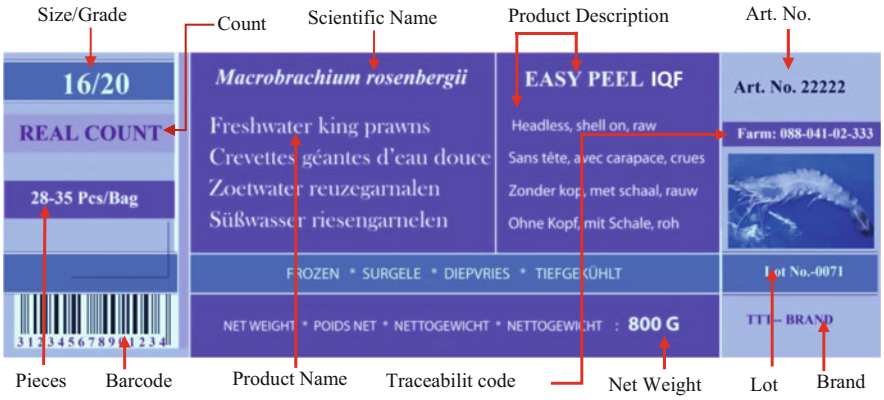


Fig. 8.4 Rider card (front side)

8.4.2 Rider Card

Rider card is also called header card because it is inserted into the top/head region of the polybag. Rider cards are inserted into polybag before sealing of goods. Uses of rider cards are the easiest way and cost-effective method of packaging. No need to purchase expensive equipment for it. Dimension, color, design, labeling, etc. should be accurate for rider cards. The following are the examples of an ideal rider card (Figs. 8.4 and 8.5).

- **Precaution**
  - Dimension, design, color, and logo must be accurate.
  - Labeling information must be accurate. Polybags with wrong labeling are not accepted.
  - Sealing should be perfect. Improperly sealed bags and rider cards are not accepted.
  - Damaged/tare/punctured bags are not accepted.
  - Uses of chemicals or metals are strictly prohibited.
  - Packaging materials must be safe and inactive in chemical reactions.

[Note: Polybag is used for IQF packaging, but some factories are now using polybag for the packaging of block products.]

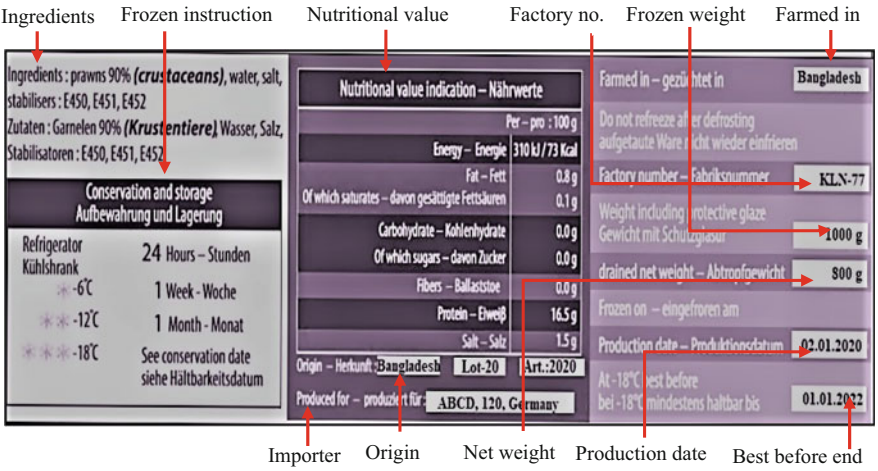


Fig. 8.5 Rider card (back side)

8.5 Inner Box (Block and Semi-IQF)

Inner boxes are used for the inner packaging of block and semi-IQF products. Style, design, and dimensions are different for block and semi-IQF products of shrimp. There are two types of boxes that are used for inner packaging of block and semi-IQF shrimp. These are:

- Preprinted box without sticker
- Preprinted box with sticker

All information is displayed on a printed box as there is no sticker here. On the contrary, the information goes to sticker area if the sticker is attached in the box. A preprinted box with sticker is the best practice because it is very easy to change information and a cost-effective method. Fixed information goes to the preprinted box, and variable information goes to sticker area. Description of the inner box is given below for both block and semi-IQF shrimp.

8.5.1 Properties of Inner Box for Block Products

The following are the criteria of the inner box of block products:

- Packaging materials of inner box should be approved by the buyers.
- Design, dimensions, color, and logo must be accurate.
- Kraft liner paper should be used for the preparation of inner box.

- The box should be made by folding of Kraft liner paper. Preprinted Kraft liner papers are cut in such a way that it can be transformed into the box by just folding of Kraft liner paper. No need to use tape, pin, gum, rubber, or others.
- Thickness of the inner box should be 200–300 gsm or 350–400 micron.
- Box should be laminated by a poly paper to avoid direct contact of the frozen block. Direct contact of Kraft liner paper may damage the Kraft paper. Thickness of the laminated paper should be 10–20 micron.
- Materials of the inner box should be safe, free from contamination, and free of health hazards.
- Box should be strong enough to protect the frozen products.
- Sticker should be attached in an appropriate position in the box (if necessary).
- Labeling must be accurate.
- The paper should be suitable for attractive color and printing.
- A packaging certificate should be collected from the packaging company.
- The box should be recyclable and biodegradable.

- **Dimension (s)**

Dimension (s) of the inner box should be approved by the buyer. It may vary from supplier to supplier, buyer to buyer, or country to country. Dimension (s) of the master carton, inner box, and sticker of inner box for block products are given below for your reference (Table 8.2).

[Note: Dimension is not a rigid thing. It may vary buyer to buyer and country to country as per requirement. Polybag could be used as an alternative to the inner box. Some buyers have already introduced polybag for the packaging of block products. It would be more convenient for handling and transportation, but it's time to think biodegradable issue also.]

The followings are the design and dimension of an inner box for your reference (Fig. 8.6).

8.5.2 Properties of Inner Box for Semi-IQF Products

A special type of box is used for semi-IQF shrimp. The following are the criteria of inner box for semi-IQF shrimp:

Table 8.2 Dimension (s) of the master carton, inner box, and sticker of inner box for block products

Types of products	Length (mm)	Width (mm)	Height (mm)	Remarks
Master carton	380 ± 10	280 ± 10	170 ± 10	6 inner box/MC
Inner box	280 ± 10	180 ± 10	55 ± 10	1.8 kg weight unit box
Inner box sticker	155 ± 10	115 ± 10	–	1 sticker/inner box

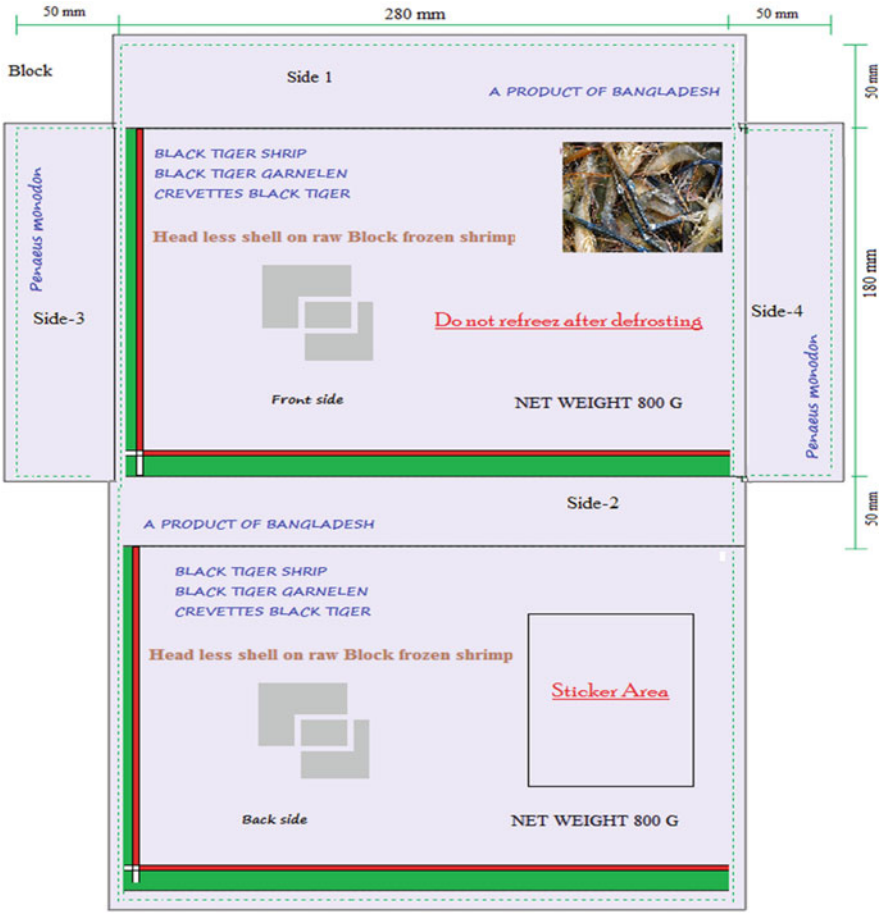


Fig. 8.6 Dimension and design of inner box for block products

- Inner box of semi-IQF products is divided into two parts: (1) top (upper) part and (2) bottom (lower) part. The top part is greater than the bottom part so that bottom part can easily be entered inside the top. Top part is used as a lid and bottom as a base. Frozen shrimps are kept in the bottom part.
- Printed top and plain bottom are commonly used for semi-IQF inner box.
- Both the top and bottom of inner box are made by the folding process. Preprinted Kraft liner papers are cut in such a way that they can be transformed into a box by folding process. No need to use tape, pin, gum, or others.
- Thickness of inner box should be around 200–300 gsm or 350–400 micron.
- Boxes are laminated with poly paper to avoid direct contact of frozen block. The thickness of laminated paper should be around 10–20 micron.
- Finally, a complete box (both top and bottom) is wrapped with a poly paper to make it air tight. The wrapping also helps to protect cross-contamination as it is

Table 8.3 Dimension of master carton and inner box for semi-IQF shrimp

Types of products	Length (mm)	Width (mm)	Height (mm)	Remarks
Inner box (top)	260 ± 10	180 ± 10	50 ± 10	1 kg weight/inner box
Inner box (bottom)	255 ± 10	175 ± 10	50 ± 10	
Master carton	370 ± 10	270 ± 10	160 ± 10	10 inner box/MC

semi-IQF shrimp and sensitive to contamination. Shrink poly paper is used to wrap the box.

- A window is a special character of semi-IQF shrimp. Every box has a window in the top part of the box. Window is used to visualize the frozen shrimp from outside.
- Size, shape, design, and dimension of the box are dependent on buyer requirements.
- Sticker should be attached in an appropriate position of the box (if necessary). Size of sticker depends on the size of box.
- Materials of the box should be safe, free from contamination, and free of health hazards.
- Box should be strong enough to protect frozen product.
- Labeling must be accurate.
- Paper should be suitable for attractive color and printing.
- A packaging certificate should be collected from the packaging company.
- The box should be recyclable and biodegradable.
- Easily available and cheap.

- **Dimension (s)**

Dimension (s) should be approved by the buyer. It may vary from packer to packer and buyer to buyer (Table 8.3, Fig. 8.7).

[Note: Dimension is not a rigid thing. It may change from buyer to buyer and country to country as per requirement]

- **Precaution**
  - Design, dimension, color, logo, and labeling should be correct.
  - Box should be strong enough to protect the frozen product.
  - Sticker should be attached to a fixed place. Size of sticker should be more accurate.
  - Closing, sealing, and wrapping of box should be accurate.
  - Damaged/punctured boxes are not accepted.
  - Chemicals, gums, or metal staples are strictly prohibited.
  - Never walking on semi-IQF packaging. It may damage the window, carton, and product.

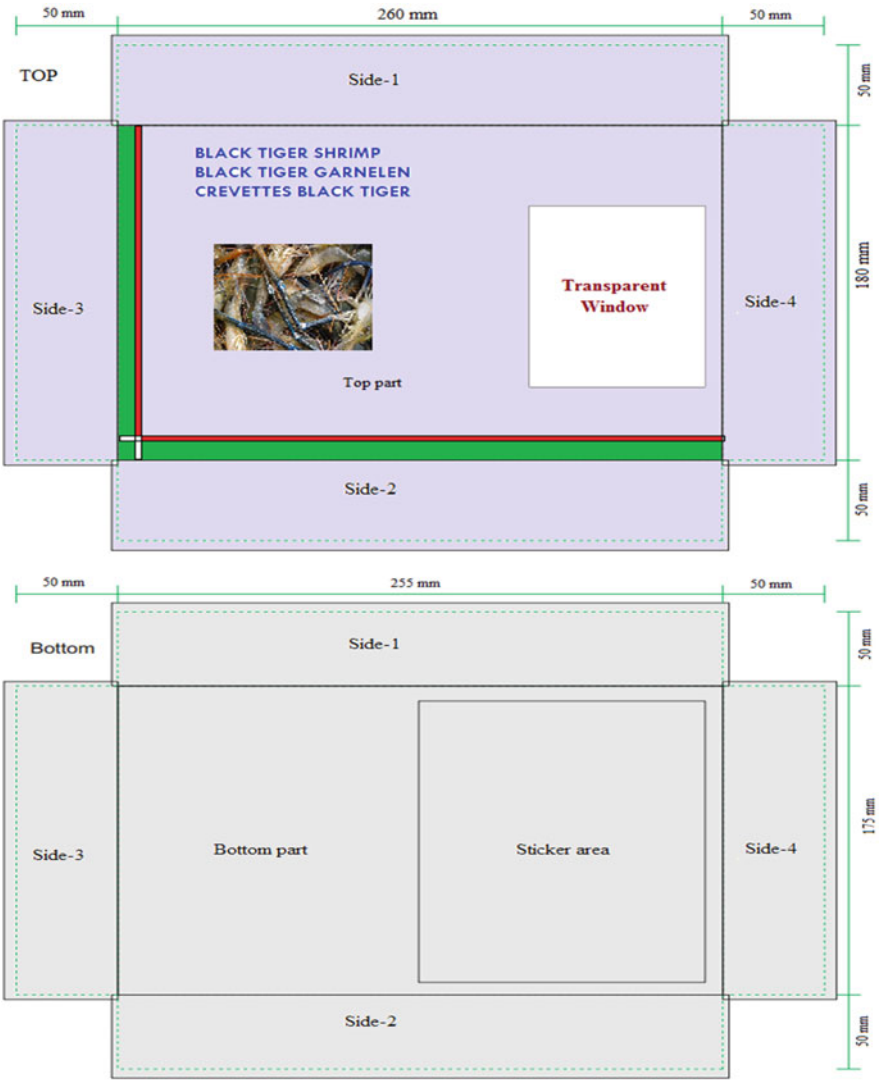


Fig. 8.7 Design and dimension of inner box for semi-IQF shrimp

8.6 Master Carton (MC)

Master carton is the final outer box that is used for the packaging of retail items. It is a large carton packaging used to pack a number of inner boxes or bags for greater protection from damage, reduces the number of cartons during handling process, and helps to transport easily for long distances. Master carton is also called shipping

carton because it is the final box in which the product will be shipped. The following are characteristics of an ideal master carton:

- Raw materials of MC should be safe, free from contamination, and free of health hazards.
- MC should be strong enough to protect heavyweight.
- MC should be convenient for handling and processing.
- MC should be attractive to look at.
- MC should be convenient for long-term frozen storage and transportation.
- MC should be durable, lightweight, fine finishing, and suitable for printing and labeling.
- Size, shape, design, and dimension of the MC should be accurate as per requirement.
- MC should be recyclable and biodegradable.
- MC should be cheap and easily available.

The following information should be presented on a master carton:

- Art. No./Article No.
- Lot No./PO No./Reference No.
- Factory approval No.
- Name of product
- Origin of country
- Frozen instructions
- Logo/brand
- Farming method
- Packing
- Size and count
- Production date
- Expiry date
- Gross weight
- Net weight
- MC opening identification mark
- Barcode
- Country of destination
- Importer name and address
- Special sign/text (if any) or
- Others

In case of wild catch, the FAO catch area should be inserted instead of farming method. FAO identified the zone area in the ocean and marked it by different FAO numbers. This is the easiest way to identify products and their origin in the open ocean.

There are three different styles of the master carton that are in practice:

- Preprinted master carton
- Preprinted master carton with sticker
- Plain master carton with sticker

8.6.1 Properties of Master Carton (MC)

Packaging materials of the master carton should be approved by the buyers and it must satisfy the international packaging law. The following are the properties of an ideal master carton.

Materials:	Solid wood, plywood, or vegetable origin corrugated fibers are used to prepare the master carton. Master carton consists of corrugated paper, media paper, and mount paper. Thickness of corrugated papers, media papers, and mount paper should be ranged 150–200 gsm, 200–300 gsm, and 300–350 gsm, respectively. The media paper and corrugated paper should be treated at 250^0 C temperature and above.
Ply:	3 ply or 5 ply or 7 ply corrugated paper is used to prepare master carton, but 5 ply corrugated paper is most common. Corrugated papers are in high strength, biodegradable, and environment-friendly in nature.
Flute:	The flute is another important factor that distinguished the characteristics of corrugated paper. Common sizes of flutes are A, B, C, E, F, N, BB, AB, BC, BE, etc. Flute size refers to the number of flutes per linear feet. Flute requirement depends on the buyer's instruction. EB flute and BB flute are commonly used for master carton construction. EB flute means the combination of E and B flute, and BB flute means the combination of B and B.
Laminating:	Outer side of the master carton should be laminated with poly paper. Thickness of laminated poly papers should be around 10–15 micron.
Wax coating:	Wax coating may use inner side of the master carton. Wax coating must be with organic wax. Inorganic wax is not allowed. Thickness of wax coating should be 110–150 micron. Wax coating makes the master cartons strong enough.
Sealing:	Adhesive tape is used for the sealing of master carton. Organic gums may also be allowed for sticking of paper/sticker. Uses of metals are strictly prohibited.
Strap:	Strap can be used, but metallic straps are strictly prohibited.
Biodegradation:	Master carton should be recyclable and biodegradable.
Packaging certificate:	Packaging certificate should be collected from the packaging company.

The following are the components of a master carton (Fig. 8.8, Table 8.4):

[Note: Flute height and flutes per linear foot are not constant always]

The following are the images of different types of master carton (Figs. 8.9, 8.10, 8.11, and 8.12).

Image of master carton sticker (Fig. 8.13).

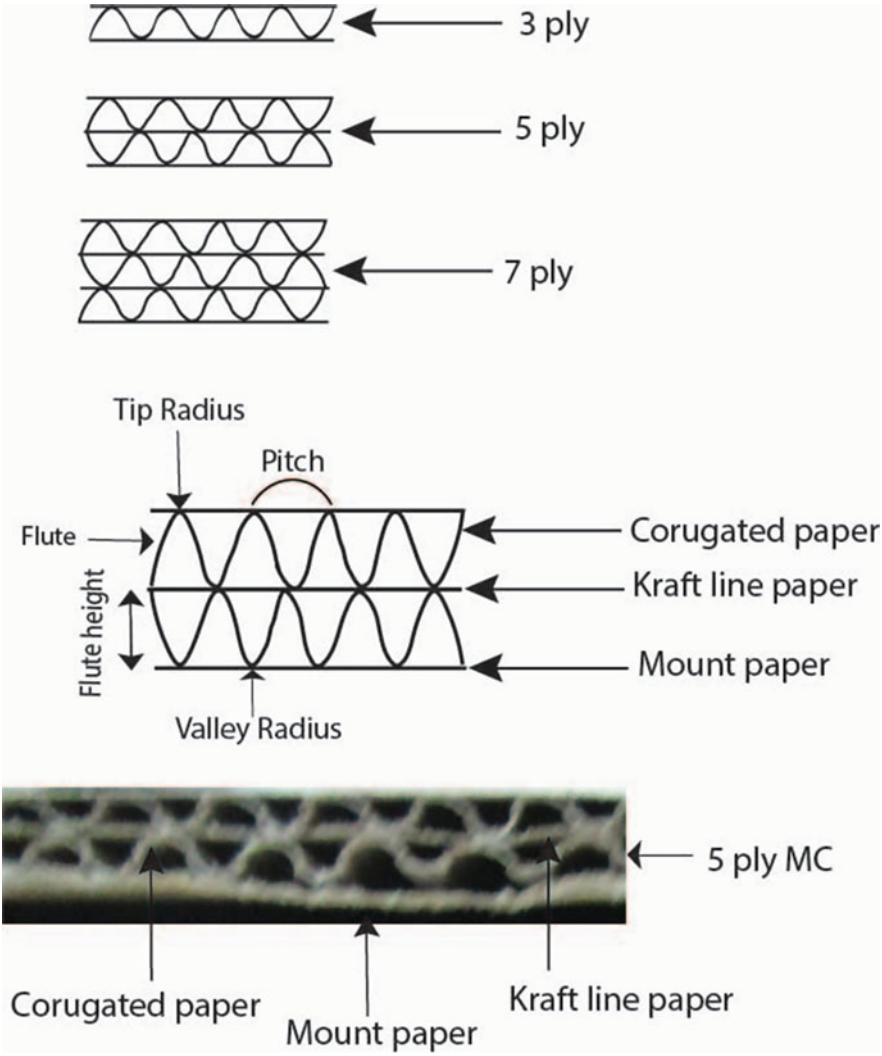


Fig. 8.8 Components of master carton

8.6.2 Procedure of Master Carton Preparation

The description of the production process is given below (Fig. 8.14).

Step 1 (Receiving of raw materials):	Raw materials mainly Kraft liner paper and other necessary materials are imported from the foreign country if not available in local market. Developing countries import the Kraft liner paper from Indonesia and Thailand.
Step 2 (Heat treatment):	Kraft liner paper and the media paper are treated at 260 °C through a boiler machine to make it food grade.
Step 3 (Corrugation and sticking):	The media paper became corrugated first. Corrugated paper is a brown color paper that is very strong, firm, and light weight material suitable for frozen shrimp transportation. The corrugated media paper and the Kraft liner paper pass together with organic gum (starch) to stick them together.
Step 4 (Laminating and assembling):	Preprinted mount paper is used in corrugated board. The mounting paper is laminated with poly paper. The laminated mount paper and corrugated sticking paper (liner and media paper) are paired together with gum by using hydraulic pressure. Lamination is used only in the outer side of the master carton.
Step 5 (Drying):	After lamination and assembling process, the papers are sent for drying. Drying should be done properly since it helps to make paper harder.
Step 6 (Wax coating):	Organic wax is used for the coating of the master carton. Wax coating is given over inner side of the carton. Wax coating makes the carton strong enough to protect the frozen weight. Use of inorganic gum is strongly avoided.
Step 7 (Cutting):	After wax coating, the papers were cut properly to make a master carton. Dimension of master carton is specified previously as per requirements of the products.
Step 8 (Folding and re-cutting):	The prepared paper board was folded and cut again to make them in accurate shape as per the buyer's requirement.
Step 9 (Shipment):	After completion of the whole process, the complete master cartons are delivered to shrimp processing industry.

- **Precaution**
  - Handling of cartons should be very careful during transportation.
  - Uses of chemicals and metals are strictly prohibited.
  - Walking over cartons is strictly prohibited.
  - Damaged cartons (inner and outer) are not accepted anymore. If found, need to replace before shipment.
  - Printing and labeling should be 100% accurate. Zero tolerance in mislabeling.
  - Packer has no right to change design, color, logo, dimension and other information without buyer consent.
  - All packaging materials should be kept in dry, clean, and safe place.
  - Cartons must be well labeled. Removable label or temporary information on master cartons will not be accepted anymore.

Table 8.4 Flute characters of master cartons (http://www.realisticpack.com/infrastructure.php)

Flute type	Flute image	Flute height (mm)	Flutes/linear foot
A		4.5–4.9	Around 35 flutes/linear foot
B		2.2–3.0	Around 50 flutes/linear foot
C		3.2–4.0	Around 40 flutes/linear foot
E		1.0–1.8	Around 100 flutes/linear foot
F		0.8–1.2	Around 130 flutes/linear foot
N		0.5–0.6	Around 170 flutes/linear foot

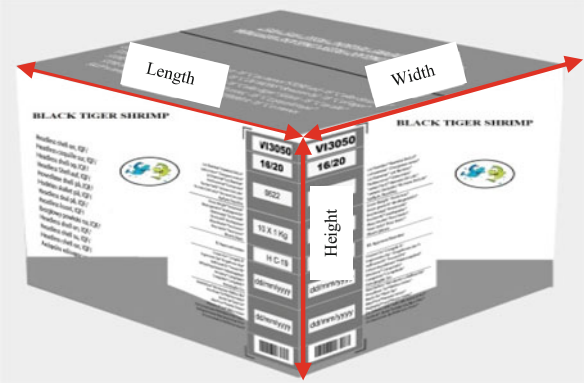


Fig. 8.9 3D structure of a master carton

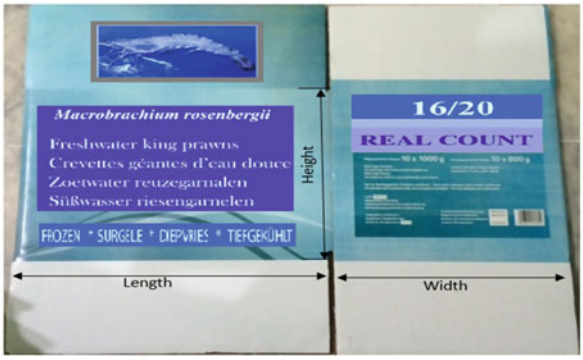


Fig. 8.10 Preprinted master carton

Fig. 8.11 White master carton with sticker

Fig. 8.12 Master carton with strap

- **Defects of Packaging**

  The following are the defects of inner packaging and outer packaging (Figs. 8.15, 8.16, 8.17, 8.18, 8.19, and 8.20).

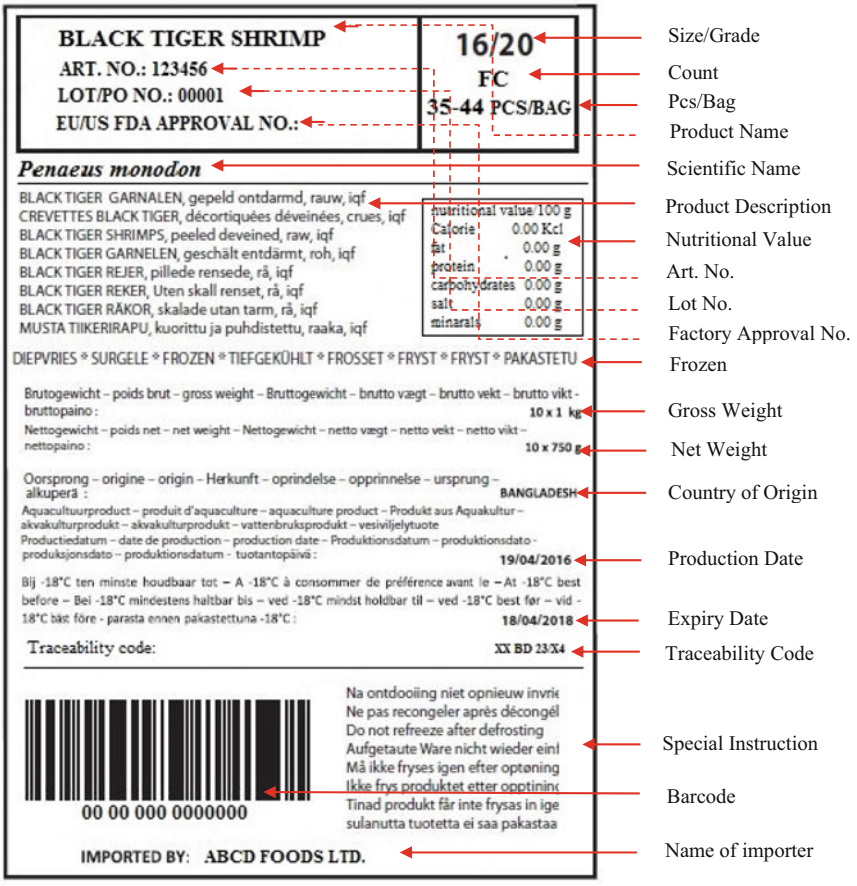


Fig. 8.13 Master carton sticker

8.7 Pallet

A pallet is a horizontal platform, typically affixed to a superstructure and a bottom deck which allows it to be lifted and moved by material handling equipment. It provides the base for assembling, storing, handling, and transporting materials and frozen products. Additionally, a pallet provides protection to the product on it. Pallet jack is a commonly used vehicle that helps to transport heavy-weighted pallets from one place to another easily.

Typically, hardwood or plastic pallets are used for standard pallet. Wooden pallets are most commonly used in shrimp industries. Wooden pallet offers a great combination of weight, stiffness, durability, and cost. Preparation and customization are easy for wooden pallets. Plastic is the second most common material used for

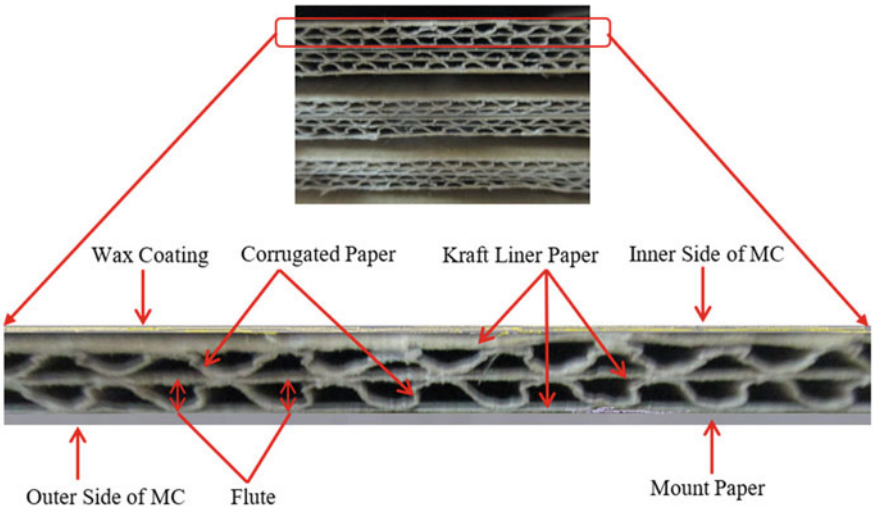


Fig. 8.14 Specification of master carton

pallet preparation. Plastic pallets are lightweight, durable, high-performance design, and good for sanitation performance but typically expensive comparative to a wooden pallet. Other materials (metals, papers) are also used for pallet preparation.

Pallets generally comply with local standards. Different countries have different standards and dimensions for pallets. Dimensions of pallet depend on the dimensions of master cartons. Cartons are stacked on a pallet in such a way that a little gap is present in between two master cartons. This is called air space or air gap. Refrigerated air passes through the gaps and keeps product cool. Uses of pallets are very common in shrimp processing industries. It should be mandatory for all because of buyer's preference. The dimensions of different types of pallets are as follows.

Type of pallet	Dimension (mm)
Euro pallet	1200 × 800
	1200 × 1000
	1140 × 1140
USA pallet	1200 × 1100
	1100 × 1100

[Note: Size and type of pallet may vary on buyer's specification. The base height of the pallet is around 150 mm, and pallet height is 1800 mm standard unless the product itself exceeds 1800 mm. Pallet height means maximum no. of master carton cover the vertical height. The pallet must be shrink wrapped.]

Fig. 8.15 Dirt and forest on carton

Fig. 8.16 Tear carton

Fig. 8.17 Damaged carton

Fig. 8.18 Imperfect sealing of bag

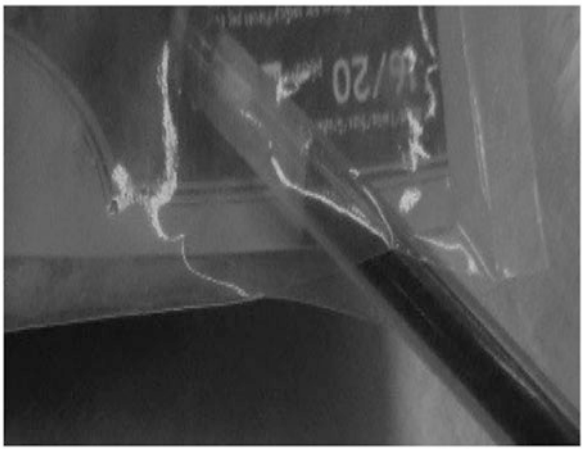


Fig. 8.19 Imperfect sealing of rider

The following are the images of different types of pallets (Figs. 8.21, 8.22, 8.23, 8.24, and 8.25).

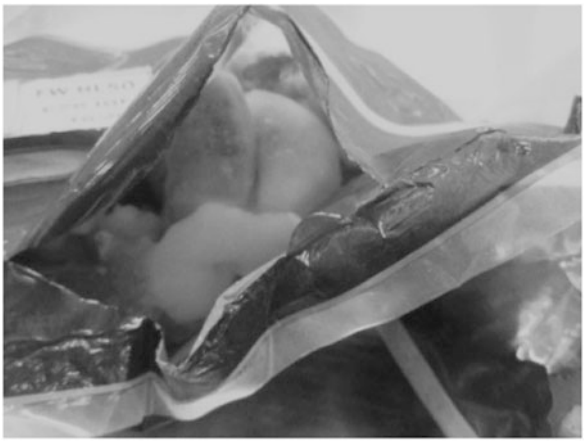
8.7.1 Pallet Calculation

*Calculate how many cartons will be in a pallet if dimension of a carton is 380 × 280 × 250 mm and dimension of euro pallet is 1200 × 800 × 150 mm. [Consider max. pallet height is 1800 mm].

Area of master carton = Length × Width = 380 × 280 mm = 106,400 mm^2 Again, Area of pallet = Length × Width	Here, Length of carton = 380 mm Width of carton = 280 mm Height of carton = 250 mm Length of pallet = 1200 mm

(continued)

Fig. 8.20 Damaged bag



$= 1200 \times 800$ mm $= 960{,}000$ mm^2 No. of cartons per layer $= \frac{\text{Area of pallet}}{\text{Area of master carton}}$ $= \frac{960000}{106400}$ $= 9.02$ $= 9.0$ No. of layers per pallet $= \frac{\text{Height of pallet}}{\text{Height of master carton}}$ $= \frac{1800}{250}$ $= 7.2$ $= 7.0$	Width of pallet = 800 mm Max pallet height = 150 mm Now calculate: No. of cartons per layer = ? No. of layer per pallet = ? Total cartons per pallet = ? Calculate following air space: 1. Space left per layer = ? 2. Space left in upper region = ? 3. Total air space left in pallet = ?
Total no. of cartons per pallet = No. of carton per layer × No. of layers $= 9 \times 7$ $= 63$ So, Total no. of cartons per pallet is 63.	
Air gap or space for air flow	
1. Space left per layer = 960,000–957,600 mm^2 $= 2400$ mm^2 2. Space left in upper region = 1800–1750 mm $= 50$ mm (Space left vertically)	Area of master carton = 106,400 mm^2 Total space used/layer = 106,400 × 9.0 $= 957{,}600$ mm^2 Area of pallet = 960,000 mm^2 Carton height = 7 × 250 mm $= 1750$ mm Pallet height = 1800 mm
Total space or air space left in a pallet is = Volume of pallet − Volume of master cartons $= 1{,}728{,}000{,}000$ mm^3 − $1{,}675{,}800{,}000$ mm^3 $= 52{,}200{,}000$ mm^3	

Fig. 8.21 Wooden pallet

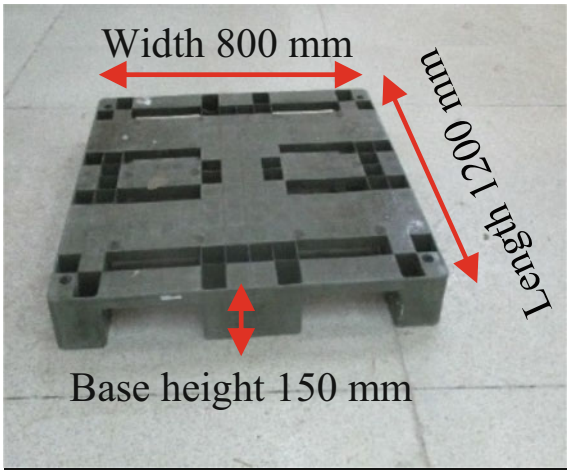


Fig. 8.22 Plastic pallet

Perform the following exercise

Exercise 1:	Calculate how many cartons are present in a pallet if dimension of a carton and a pallet is 380 × 280 × 230 mm and 1200 × 800 × 150 mm, respectively, and pallet height is 1850 mm. Is pallet size suitable for the size of master carton?
Exercise 2:	Calculate how many cartons are present in a pallet if dimension of a carton is 380 × 280 × 250 mm and dimension of a pallet is 1200 × 1100 × 130 mm. Is pallet size suitable for the size of master carton? [Height of cold storage is 1900 mm].
Exercise 3:	Calculate how many cartons are present in a pallet if dimension of carton is 380 × 285 × 180 mm and dimension of a pallet is 1200 × 800 × 150 mm. Is pallet size suitable for the size of master carton? [Pallet height is 1750 mm].

(continued)

Fig. 8.23 Cartons on pallet

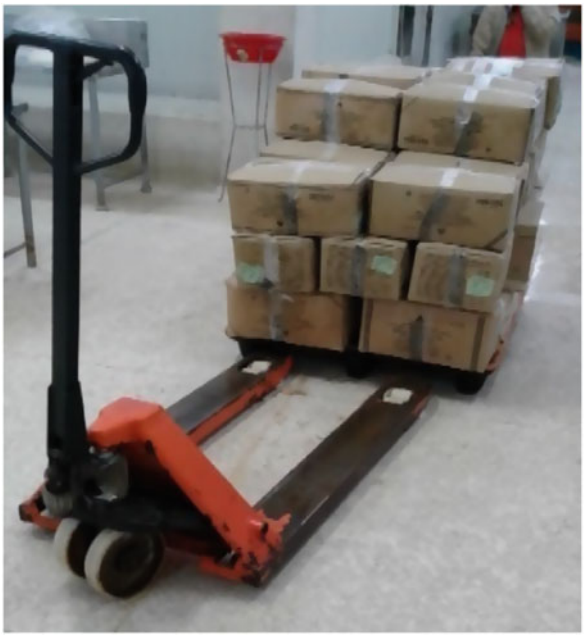


Fig. 8.24 Pallet jack

Exercise 4:	Calculate how many cartons are present in a pallet if dimension of a carton is 390 × 285 × 255 mm and dimension of a pallet is 1140 × 1140 × 150 mm. Calculate air space. [Cold storage height is 1850 mm and maximum capacity of pallet is 600 kg].
Exercise 5:	Suppose dimension of a carton and a pallet is 380 × 280 × 230 mm and 1100 × 1100 × 130 mm, respectively. Height of cold storage is 1910 mm. Calculate the following: 1) No. of cartons per layer, 2) No. of layer per pallet, 3) Total air space left in the pallet.

8.8 Barcode Scanning

A bar code is the small image of bars (lines) and spaces that represent a set of data. The code uses a sequence of vertical bars and spaces to represent numbers and other symbols. Systematically it represents data by varying the widths and spacings of parallel lines. A bar code symbol typically consists of following parts (Fig. 8.26):

- A quiet zone
- A start character
- Data characters
- A stop character
- Another quiet zone

Fig. 8.25 Pallet description

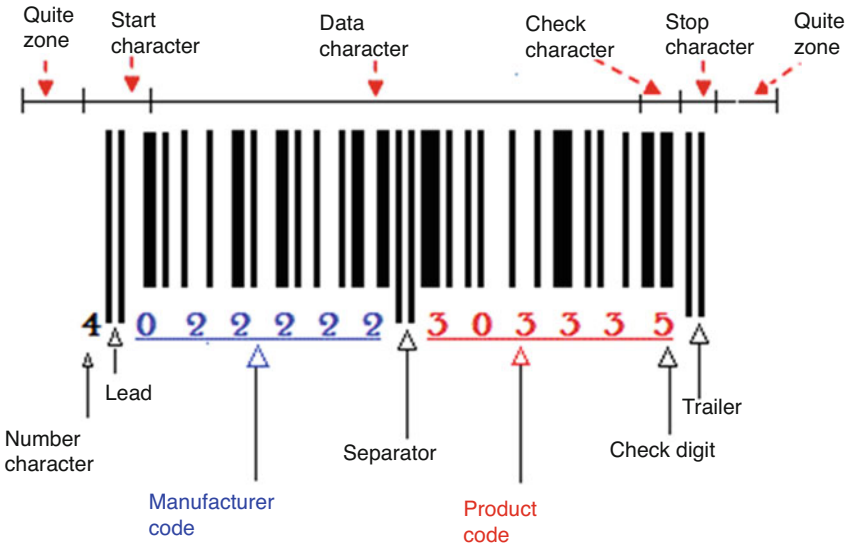


Fig. 8.26 Characteristics of barcode

Fig. 8.27 Different types of barcode

Each country has a coding authority (or numbering association) which assigns codes to manufacturers and maintains a central database. Separate Article Numbering Associations are assigned for separate countries. Usually EAN-13, GTIN-13, and ITF-14 are commonly used to identify seafood products, but EAN-128 is also used sometimes in some countries. The products contain the EAN number used to identify product itself. The standard EAN/GTIN product code has 13 digits, but a short version of EAN/GTIN code that is EAN-8 is also used for smaller sized product. The following are the characteristics of standard EAN/GTIN code (Fig. 8.27):

- The first 2 digits of the EAN-13 or GTIN code are containing the country of the article. The country is coded with 2 numbers. For example, 40, 41 represent Germany.
- The next 5 digits code the producer of the article.
- The following 5 digits represent the article number which is given by the producer.

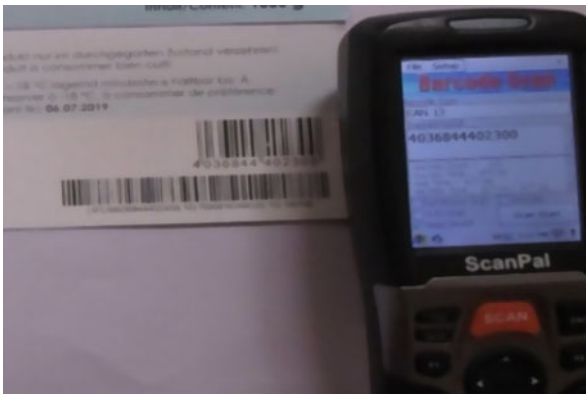


Fig. 8.28 Scanning of rider card

- The remaining last digit is the check digit. Software automatically calculates the digit and helps to justify the barcode.

A barcode scanner is an optical readable machine that identified a set of data. This data usually describes details of the products. The reader uses a laser beam that is sensitive to the reflections from the line and space thickness and variation. The reader translates the reflected light into digital data that is transferred to a computer for immediate action or storage (Fig. 8.28).

8.9 Metal Detection

Metal detection is a mandatory process for frozen shrimp. This process can be performed for the protection of consumers. It's true that maximum care is taken during processing of shrimp, but metallic contaminations of frozen shrimp may not be fully excluded. Metal detection is the last step of shrimp processing after completion of final packaging. Products are sent to metal detector for the confirmation of metal fragments whether they are present or not. Each sealed polybag/master carton must be passed through the metal detector for the confirmation of metal fragments. Metal detectors for frozen shrimp provide effective protection against ferrous and non-ferrous metals (iron, aluminum, stainless steel, etc.). Standard limits of metal detection depend on its capacity metal detector, i.e., 2 mm Fe, 3 mm non-Fe, and 3 mm St-St. After confirmation of the metal detection process, products free from metal fragments are sent to cold storage for preservation. At the same time, products are kept outside for further evaluation if found positive in metal detection. Note that products containing metal fragments are not allowed for shipment. Detection of metals in food items will be the result of negative brand image and loss of consumer trust (Figs. 8.29, 8.30, and 8.31).

Fig. 8.29 Metal detector

Fig. 8.30 Metal detection of shrimp

Fig. 8.31 Metal detection of shrimp

8.10 Frozen Storage

Finished products are sent to cold storage immediately after metal detection of frozen shrimp. Products should be stored on a first-in, first-out basis. Products are stored in a well-packed and sealed condition with proper labeling. Storage must be well facilitated, clear, and hygienic. The following should be considered during storage of frozen shrimp:

- Cold storage temperature must be at least −18 °C or below.
- Storage environment must be clean, hygienic, and free from dust, rodents, and insects.
- Pallet should be used for the stacking of master cartons.
- Stacking of cartons must be product-wise and lot-wise.
- Products of different lots must be in different pallets and different locations.
- It is strongly avoided to stack different products of different buyers at the same stack.
- Master carton serial no. should be maintained before going to final stacking.
- Too much handling and too long storage is strongly avoided.
- Cold storage should be free from excessive frost. It may damage master cartons. Damaged master cartons are not accepted anymore by the importers. It's better to cover master cartons with poly papers to avoid direct contact with frost.
- Walking above master cartons or stack of master cartons is strongly avoided. It may damage/crack/tear outer and inner packaging especially the window of semi-IQF products and bag of IQF products.

- **Changes of Products in Frozen Storage**

There are some changes observed in final products of frozen storage. The changes in frozen storage are as follows:

- Moist/damaged/tear/crack cartons
- Nutrient loss, drip loss, and freeze-burn in shrimp
- Rigidity and toughness of muscle in frozen shrimp

The following are the causes of changes in frozen storage (Figs. 8.32, 8.33, and 8.34)**:**

- Lack of well-facilitated cold storage
- No palatalization in frozen storage
- Unhygienic condition of cold storage
- Frequently or long-term temperature fluctuation
- Excess frost in cold storage
- Walking over master cartons
- Improper glazing of frozen shrimp
- Lower quality of packaging materials

Fig. 8.32 Walking over MC

Fig. 8.33 Excess frost on MC

Fig. 8.34 Protection from frost

Inspection of Frozen Shrimp

9

Abstract

Inspection of frozen shrimp means assessment of final product through a variety of steps like physical, chemical, and biological examination or evaluation. The chapter highlights the topics on inspection, its importance and types, and the details of final inspection procedures, viz., inspection of cold storage temperature; selection of MC from cold storage; inspection of product temperature; inspection of size, count, color, grade, weights (gross weight/frozen weight/deglaze weight/defrost weight/net weight and individual weight of shrimp), uniformity ratio, organoleptic characteristics, and defects; cooking test; and inspection of final packaging, labeling, and reporting. The chapter also highlights the process of inspection of internal environment, inspection of sanitation standard, as well as rejection policy of the products. Different types of calculation, viz., formula of carton selection, calculation of pieces of frozen shrimps per pound, pieces of deglaze shrimps per pound, etc., are also included in this chapter.

Keywords

Gross weight · Net weight · Thawed weight · Cooking test · Rejection policy

9.1 Inspection

Normally, inspection means examination or evaluation of a product. Inspection of frozen shrimp means assessment of the final product (frozen shrimp) through examination, measurement, testing, evaluation, comparison, and final decision about the export grade shrimp. Inspection of frozen shrimp determines the quality, quantity, and condition of final products of the whole lot and also whether the applicable or specified requirements of the buyer as per specifications are being

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_9

conformed. It also identifies the errors or the defects of final products before shipping. The purpose of inspection is to meet customer satisfaction and needs.

9.2 Importance of Inspection

Inspection of frozen shrimp has been performed for the following reasons:

- Inspection of frozen shrimp ensures the quality of product.
- Inspection of frozen shrimp helps to identify processing faults.
- Inspection of frozen shrimp helps to identify hazards (physical, chemical, biological, etc.) of final products and recommend corrective actions.
- Inspection of frozen shrimp helps to produce uniform products.
- Inspection of frozen shrimp confirms packaging and labeling of the final products.
- Inspection of frozen shrimp helps to avoid conflict in the future.
- Inspection of frozen shrimp helps to share knowledge among industries even among the countries.
- Inspection of frozen shrimp minimizes the customer complaints.
- Inspection of frozen shrimp controls business reputation of the industry.
- Inspection of frozen shrimp confirms buyer's specifications and consumer's satisfaction.
- Inspection should be the mandatory process although it is expensive. Buyers/suppliers have to pay extra money to conduct the inspection.
- Inspection is a time-consuming process.
- Inspection has a chance to reject the product and fail shipment.

9.3 Types of Inspection

There are two types of inspection that are mainly conducted in shrimp processing industries. These are:

1. Regular inspection
2. Final inspection

9.3.1 Regular Inspection

Regular inspection refers to the checking of running production. It is also called "on-line inspection." Regular inspection started from receiving of raw material and continued up to the storage of final product. Regular inspection is performed in every production period. Quality personnel of the processing industries have performed this supervision when production is going on. Sometimes buyers nominate their own recruited personnel who ensure the requirements as per the specification of the buyers. The main purpose of this inspection is to confirm the quality of

products in every step of production. It is necessary to maintain a written document in every step of inspection with photographs as proof. Quality personnel have the right to check random production. He/she may visit any area of the processing industries at any time and may select random products from anywhere of the processing line.

Responsible/quality personnel should check the following during regular inspection.

- Traceability of the products
- Quality of raw materials
- Freshness color, texture, appearances, etc.
- Product size/grade, count, glaze, etc.
- Frozen weight, deglaze weight, net weight, thawed weight, individual weight, etc.
- Total pieces/bag, pcs/*lb*, pcs/kg, etc.
- Uniform size, uniform weight, uniformity ratio, etc.
- Approved additive, % of additives, soaking duration, soaking gain, etc.
- Source of defect, type of defects, % of defect, recovery steps, etc.
- Temperature of raw materials, soaking water, chilled water, etc.
- Temperature of all equipment, processing room, anti-room, chill room, and store room
- Packaging and labeling
- Hygienic condition of processing industries, factory personnel, labor, and visitors
- Written documents and photographs for record keeping

It is necessary to analyze all the data after completion of regular production. If any kind of inconsistency in production line is found, then corrective action should be taken immediately to solve the problem. Quality personnel reserve the right to reject production if arise serious problem on running production (Appendix C: A model template of production supervision report).

9.3.2 Final Inspection

The term final inspection refers to the activity of checking products that are performed in the final stage of export items. The main objective of final inspection is to assess the quality of final products to obtain customer's satisfaction. Buyers assign their staff or reputed third party to conducting final inspection. Sometimes buyers relay on suppliers QC report or final inspection report if the suppliers are well reputed or qualified. Normally, buyers prefer third-party inspection because of their independencies. Third-party inspection is conducted as per the buyer's protocol. Every buyer has his or her own protocol to conduct the final inspection or follow third-party inspection protocol. Quality personnel must follow the buyer-nominated inspection protocol. Final inspection is a mandatory requirement before shipping the product. Products are shipped only when the final inspection report got satisfactory. Unsatisfactory inspection report may stop the shipment without any official notice.

Assigned quality personnel should confirm that he/she has enough experience and no conflict of interest and is unbiased. Quality personnel should be very careful before concluding final inspection report because he/she has to assess the whole consignment considering only the inspection sample. Final inspection is also called "pre-shipment inspection." The following steps should be addressed during conducting of a final inspection:

- Inspection of internal environment or internal audit
- Inspection of sanitation standard
- Inspection of final product
- Inspection of packaging and labeling
- Checking of traceability documents
- Preparation of final inspection report

[Appendix D: A model template of final inspection report]

9.3.2.1 Inspection of Internal Environment

Inspection of internal environment refers to checking of internal condition of the factory. It helps to assess quality of the factory whether it is suitable to produce food grade product or not. Internal environment of the processing industries must be clean, safe, and free from dirt, rodent, and contamination. It's a mandatory requirement for food industry. Internal environment should be checked regularly, and findings need to be preserved in record file. The inspectors of the buyer representative took a round of the whole processing industries, performed a mini audit, and reported to buyer about the internal environment of the factory. The following parameters are checked before starting final inspection:

- Cleanliness of inspection location/place
- Proper lighting on the room
- Cleanliness of inspection table and other equipment (scissor, balance, basket, etc.)
- Room temperature and cold storage temperature
- Cold storage condition, cleanliness and hygiene
- Stacking of master cartons (either master cartons are separated or not, or mixed with others products of same buyer or other)

9.3.2.2 Inspection of Sanitation Standard

Inspection of sanitation standard refers to checking of overall hygienic status of the processing industries. It specifies what to clean, how to clean, which methods are followed to clean, frequency and interval of cleaning, who is responsible person, what are the safety issues, what are the data to record, etc.

The following are inspected for the confirmation of sanitation standard:

- Are insect, birds, flies, rodents, etc. observed or not?
- Are dusts, darts, or frosts observed or not?

- Are workers found without gum boot, apron, hand gloves, musk, and head gear or not?
- Are workers following hygienic protocols or not?
- Are processing area, floor, utensils, and aprons clean and washed or not?
- Are grading, de-heading, peeling, deveining, washing, etc. in hygienic condition or not?
- Is there any chance of cross-contamination or not?
- Is processing industries GMP and HACCP certified or not?

9.3.2.3 Inspection of Packaging

The inspection of packaging refers to checking of packaging materials and their design, dimension, and labeling information. It's an essential part of final inspection. Packaging and labeling must be 100% accurate. Mislabeling is unaccepted. Any kind of anomalies in packaging and labeling may stop shipment or claim demurrage for this mistake. Inspectors or buyer representative should check the packaging and labeling very carefully and compare with approved packaging. Packaging materials, design, dimension, and labeling information all are approved by the buyer before printing. It's better to prepare a packaging and labeling checklist during or before final inspection. If any kinds of anomalies in packaging and labeling checklist are found, necessary steps should be taken before shipment. Quality personnel should prepare a packaging and labeling checklist and send to the buyer before shipment. The product will be shipped only subjected to the buyer's approval. The following parameters should be checked during the inspection of packaging:

- Is packaging made by approved materials?
- Is there any objectionable material present?
- Is the condition of master carton/box/bag ok?
- Is it free from dirt/dust/frost/torn?
- Is there any damaged bag/box/master carton present?
- Is the sealing of bag/box/master carton perfect?
- Is design and dimension ok as per requirements?
- Is there any color variation?
- Is labeling correct as per approved packaging (i.e., product name, art. no., lot no., size, count, factory approval no., barcode, language, production date, frozen date, expiry date, nutritional value, ingredients, etc.)?
- Is there any spelling mistake?
- Is there any language mistake?

[Appendix E: A model template of packaging and labeling checklist]

9.3.2.4 Inspection of Final Product

The steps of final inspection of frozen products are as follows:

1st Step: Preparation for Inspection

The inspectors or buyer representative should have proper knowledge about the products. All necessary information should be collected from buyers/suppliers, and the necessary documents should be prepared before going to start inspection. If the inspectors have a limitation on proper knowledge, then it will be difficult to handle the inspection. So, it's better to confirm the following parameters before starting the final inspection:

- Reference PO/code list/packing list etc.
- Importer address, supplier address, inspection location, etc.
- Details of product description (type of product, size, count, glazing, frozen weight, net weight, total volume, etc.)
- Buyer's instruction (sampling method, sampling plan, inspection protocol, etc.)
- Acceptance limits (pcs/*lb,* pcs/bag, defects list, defects %, uniformity ratio, etc.)
- Approved packaging materials
- Rejection policy of the buyer
- Need to prepare necessary documents and printed previously if necessary

2nd Step: Inspection of Cold Storage Temperature

At first, the inspectors should check the temperature of cold storage where the products are stored and waiting for shipment. Standard temperature of cold storage should be at least −18 °C. Photographs of temperature reading should be taken and need to keep the records for final reporting (Fig. 9.1).

3rd Step: Selection of Master Cartons

Master cartons for final inspection should be selected randomly. Inspectors should go inside the cold storage to select the cartons with their preference. Inspectors have full freedom to select the cartons randomly from any location of any pallet. Selection

Fig. 9.1 Cold storage temperature

Fig. 9.2 Selection of cartons

of master cartons should be done in such a way that it covers all the products (same lot) in the store room (Fig. 9.2).

Cartons for final inspection should be selected based on the following parameters:

- Size/grade of products
- Types of products
- Types of brands
- Types of packing
- Date of production
- Total volume/quantity to be shipped

Inspectors should select the cartons randomly and mark the cartons with their signature over them. After selection, cartons are brought out from the cold storage and kept open for inspection. Different buyers have different standard for the selection of master cartons and final inspection.

- Generally, 1% master cartons of the total volume should be selected for final inspection, but minimum no. of selection will be at least 2 cartons if sample size is smaller ($\leq$ 100 MC).
- Sometimes buyers ask to follow the formula below for selection of master cartons.

The formula is $= (\sqrt{n} + 1)/2$	Here, n = total no. of cartons.

For example, calculate the number of cartons for final inspection if total lot size is 1800.

Total no. of cartons $= (\sqrt{n} + 1)/2$ $= (\sqrt{1800} + 1)/2$ $= 21.7$ or 22 cartons	Here, n = 1800 no. of cartons to be selected = ?

Perform the following exercise

Exercise 1:	Calculate the number of cartons to be selected for final inspection if the lot size is 2000.
Exercise 2:	Calculate the number of cartons to be selected for final inspection if the lot size is 1000.
Exercise 3:	Calculate the number of cartons to be selected for final inspection. The breakdown of products is as follows: 70% net weight 16/20 HLSO IQF 600 MC 80% net weight 21/25 HLSO IQF 500 MC 80% net weight 21/25 HLSO-EZP IQF 100 MC 80% net weight 26/30 HLSO block 600 MC 70% net weight 16/20 HLSO S. IQF 200 MC

4th Step: Inspection of Product Temperature

Temperature of the final product is checked through the digital thermometer. The thermometer should be inserted into the master carton and waited until stable of the temperature reading. It is necessary that sensor of the thermometer is completely inserted into the master carton. Temperature of the frozen products must be at least −18 °C. Photographs of temperature reading should be taken for every product. Inspected temperature should also be recorded in hard copy. Temperature of the frozen products should be checked as soon as possible (Fig. 9.3).

5th Step: Inspection of Gross Weight

Gross weight of the master carton should be checked by using digital balance. Digital balance must be calibrated. Weight of every selected master carton is measured separately. Weight should be recorded in relevant hard copy for reporting. Photographs of gross weight should be taken as reference documents (Fig. 9.4).

It is necessary to check calibration before going to weighing of shrimp. Calibration certificates should be attached to the balance. There is a rough technique that

Fig. 9.3 Inspection of product temp

Fig. 9.4 Gross weight

may be used to assess the weighing performance of your balance and confirm whether the balance is okay or not. Check the procedure below:

- Select two samples (any kind of) first. Suppose, two samples are A and B.
- Weigh the samples separately. Let the weight of A be 1.0 kg and the weight of B be 2.0 kg.
- Weigh these two samples at a time. If the weight remains the same (1 + 2 = 3 kg), it means the balance is ok. But if these two weights are not same, it makes sense that the balance is not ok and needs to be sent for calibration.

Uses of equipment without calibration are strongly prohibited. Routine calibration of equipment is a mandatory process for processing industries.

6th Step: Selection of Inner Bag/Box

After checking of gross weight, it is necessary to open all master cartons for the selection of inner bag/box for final inspection of frozen products. Every bag/box within the master carton should be checked very carefully. The following parameters are checked carefully before selecting of inner bag or box:

- Frozen condition of products (good or not)
- Quality of products (good or not)
- Condition of packaging (perfect or damaged)
- Sealing of packaging (perfect or leak or tear)
- Location and information of rider card/sticker (perfect or not)
- Labeling of packaging—is outer packaging as same as inner packaging, etc.

Some common mistakes like label of outer packaging (master cartons) not matched with inner packaging (bag or box), wrong placement of rider card/sticker, inverse position of rider card, wrong rider card/sticker, etc. are observed sometimes. In that case, it is necessary to recheck all the cartons and needed to attach proper labels as well. After checking of packaging inspectors, select an inner bag/box from

Table 9.1 The standard of gross weight in different products

Product type	Packing	Gross weight
• Block	6 × 1.8 kg	10.8 kg (6 × 1.8 kg) + Packaging (inner box + master carton)
• S.IQF	10 × 1 kg	10.0 kg (10 × 1 kg) + Packaging (inner box + master carton)
• IQF	10 × 1 kg	10.0 kg (10 × 1 kg) + Packaging (inner bag + master carton)

the master carton and send it for next step. Selection of inner packaging should be done in such a way that one bag/box is from one master carton.

7th Step: Inspection of Gross Weight

Weighing is a crucial part of the shrimp business. Weight must be accurate as per product specifications. Weight shortage is an illegal practice that makes a bad reputation for the suppliers as well as the country. Calibrated electronic/digital balance is used for the measurement of accurate weight. Weighing is performed in different stages of processing, i.e., during receiving of raw materials, counting of pieces, before freezing, and sometimes after freezing. Different types of weights, i.e., frozen weight, gross weight, net weight, thawed weight, defrost weight, etc., are inspected during final inspection. Inspection of gross weight is the 1st step of weighing process. Literally, gross weight means total weight including frozen product and packaging. In case of frozen seafood, gross weight means a total weight of a master carton, inner cartons, and frozen shrimp. See the following equation of gross weight (Table 9.1):

$$\text{Gross weight} = \text{Weight of master carton} + \text{Weight of inner cartons} + \text{Weight of frozen shrimp}$$

[Note that gross weight is not a constant value. It may vary from one master carton to another. There is no objection from the buyer if gross weights vary within the same products, but suppliers may face weighing problems in port or customs during shipment. Weights of packaging materials (master cartons + bag/box) are also variable]

The following are the images of gross weight of different products (Figs. 9.5, 9.6, and 9.7).

8th Step: Inspection of Frozen Weight

Frozen weight means weighing of frozen shrimp including its protecting glaze. Weights of packaging materials are not included here. See the following equation of frozen weight (Table 9.2):

$$\text{Frozen weight} = \text{Weight of frozen shrimp} + \text{Weight of protecting glaze}$$

During final inspection frozen weight of the selected inner bags/boxes is measured and recorded. Frozen weights are measured separately for every single unit (bag or block). Calibrated digital balance is used for accurate measurement. It's better to have frozen weight within standard limit although a little bit variation is

Fig. 9.5 Gross weight (S. IQF)

Fig. 9.6 Gross weight (IQF)

Fig. 9.7 Gross weight (Block)

Table 9.2 The standard of frozen weight in different products

Product type	Packing	Glaze	Frozen weight
• Block	6 × 1.8 kg	20%	1.8 kg (1.44 kg shrimp +0.36 kg glaze)
• S.IQF	10 × 1 kg	20%	1.0 kg (0.8 kg shrimp +0.2 kg glaze)
• IQF	10 × 1 kg	20%	1.0 kg (0.8 kg shrimp +0.2 kg glaze)

Fig. 9.8 BT-HLSO-Block

Fig. 9.9 BT-HLSO-Block

acceptable. The following are the images of frozen weight of different products (Figs. 9.8, 9.9, 9.10, 9.11, 9.12, and 9.13):

[Note: It's not possible to find exactly 1.8 kg or 1.0 kg practically. Usually, it is greater than the standard. Frozen weight may vary from one block to another or one

Fig. 9.10 BT-HOSO-S.IQF

Fig. 9.11 BT-HOSO-S.IQF

bag to another. Weight of inner packaging is not included in frozen weight. If included, then it will be gross frozen weight instead of frozen weight. Supporting equipment (basket, inner box, polybag, etc.) must be tare before weighing of frozen weight.]

9th Step: Inspection of Frozen Count (Pcs/*lb*)

After the measurement of frozen weight, it is necessary to calculate the frozen count of shrimp. Frozen count calculates how many pieces (including protecting glaze) of shrimps are present in one pound. Frozen count is calculated for IQF shrimp only. Pcs of shrimp should be selected randomly for the calculation of frozen count. Inspectors may also separate the larger grade and smaller grade shrimp to calculate the frozen count separately for higher grade and lower grade of shrimp (Fig. 9.14).

Fig. 9.12 BT-EZP-IQF

Fig. 9.13 FW-EZP-IQF

10th Step: Calculation of Frozen Count (Pcs/*lb*)

*Calculate how many pieces (pcs) of frozen shrimp are present in one pound for BT, HLSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg IQF products, if total no. of pcs/bag is 26 and frozen weight is 1000 g.

Frozen count (pcs/*lb*) can be calculated in two ways:

- **Manual process**

Weigh first 454 g frozen shrimp (including glaze), and then count manually how many pcs of shrimp are present in 454 g frozen weight. Result should be noted in hard copy.

Fig. 9.14 Frozen count (pcs/lb)

- **Mathematical process**

Frozen count (pcs)/*lb* $= \frac{\text{Total no.of pcs per bag}}{\text{Frozen weight}} \times 454$ $= \frac{26}{1000} \times 454$ $= 11.8$ $= 12$ pcs/*lb*	Here, Size/grade = 8/12 Frozen weight = 1000 g Net weight = 800 g Total no. of pcs per bag = 26 1 *lb* (pound) = 454 g Frozen count (Pcs)/*lb* = ?

Result: 12 pcs of shrimps are present in one pound (*lb*) for frozen count of shrimp.

Perform the following exercise

Exercise 1:	Suppose a product is FW, HLSO, raw, 21/30, FC, 80% net weight, 10 × 1 kg IQF products. Calculate frozen count (pcs/*lb*). [Hints: All are standard parameters].
Exercise 2:	Calculate frozen count (pcs/*lb*) for FW, HLSO, raw, 41/50, FC, 75% net weight, 10 × 1 kg IQF products. Frozen weight is measured 1080 g. [Hints: Consider minimum no. of pcs of standard calculation].

11th Step: Inspection of Deglazed Weight

Deglazed weight means the weight of shrimp without its protecting glaze. Shrimps are weighted immediately after removing of protecting glaze. Deglaze weight is always greater than drained net weight. Standard process should be followed during the measurement of deglazed weight. Time is very short for removing of protecting deglazed for IQF products. Frozen shrimps are dipped into water for removing of protecting glaze at a temperature of 20 °C ± 5 °C. Time of deglazing may vary from 10 s to 2 min depending on the percentage of glaze, type of product, and size/grade

Fig. 9.15 Removing of glaze

Fig. 9.16 Releasing of water

of shrimp. Do not let the sample be dipped for long time; otherwise it will be defrosted instead of deglazed. Special care should be taken during deglazing of small size shrimp, it tends to defrost within very short time.

$$\text{Deglaze weight} = \text{Frozen weight} - \text{Weight of protecting glaze (external)}$$

Deglaze weight is too important and it must be accurate. It is necessary to measure deglazed weight very carefully and keep the record in hard copy during final inspection. Inspectors should be more careful in this step because deglaze time is very short; inspectors should avoid defrost weight during the measurement of deglaze weight. Calibrated digital balance is a must for accurate measurement. The following are the images of deglazed weight of different products (Figs. 9.15, 9.16, 9.17, 9.18, 9.19, and 9.20).

Fig. 9.17 Deglaze weight (HLSO)

Fig. 9.18 Deglaze weight (P&D)

[Note: Only external glaze can be removed for deglaze weight. If internal fluid is drained out, then it will be defrosted weight. Never use hot water for doing the step faster. Uses of hot water and longtime dip into water make weight shortage due to release of internal fluid of soaking gain.]

12th Step: Inspection of Deglazed Count (Pcs/*lb*)

Besides deglaze weight, inspectors have to calculate deglaze count as per buyer requirements. Deglaze count calculates how many pieces (excluding protecting glaze) of shrimp are present in one pound. Pieces (pcs) of shrimp should be selected randomly for the calculation of deglaze count. Inspectors may also separate the larger grade and smaller grade of shrimp to calculate the deglaze count separately for higher grade and lower grade of shrimp.

Fig. 9.19 Deglaze weight (P&D)

Fig. 9.20 Deglaze weight (EZP)

13th Step: Calculation of Deglaze Count (Pcs/*lb*)

*Calculate how many pcs of deglaze shrimp are present in one pound for BT, HLSO, raw, 8/12, FC, 80% net weight, 10 × 1 kg IQF products? [Total no. of pcs/bag is 26].

Frozen count can be calculated in two ways:

- **Manual process**

Weigh first 454 g deglazed shrimp (without glaze), and then count manually how many pcs of shrimp are present in 454 g deglaze weight. Result should be noted in hard copy.

- **Mathematical process**

Deglaze count (pcs)/*lb*. $= \frac{\text{Total no.of pcs per bag}}{\text{Deglaze weight}} \times 454$ $= \frac{26}{800} \times 454$ $= 14.7$ $= 15$ pcs/*lb*.	Here, Size/grade = 8/12 Frozen weight = 1000 g Deglaze weight = 800 g Total no. of pcs per bag = 26 1 *lb* (pound) = 454 g Deglaze count (Pcs)/*lb*. = ?

Result: 15 pcs of shrimp are present in one pound for deglaze count.

Perform the following exercise

Exercise 1:	Calculate how many pcs of deglaze shrimp are present in one pound for BT, raw, HLSO, 21/30, FC, 80% net weight, 10 × 1 kg IQF products. [Hints: Consider maximum no. of pcs of standard calculation.]
Exercise 2:	Calculate deglaze count (pcs/*lb*) for FW, raw, HLSO, 41/50, FC, 75% net weight, 10 × 1 kg IQF products. [Hints: Required all are standard parameter.]
Exercise 3:	Calculate deglaze count (pcs/*lb*) for FW, raw, PND, 16/20, RC, 80% net weight, 10 × 1 kg IQF products if deglaze weight is 815 g and. [Hints: Consider minimum no. of pcs/bag in standard calculation.]

14th Step: Inspection of Defrost/Thawed and Net Weight

The term defrost/thawed weight refers to the weight of shrimp after completely melting of ice (external + internal) crystal from its body. To perform defrost/thawed weight, shrimps are dipped into water for long time until completely removing ice crystal from the body. Defrost/thawing time depends on freezing method, product type, size/grade of shrimp, and percentage of glaze. Thawing should be performed in chilled water; never use hot water to make thawing faster. The complete thawing of the product is determined by gently squeezing the sample occasionally so as not to damage the texture of the shrimp, until no hard core or ice crystals are left. Frozen shrimps are soaked in water for a long time up to completely removing protective glaze/ice from the outer surface of shrimp and also the core of its body. After completely defrosting/thawing, shrimps acted as soft as raw shrimp. Inspectors should perform defrosting in chilled water instead of adding warm/hot water for making time short. Uses of warm/hot water are strictly prohibited. Let the shrimp defrost itself. Avoid mass handling during thawing process; otherwise, soaking gain will be released in water that may result in the shortage of weight. On the other hand, net weight means actual weight of shrimp without its external and internal glaze. Basically, there is no huge difference between defrost/thawed and net weight. Both of them are almost similar. Soaking gain of shrimp should be included during calculation of net weight. See the following formula for the measurement of net weight:

Fig. 9.21 Thawing/defrosting

Fig. 9.22 Addition of flake ice

$$\text{Net weight} = \text{Frozen weight} - \text{Weight of glaze (external} + \text{internal)}$$

Measurement of net weight is very important for avoiding of weight shortage. Shortage of weight is a crime in international seafood business though it is very rare in practice. Normally, suppliers put some extra weight than their declared to avoid weight shortage and keep them in safe side. Inspectors should check the net weight very carefully to avoid weight loss.

The following are the images of defrost/thawing process and net weight (20% glazed) of different products (Figs. 9.21, 9.22, 9.23, 9.24, 9.25, 9.26, 9.27, 9.28, and 9.29):

15th Step: Inspection of Individual Weight

Normally, measurement of individual weight of shrimp is not an essential requirement, but sometimes buyer asked to check individual weight for more accuracy. At that time, inspectors need to check individual weight for every shrimp in a bag or

Fig. 9.23 Defrosting of IQF shrimp

Fig. 9.24 Checking of defrosting

block. After checking of individual weight, it is necessary to calculate and note down how many pcs of shrimp are out of standard limit (maximum and minimum). A standard of individual weight measurement procedure (Table 9.3) and comparison of standard weight (Table 9.4) of different products are given below.

16th Step: Inspection of Uniformity Ratio

After completing of thawing process, inspectors go ahead for the measurement of uniformity ratio. Uniformity is one of the major concerns of the buyer. Inspectors should check the uniformity ratio very carefully and make a comparison with buyer requirements. If uniformity ratio goes out of limit, it makes sense that the product quality is not good and may not be accepted by the buyer. It makes a great problem to the buyer and may lose his customers for this uncontrolled uniformity. Sometimes buyer suggests repacking the product with correct uniformity. Note that standard uniformity ensures accurate pieces and individual weight of shrimp. Uniformity

Fig. 9.25 Thawing of S.IQF shrimp

Fig. 9.26 Shrimp after thawing

Fig. 9.27 Net weight

Fig. 9.28 Shortage of weight

Fig. 9.29 Excess of weight

ratios are recorded in hard copy for reporting to buyer. The following are the images of uniformity ratio of different products (Figs. 9.30, 9.31, and 9.32).

17th Step: Inspection of Organoleptic Characteristics

Freshness, smell, color, odor, texture, general appearance, etc. are the important characteristics of quality assessment of frozen shrimp. The organoleptic sensory method is used for the assessment of these characters. Organoleptic assessment in final inspection totally depends on buyer representative or buyer nominated inspectors. Actually, organoleptic assessment is a relative perception; it may vary from one person to another. Expert personnel or inspectors check the freshness, smell, color, odor, general appearance, texture, and taste and make a grade whether it is poor, normal, good, very good, or excellent. If the freshness of shrimp is good, the general appearance is good, the texture is firm, and it is free from odor, then quality personnel will approve it, but if any kind of inconsistency is found, the product may

Table 9.3 Individual weight measurement procedure for frozen shrimp

Sl. No.	Product description	No. of Pcs/bag	Min.–Max. individual weight of shrimp (g)	Observed individual weight (g)	Remarks
1	FW HLSO Raw 4/6 RC 80% NW 10 × 1 Kg IQF Shrimp	11	76–114	76	Weight within standard limit (accepted)
2				122	Bigger than standard (not accepted)
3				77	Weight within standard limit (accepted)
4				45	Smaller than standard (not accepted)
5				102	Weight within standard limit (accepted)
6				56	Smaller than standard (not accepted)
7				77	Weight within standard limit (accepted)
8				75	Weight within standard limit (accepted)
9				78	Weight within standard limit (accepted)
10				48	Smaller than standard (not accepted)
11				52	Smaller than standard (not accepted)

[Appendix B: Size and weight table]

go for further assessment or non-shipment. Serious reasons may cause rejection of the consignment. The following are the images of organoleptic assessment of shrimp (Figs. 9.33, 9.34, and 9.35).

18th Step: Observation of Defects

Inspectors checked the defects very carefully. Defects may be caused by poor quality of raw materials and improper handling and processing of shrimp. A variety of defects occur during the processing of shrimp that are not accepted by the buyer. Inspectors should enlist the defects in hard copy for analysis of the percentage of

Table 9.4 The comparison of standard weight of different products of frozen shrimp

Product description	Block	IQF	Semi-IQF
Size/grade	8/12 RC	8/12 FC	8/12 FC
Glaze	20%	20%	20%
Packing	6 × 1.8 kg	10 × 1 kg	10 × 1 kg
Pcs per bag/block (Min.-Max.)	25–38 pcs	18–26 pcs	8–12 pcs
Weight (s)			
Gross weight	10.8 kg	10.0 kg	10.0 kg
Frozen weight	1.8 kg	1.0 kg	1.0 kg
Net weight	1440 g	800 g	800 g
Individual weight of shrimp (Min.–Max.)	38–57 g	30–45 g	67–100 g

Fig. 9.30 Uniformity (BT-HOSO)

Fig. 9.31 Uniformity (BT-HLSO)

Fig. 9.32 Uniformity (BT-PND)

Fig. 9.33 Checking of odor/ bad smell

defects and also for record keeping. Photographs are a must in every defect with proper tagging. If defects exceed buyer requirements, buyer may reject the container.

19th Step: Inspection of Cooking Test

The final step of inspection is cooking test. Cooking test can be performed at 65–70 °C temperature. Cooking duration varies depending on size and type of shrimp and cooking temperature and cooking method. It should be kept in mind that shrimp must not be overcooked; it may misguide your assessment. Cooking test can be performed as per buyer requirements. Microwave method and boil-in-bag method are used in cooking test. The most commonly used cooking technique is boil-in-bag procedure. The steps of boil-in-bag procedure in shrimp are given below.

Fig. 9.34 Checking of general appearance

Fig. 9.35 Checking of texture, color, and taste after cooking

Step 1:	At least two pcs of shrimp are selected from every sample after completion of the inspection.
Step 2:	Products of different samples are kept separated in different poly bags.
Step 3:	Selected samples must be sealed in air tide conditions before going to boil.
Step 4:	Selected samples are kept in ice with proper tagging.
Step 5:	Sample-sealed poly bags are dipped into boiling water for cooking.
Step 6:	Products are kept in ice immediately after cooking of shrimp.
Step 7:	After a few minutes, inspectors open the sealed bags and observe its smell/odor, appearance, color, texture, and taste. Inspectors may consume the cooked shrimp for better assessment.

- **Observation of Cooked Shrimp**

Smell/odor:	Smell/odor should be checked immediately after opening of the sealed bags. Smell of quality shrimp is fresh, typically with no muddy or moldy smell, but decomposed shrimp produce a bad smell (odor) when opening the sealed bags.
Appearance:	Freshly cooked shrimp looks like gorgeous or shiny but not for defect shrimp.
Color:	Good-looking shiny color comes up for freshly cooked shrimp, but if the shrimp has any defects, that would be exposed clearly after cooking. For example, the sign of melanosis/necrosis is more visible in cooked shrimp.
Texture:	Texture of shrimp is checked by chewing off its muscle/meat. Texture of quality shrimp is firm, not too soft, and not too dry, but decomposed shrimp has no texture; it's too soft and breaks down easily that is observed clearly in cooked shrimp.
Taste:	Taste should be fresh, be typical, and have no foreign taste from fresh shrimp, but the taste is not good and off-flavor from decomposed shrimp.

The following are the images of cooking test of shrimp (Figs. 9.36, 9.37, 9.38, 9.39, 9.40, and 9.41).

20th Step: Reporting

After completion of the inspection procedure, it is necessary to prepare a report for the importer/buyer. A complete report has two parts:

1. Written documents
2. Photographs

Written documents are prepared based on inspected results, analysis, and interpretation of the results with reference photographs. Photographs are the mandatory part of inspection. It is necessary to be taken in every step of inspection and must be with a proper identification tag. Tag-less photographs are meaningless. Every photograph would have a self-explanation. The following necessary photographs are taken in final inspection:

Fig. 9.36 Sample in bag with ice

Fig. 9.37 Sealing of sample

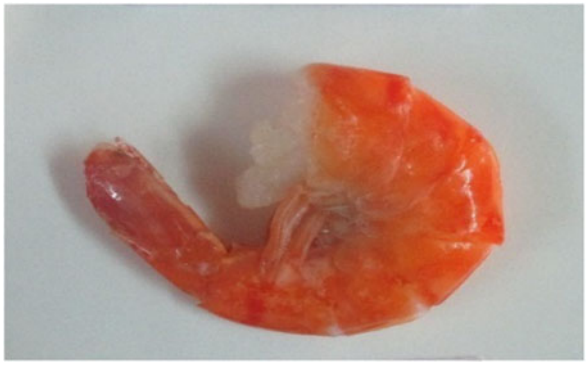


Fig. 9.38 Cooked HLSO-EZP IQF

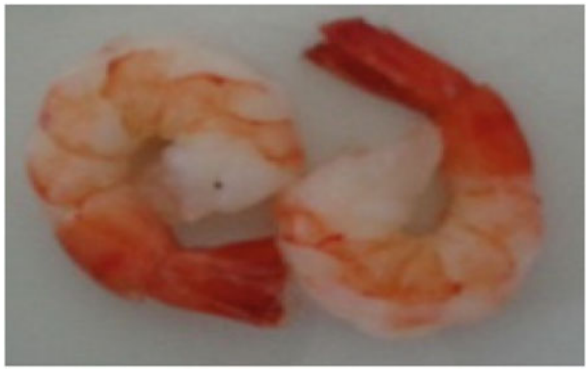


Fig. 9.39 Cooked PD Tail-On IQF

- Photographs of cartons selected for final inspection (all cartoon in a stack)
- Photographs of cold store temperature and product temperature
- Photographs of cartons stored in cold storage
- Photographs of all sides of the master carton, inner bag, and box
- Photographs of the outer label, inner label, sticker, and rider card
- Photographs of open master carton/bag/open box

Fig. 9.40 Cooked PD IQF shrimp

Fig. 9.41 Cooked HOSO shrimp

- Photographs of frozen product, deglazed product, and defrost/thawed product.
- Photographs of gross weight, frozen weight, deglazed weight, net weight, and defrost/thawed weight.
- Photographs of shrimp per pound.
- Photographs of 10% largest and 10% smallest weight of shrimp.
- Photographs of uniform/line-up shrimp.
- Photographs of defects and defect weight of shrimp.
- Photographs of cooked shrimp
- Photographs of barcode scanning
- Others

A complete report has a great combination of written words and reference photographs. Without photographs, the report has no meaning. Photographs act like an explanation of your written word. No one trusts you or your report without your photographs. Reports should be more accurate. It is necessary to review the reports several times before sending to the buyer. Besides inspection reports, buyer may ask you a raw inspection report, packaging checklist, supplier's checklist, supplier QC report, or other necessary documents. Inspection reports and other

necessary documents must be signed by the suppliers for authentication. Buyer or buyer representative checks all the reports and analyzes and takes the decision whether goods will be shipped or not. Final inspection report also known as a pre-shipment report (Appendix D: A model template of final inspection report).

9.3.2.5 Rejection Policy

Any kind of anomaly may cause container rejection. Different buyers followed the different policies to reject the container. Everyone has their own standard of sampling, inspection, and rejection procedure of the container. The following examples are the rejection policy of different importers.

If the inspectors check 1% of produced quantity (at least two for $\leq$100 MC) and all results are at satisfactory level, then the inspectors may advise to ship the container. If any kind of anomalies are found, only then the inspectors will check another 1% of the produced quantity or more than 1% (or as much as possible depending on product quantity and condition) of defect items. If the inspected products are in the satisfactory level, then the inspectors analyze the whole products, percentage of defects, types of defects, severity of defects, quantity of product, etc. and ask the responsible buyer to take their decision. Buyer will decide whether it is accepted or not. Inspectors are not the decision-maker; only buyer can take his or her decision. But, if the problems are found again, then buyer may cancel the shipment permanently or temporarily. Sometimes buyers try to find out the problems with its origin and causes and advise to take necessary steps of solutions. The products may be re-processed, re-packed, and re-inspected if necessary. Sometimes buyer advises to ship the products that have no defects. However, if found a serious problem that cannot be solved anymore, only then the container may not be accepted by the buyer.

[Note: All necessary documents of defects and causes of defects with photographs must be well noted in hard copy as well as soft copy for your safety and also for record keeping.]

Laboratory Analysis

10

Abstract

Laboratory is a facility of scientific experiment in which samples are being tested in controlled conditions for the analysis of physical, chemical, and biological parameters that ensure quality of frozen shrimp and certify products either edible or not for human consumption. Laboratory analysis of export grade frozen shrimp is the determination of characteristics through a variety of tests to obtain its original properties. The chapter highlights the sample collection procedure for laboratory analysis and explains the details of analysis of physical, chemical (heavy metal, dye, pesticides, and antibiotics), and biological parameters of consumable export grade frozen shrimp items.

Keywords

Sample collection · Physical test · Chemical test · Biological test · Antibiotics test

Laboratory analysis of frozen shrimp is a mandatory process that must be performed before shipment. All tested parameters must be within standard limit. Products are shipped only based on satisfactory result of the laboratory analysis. The laboratory analysis procedure is completed through the following steps:

1. Sample collection
2. Testing/analysis
3. Reporting

Description of the above three steps is given below.

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_10

10.1 Procedure of Sample Collection

Before going to start sample collection procedure, the following materials, equipment, and chemicals should be arranged. These are:

• Hand gloves, mask, and head gear • Digital balance • Hammer • Sprit lamp • Knife • Forceps • Scissors	• Sealing machine • Polybag • Sampling tag • Insulated box • Ice/dry ice/gel ice • 70% ethanol • Others

All necessary equipment used must be calibrated and sterilized. Samples for laboratory analysis are collected directly from processing industries. Sampling should be done after completion of the whole production. Partial productions are not allowed to collect the samples for laboratory testing. Samples should be drawn by maintaining standard sampling protocol (ISO) or buyer's specified method. All procedures must be in aseptic condition. The following procedure is maintained during collection of frozen shrimp:

- Samples for microbial analysis and chemical analysis should be drawn separately.
- Weight of samples are measured and recorded. Normally, 200 g sample for microbial analysis and 400 g sample for chemical and heavy metals analysis are enough for laboratory analysis.
- Sample must be sealed with air tide polybags.
- Sample identification tag is must.
- Sample is wrapped inside the insulated box with a clean and dry paper.
- Ice should be placed layer by layer, but a layer of ice at the bottom and top of the insulated box is mandatory.
- Standard icing ratio is 1:1, but quantity of ice may vary depending on sample volume and transport distance. Dry ice is better for long distance. Gel ice can also be used for sample transportation.
- Box should be wrapped with transparent tape and closed as early as possible.
- Lab address and test request form are added to the box and sent to lab for testing.
- A same volume of reference samples should be stored in supplier's cold storage as well for further analysis (if necessary).
- Frozen shrimp should be collected from each and every bag of the selected samples as per sampling plan. Sampling plan is made using following formula:

No. of cartons to be selected $= (\sqrt{n} + 1)/2$ $= (\sqrt{1800} + 1)/2$ $= 21.7$ $= 22$	Here, n = total no. of cartons = 1800

Table 10.1 Sample purchase order (PO) for a consignment

Production date	Product description	Brand name	Type of packing		Size and count of shrimp		Subtotal (MC)
			Gross weight	Net weight	8/12 (RC)	16/20 (FC)	
28.12.2021	Raw IQF BT HLSO shrimp	ABC	10 × 1 kg	10 × 800 g	400	–	400
29.12.2021	Raw IQF BT HLSO shrimp	ABC	10 × 1 kg	10 × 800 g	–	300	300
30.12.2021	Raw IQF BT PD shrimp	EFG	10 × 1 kg	10 × 800 g	500	–	500
31.12.2021	Raw IQF BT PDTO shrimp	EFG	10 × 1 kg	10 × 800 g	–	600	600
Grand total of master carton (MC)							**1800**

A total of 22 master cartoons have to be selected randomly for sampling. Sample selection procedure is also known as sampling plan. The details of sample selection procedure are given below (Tables 10.1 and 10.2).

Now,

Total no. of selected cartons will be 22

From 400 CTS of 8/12, RC, IQF Raw BT HLSO Shrimp (28.12.2021).

$$\text{Total no. of samples to be drawn} = \frac{\text{No of cartons to be selcted}}{\text{Total No.of catons on PO}}$$

$$\times \text{No.of variable(cartons)} = \frac{22}{1800} \times 400$$

$$= 4.8 \text{ or } 5 \text{ cartons}$$

At the same way:

$$\text{For 300 CTS of } 16/20, \text{FC, IQF Raw BT HLSO Shrimp} = \frac{22}{1800} \times 300$$

$$= 3.6 \text{ or } 4 \text{ cartons}$$

$$\text{For 500 CTS of } 8/12, \text{RC, Raw IQF BT PD Shrimp} = \frac{22}{1800} \times 500$$

$$= 6.1 \text{ or } 6 \text{ cartons}$$

Table 10.2 Final sampling plan

Production date	Product description	Brand name	Type of packing		Size and count of shrimp		Subtotal (MC)	No. of samples drawn
			Gross weight	Net weight	8/12 (RC)	16/20 (FC)		
28.12.2021	IQF Raw BT HLSO shrimp	ABC	10 × 1 kg	10 × 800 g	400	–	400	5
29.12.2021	IQF Raw BT HLSO shrimp	ABC	10 × 1 kg	10 × 800 g	–	300	300	4
30.12.2021	IQF Raw BT PD shrimp	EFG	10 × 1 kg	10 × 800 g	500	–	500	6
31.12.2021	IQF Raw BT PDTO shrimp	EFG	10 × 1 kg	10 × 800 g	–	600	600	7
Grand total of master carton (MC)							**1800**	**22**

$$\text{For 600 CTS of 16/20, FC, IQF Raw BT HLSO Shrimp} = \frac{22}{1800} \times 600 = 7.3 \text{ or 7 cartons}$$

[Note: Sampling plan may change as per buyers' instruction/protocol/sampling plan]

Perform the following exercise

Exercise 1:	Make a sampling plan for the following breakdown: BT HLSO 70% NW 16/20 IQF 1000 CS BT HLSO 80% NW 21/25 IQF 1000 CTS
Exercise 2:	Make a sampling plan for the following breakdown: BT HOSO 16/20 S.IQF 600 CTS BT HOSO 26/30 S.IQF 800 CTS BT HLSO 21/25 IQF 400 CTS
Exercise 3:	Make a combined sampling plan for the following breakdown: BT HOSO 16/20 & 21/25 S.IQF 300 CTS & 600 CTS BT HLSO 8/12 & 13/15 IQF 400 & 600 CTS

- **Dry Ice and Gel Ice**

Dry ice and gel ice function as cooling agents and are used in long transportation of frozen sample. Both dry ice and gel ice are used as alternative to cube/regular ice without the messes of melting water. In the case of dry ice, insulated box must be sealed in such a way that no gases pass out of the box as they turn into carbon dioxide gases directly rather than liquid. Dry ice is a frozen carbon dioxide (CO_2) or solid form of carbon dioxide (CO_2), and it has no residue like cube/regular ice. Temperature of dry ice is much lower than that of cube/gel ice. Surface temperature of dry ice is −109.3 °F or −78.5 °C. Again, the temperature of gel ice is around 0 °C (32 °F) or lower. Gel packs are made of leak-proof polyethylene bags filled with cooling gel. The gel packs are often made of nontoxic materials, have no mess of melting water, and are free of contamination. Gel ice can be reused several times through freezing and thawing. The following are the images of sample collection procedure (Figs. 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, and 10.9).

[Note: Handling of dry ice should be done very carefully. This extreme cold ice is very dangerous if handling it without any protection. It may cause burn in your hands/body if it is used without any protection.]

10.2 Testing/Analysis

International standards are followed for t**esting of seafood items**. **Testing** results confirm whether these products are safe for human consumption or not. **It**'s one of the greatest challenges in international food business. The main outcome of seafood testing is to confirm quality products, food safety, and consumer's satisfaction. It's a mandatory requirement for all seafood processing industries to confirm laboratory

Fig. 10.1 Sample isolation

Fig. 10.2 Sample collection

Fig. 10.3 Weighing of sample

test (physical, chemical, biological, heavy metals, dyes, pesticides, preservatives, additives, etc.) before shipping the consignment. Sometimes buyers perform their testing through other facilitated **independent** laboratories of the same country or outside of the country to make a comparison for more accurate results. Remember that we are dealing with food products, and our prime concern is food safety and quality. Any kind of hazards may cause serious illness in human health.

Fig. 10.4 Sample sealing

Fig. 10.5 Bottom layer of dry ice

Fig. 10.6 Layer of sample

Fig. 10.7 Final layer of dry ice

Fig. 10.8 Test sample

Fig. 10.9 Reference sample

10.2.1 Physical Test

Physical test is the first step of laboratory analysis. The following physical characteristics are tested in frozen shrimp:

- General appearance
- Freshness
- Texture
- Color
- Smell/odor
- Physical damage (clamps, glaze, broken pcs, etc.)

10.2.2 Biological Test

Spoilage of food is the degradation of color, texture, flavor, taste, as well as the nutritional value of products due to the activities of microorganisms. Microbial tests significantly contribute to the identification of pathogen and food spoilage microorganisms causing foodborne illness in human. Different types of spore-forming or non-spore-forming bacteria are responsible for food spoilage.

The following biological characteristics are tested in frozen shrimp:

- *Shigella* sp.
- *Salmonella* sp.
- *Bacillus cereus*
- *Vibrio cholerae*
- *Escherichia coli*
- *Vibrio vulnificus*
- *Vibrio parahaemolyticus*
- *Clostridium perfringens*
- *Listeria monocytogenes*
- *Staphylococcus aureus*
- Aerobic plate count
- Enterobacteriaceae
- Coliforms/total coliforms/fecal coliforms

10.2.3 Chemical Test

Different types of food additives, preservatives, antioxidants, sweeteners, salt, food colors, etc. are used in food to enhance the quality, safety, and shelf life of products. Chemical tests in frozen shrimp helps to assess the presence of chemicals and their concentration and summarize whether the food product is safe for consumption or not. The following chemical parameters are tested in frozen shrimp:

- Agar
- Indole
- Chlorine
- Citric acid
- Histamine
- Salt as NaCl
- Purity of salt
- Crude protein
- Monophosphate
- Diphosphate
- Triphosphate
- Polyphosphate
- Phosphate residue as P_2O_5
- Metabisulfite as SO_2
- Sulfite residues as SO_2
- Total volatile base nitrogen

The following dyes are tested in frozen shrimp:

- Crystal violet
- Malachite green
- Leuco-malachite green
- Leuco-crystal violet
- Other synthetic colors in food

10.2.4 Pesticide Test

Pesticides are used in shrimp processing industries for pest management. Sometimes buyers ask to test different types of pesticides. The following pesticides are tested in frozen shrimp:

- Ethoxyquin
- Trifluralin
- Ivermectin
- Chlorpyrifos
- Pendimethalin
- Organochlorine
- Ethoxyquin dimer
- Organochlorine pesticide residues
- Organophosphorus pesticide residues

10.2.5 Heavy Metal Test

The metallic chemical element which has relatively high density and is toxic at low concentrations is referred to as heavy metals (Pandey and Madhuri 2014). Pb, Hg, Cd, Cr, Cu, Zn, Mn, Ni, Ag, etc. are known as heavy metals. Among them the heavy metals As, Cd, Pb, and Hg are considered as most toxic to environment, animals, fishes, and humans (Pandey and Madhuri 2014). Chemical water pollution is the main source of heavy metal contamination. Heavy metals have the ability of bioaccumulation and biomagnification and can't be eliminated from the body by metabolic activities (Elbeshti et al. 2018). Consumption of heavy metal-contaminated fish is a risk for human health that may cause different types of health hazards like skin lesions, nerve damage, skin cancer, etc. Heavy metals in frozen shrimp are tested before shipping the consignment. The following heavy metals are tested in frozen shrimp:

- Arsenic (As)
- Cadmium (Cd)
- Mercury (Hg)
- Copper (Cu)
- Lead (Pb)

10.2.6 Antibiotics Test

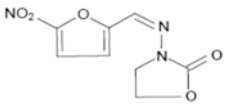
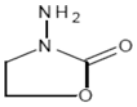
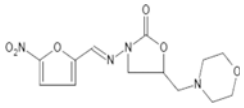
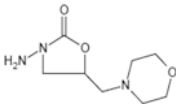
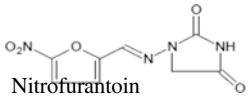
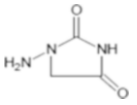
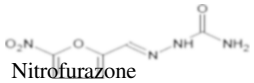
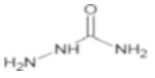
Antibiotics are medicine that slow down the growth of microorganisms or destroy it. Uses of antibiotics are strictly restricted in shrimp farms because of bioaccumulation. Experts are now concerned about resistance of antibiotics in human health. Resistance of antibiotics is the result of overusing and inappropriate using of antibiotics. Bioaccumulation can happen in youth to adult stage but significantly higher in youth stage and weakest during the adult stage of shrimp. The antibiotics exhibited higher bioaccumulation capacity in lipid-rich tissues especially head and gill of shrimp than muscle (Zhang et al. 2021). Antibiotics in frozen shrimp are tested before shipping the consignment because of mandatory requirements.

The following antibiotics are tested in frozen shrimp:

- Quinolones
- Trimethoprim
- Chloramphenicol
- Ciprofloxacin/enrofloxacin
- Nitrofurans metabolites (AOZ, AMOZ, AHD, SEM)
- Tetracycline (oxytetracycline, chlortetracycline, tetracycline)
- Fluoroquinolones (enrofloxacin, ciprofloxacin, sarafloxacin, difloxacin)
- Sulfonamides (sulfadiazine, sulfadimidine, sulfamethoxazole, sulfadimethoxine, sulfachloropyridazine), etc.

Nitrofurans are a broad-spectrum antibiotic, which works well against gram-positive and gram-negative bacteria. The tissue-bound residues of nitrofurans are very stable and do not degrade to a significant extent while preparing food like cooking, baking, grilling, and microwaving. Residues of nitrofurans ingested by consumption of contaminated product are bioavailable. When consumed, nitrofuran residues are absorbed by the consumer's body and form again tissue-bound residues. Parent molecules of nitrofuran are rapidly metabolized by animals, and their in vivo stability is no longer than a few hours, and they formed as persistent protein-bound residues. Unlike the parent molecules, these protein-bound metabolites are stable and persist in the body. The compound is considered carcinogenic and genotoxic; consumption over time of product contaminated with nitrofurans may cause human health risk. Nitrofurans were commonly employed as feed additives for growth promotion in livestock and aquaculture (i.e., fish and shrimp). The nitrofurans are a group of synthetic broad-spectrum antibiotics, which have been widely and effectively used for prophylactic and therapeutic treatment of bacterial and protozoan infections such as gastrointestinal infections caused by *Escherichia coli*, *Salmonella* sp., *Mycoplasma* sp., *Coccidia* sp., and coliforms (Vass et al. 2008).

There are four major nitrofurans: *furazolidone*, *furaltadone*, *nitrofurantoin*, and *nitrofurazone.* These nitrofurans are banned in EU because of their toxic and suspected carcinogenic and mutagenic properties (Commission Regulation 1442/95). In 2003 a definitive MRPL (Minimum Required Performance Limit) was set at 1 ng/g in the EU for the abovementioned four nitrofurans in poultry and aquaculture products (Commission Decision 2003/181/EC). The following structures of nitrofuran metabolites are tested in laboratory:

Parent compound to metabolites	Parent compound	Metabolites
Furazolidone to (3-amino-2-oxazolidinone (AOZ)	 Furazolidone	 AOZ
Furaltadone to (3-amino-5-morpholinomethyl-2-oxazolidinone (AMOZ)	 Furaltadone	 AMOZ
Nitrofurantoin to (1-aminohydantoïne (AHD)	 Nitrofurantoin	 AHD
Nitrofurazone to semicarbazide (SEM)	 Nitrofurazone	 SEM

Vass et al. (2008)

- **Others**

The following parameters are also tested sometimes as per buyer's requirement:

- Water content/moisture %
- Toxin (mycotoxins, phycotoxin, aflatoxins)
- Genetically modified organism (GMO)
- Fatty acid profile (saturated/unsaturated)
- Nutritional profile (carbohydrates/protein/fat/vitamins/ash, etc.)
- Shelf life, etc.

[Note: All parameters are not tested for every consignment. Some are mandatory (*Salmonella* sp., antibiotics) for every consignment, and some are occasional (pesticides, chemical). It depends on exporting country and customers' demands.]

References

Elbeshti RTA, Elderwish NM, Abdelali KMK, Tastan Y (2018) Effects of heavy metals on fish. Menba J Fish Fac 4(1):36–47

Pandey G, Madhuri S (2014) Heavy metals causing toxicity in animals and fishes. Res J Animal Vet Fishery Sci 2(2):17–23

Vass M, Hruska K, Franek M (2008) Nitrofuran antibiotics: a review on the application, prohibition and residual analysis. Veterinary Research Institute, Brno, Czech Republic. Veterinarni Medicina 53(9):469–500. Review Article

Zhang X, Zhang J, Han Q, Wang X, Wang S, Yuan X, Zhao S (2021) Antibiotics in mariculture organisms of different growth stages: tissue-specific bioaccumulation and influencing factors. Environ Pollut 288:117715

Shipment and Shipping Documents

11

Abstract

Shipment means the transportation of goods. Shipment of goods must be with proper documents. The chapter highlights shipment and shipping documents. Shipment includes loading and loading supervision (loading supervision at factory premises and loading supervision at port area), preparation of loading plan, and loading report. Shipping documents include technical specifications, supplier's checklists, packaging and labeling checklist, inspection report, loading report, laboratory analysis report, daily production supervision report, audit report, proforma invoice, etc. with details.

Keywords

Loading supervision · Loading plan · Technical specifications · Supplier checklist

11.1 Shipment

Shipment means the transportation of goods from one country to another employing sea/air/rail or others. Special types of refrigerated containers are used for the shipment of frozen shrimp. Refrigerated containers always keep frozen product cooled by blowing cold air. The floor of a refrigerated container is designed in a way that air passes throughout the container especially at the floor and the top of the container. Temperature of this container is designed to maintain at least −18 °C. A digital temperature meter is attached to the refrigeration unit. Dimensions of these containers also met the international (ISO) standards. The maximum loading height is marked on the inner side of the container wall. It is necessary to keep some space for adequate airflow. There are two types of containers mainly used for the shipment of frozen products. These are:

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_11

Table 11.1 Dimensions of standard frozen containers (little bit plus/minus is accceptable)

Container type (Frozen)	Length	Wide	Height
Standard 20 ft container (external)	20 ft	8 ft	8 ft 6 inch
Standard 20 ft container (internal)	19 ft 4 inch	7 ft 7 inch	7 ft 7 inch
Standard 40 ft container (external)	40 ft	8 ft	8 ft 6 inch
Standard 40 ft container (internal)	39 ft 4 inch	7 ft 7 inch	7 ft 7 inch

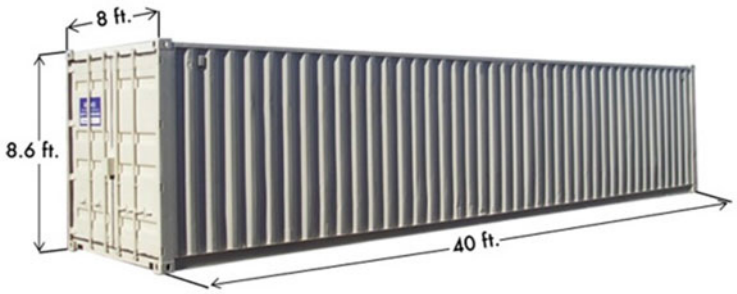


Fig. 11.1 Dimension of standard 40 ft container. (Source: Edidiwan.blogspot.com)

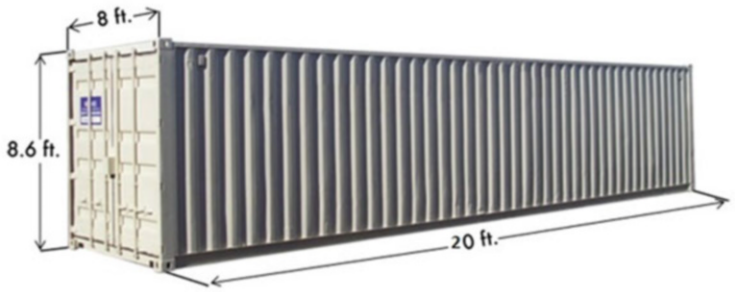


Fig. 11.2 Dimension of standard 20 ft container. (Source: Edidiwan.blogspot.com)

- Standard 20 ft container (frozen)
- Standard 40 ft container (frozen)

Reference dimensions of standard frozen containers are mentioned below (Table 11.1, Figs. 11.1 and 11.2).

11.2 Loading and Loading Supervision

Loading is the significant part of shipment. T**ransportation** and delivery of goods in its destination are confirmed by loading process. Based on satisfactory reports of pre-shipment inspection, buyer suggests loading the containers. Loading of frozen products is performed in two steps. The steps of loading procedure are as follows:

- First Step: Loading at factory area
- Second Step: Loading at port area

Arrangement of master cartons is completely reverse from loading in factory premises to loading in the port area. The cause is that container loading in the port area starts from the backside of a refrigerated van. Buyers assign their own staff or third-party representative for loading supervision. Loading supervision is performed during the loading of frozen goods at loading area. Loading supervision is important because of the following reasons:

- It confirms that exact quantity of goods is loaded into container.
- It confirms that goods are securely loaded into the container.
- It confirms that products are loaded sequentially.
- It confirms that goods are handled correctly during loading and unloading procedure.
- It confirms that goods are loaded and shipped as per good transportation practices.
- It confirms packaging and labeling requirement of goods as per specification.
- It confirms the dryness, cleanliness, and hygienic condition of the container.
- It confirms the temperature of cold storage, covered van, and frozen container.
- It confirms the perfect sealing of container, container no., and seal no.

Loading starts from factory premises and finishes at port area. Loading supervision is performed in two steps:

1. Loading supervision at factory area when frozen products are loaded from factory cold storage to refrigerated van.
2. Loading supervision at port area when frozen products are unloaded from the refrigerated van and loaded again to frozen container.

It is better to supervise loading in two locations both in factory premises and port area. The procedures of loading supervision are described below.

11.2.1 Loading Supervision at Factory Premises

Master cartons are stored in cold storage and brought out during loading time. Before starting loading supervision factory people and/or buyer representatives calculate how many rows and how many columns are required for the arrangement of the total

number of cartons. Cartons are arranged in a refrigerated van sequentially considering type and size of cartons and size, count, and brand of frozen products. Cartons are transported from factory to port through a special type of refrigerated van. There are two types of refrigerated van mainly used for the transportation of short distance. Those are:

1. Insulated AC van
2. Insulated non-AC van

The buyer preferred transportation through an insulated AC van. Transportation through an insulated AC van is good and safe for the transportation of frozen goods. But in crisis moment if insulated AC van is not available, then transportation through insulated non-AC van may be the alternative of insulated AC van. Note that insulated non-AC must be facilitated with gas supply. Transportation of frozen product without insulated van or AC or gas is totally unaccepted. The following are supervised during loading supervision at factory premises:

- Check the temperature of cold storage (must be at least 18 °C).
- Check the internal condition of insulated van and its cleanliness. The insulated van must be dry, clean, and free from dust, grease, strange smell, serious rust, leakage water, and any other substance that may damage the export cartons or affect its appearance.
- Check the temperature of insulated van and frozen products.
- Confirm that 100% of products are loaded into the van.
- Confirm that there is no waste of time, and loading time should be very short.
- Confirm the number of cartons as per specification.
- Confirm that products are arranged sequentially during loading into van.
- Reduce rough handling and confirm proper sanitation.
- Confirm that the insulated van is sealed perfectly.
- Review and collect the necessary documents.

It is necessary to select randomly one or two cartons (at least) per product, per size/grade per brand for checking of product, its packaging, labeling, and barcode scanning. Open the carton to confirm the product, internal condition, and identification by comparing the product and packaging specification according to the document provided by buyer. Sometimes checking of metal detection is done again before loading in refrigerated van. Note that damaged or wet or damp cartons are not allowed anymore. If found it must be replaced instantly. Tapping or repairing procedure is completely avoided. Avoid rough handling also. It is better to avoid manual loading process. It helps to reduce the damage of frozen products. Mechanical loading process is highly appreciated.

11.2.2 Loading Supervision at Port Area

Supervision at the port area is same as at factory premises. Products are shifted from refrigerated van to refrigerated container. Make sure the following parameters during loading supervision at port area:

- Check the container thoroughly before start loading. Container must be dry, clean, and free from dust, grease, strange smell, serious rust, leakage water, and any other substance that may damage the export cartons or affect its appearance.
- Cartons loaded inside the container shall not be damaged, deformed, cracked, dirty, or wet.
- The sealing of the cartons must be perfect, tight, clean, and firm.
- Heavy cartons shall be loaded in the floor of the container and lighter cartons on top.
- Cartons should be loaded near the door in such a way that they do not fall out when the door is opened.
- Check container temperature as per buyer specification. It must be at least −18 °C. The temperature of the container is read off from the temperature display unit on the outside of the container. Check also the air temperature inside the container by using a calibrated digital thermometer. Air temperature shall be checked in different places of the container but not touching any metal surface. Temperature of the container shall be measured in different intervals, i.e., before, middle, and end of loading process.
- Floor of the container should be utilized effectively. It is better to use entire floor for the arrangement of cartons. If there is a large free space, it may cause cartons' displacement resulting in damaged frozen products.
- Confirm that there is no waste of time; loading time should be very short.
- Confirm the container number seal number without mistake. Sealing of the container must be perfect.
- Confirm that 100% of goods are loaded into the container.
- Confirm air space inside the container.
- Confirm proper sanitation and avoid rough handling. Collect necessary documents for customs' inspection.

[Note: Sometimes loading of frozen shrimp is performed only at factory premises instead of port area if port is very near to the processing industry. Suppliers brought their container to the factory premises and load their frozen products directly to the container. At that time loading supervision is performed in factory premises only; no supervision is needed in port area.]

11.3 Loading Report

Once the loading supervision is completed, it is necessary to prepare a loading report for the buyer. A complete loading report has the following parts:

1. General information
2. Loading information
3. Loading plan and
4. Loading pictures

11.3.1 General Information

The following information may present as general information:

- PO. no., factory approval no., invoice no., B/L no., etc. Name and address of supplier and buyer
- Product description (size, count, net weight, packing, brand, etc.)
- Type of transported vehicle (insulated covered van with AC/non-AC/gas)
- Total purchased volume
- Total volume to be shipped, etc.

11.3.2 Loading Information

The following information may present as loading information:

- Date of loading/stuffing Loading starting and ending time
- Container temperature
- Container number
- Seal number
- Port of departure
- Port of destination
- B/L no.
- On board date
- Name of shipping line
- Name of feeder vessel and mother vessel
- Estimated time of delivery (ETD)
- Estimated time of arrival (ETA), etc.

11.3.3 Loading Plan

A loading plan is a tabular presentation of products that indicates the position of every item and carton of the container. If someone checks the loading plan, it is possible to identify the product very easily (Appendix F: A model template of loading report).

11.3.4 Loading Pictures

The following photographs are collected during loading supervision:

- Packaging and labeling of master cartons
- External and internal condition of refrigerated container
- Container temperature
- Container number
- Products of every row
- Closing of container
- Container sealing and seal number
- Repairing of master cartons (if any)
- Others (as per buyer specification)

The following are the images of loading supervision process (Figs. 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 11.10, and 11.11):

Fig. 11.3 Container temperature

Fig. 11.4 Internal view

Fig. 11.5 Second row

Fig. 11.6 Seventh row

Fig. 11.7 Tenth row

[Note: Once container is shipped, it is possible to identify the container by online tracking system. Here, you can find all related information regarding shipped container.]

Fig. 11.8 13th row

Fig. 11.9 Closing of container

Fig. 11.10 Sealing of container

11.4 Description of Shipping Documents

Documentation is very much important for every business. No one believes you without proper documents. It's written proof and record keeping of goods. It should be maintained in every step of seafood business. Both soft copy and hard copy documents are directly sent to buyer after completion of shipment procedure. Soft

Fig. 11.11 Container number

copy documents are sent through an email address, and hard copy (original) documents are sent to buyers through international courier services. No one can accept goods without proper documents. Specification and documentation depend on the requirements of both the government of exported countries and the government of the imported country. The following necessary documents are sent to the buyer during shipment of frozen products:

- Commercial invoice [Appendix L: Commercial Invoice]
- Bill of loading (B/L)
- Packing list GSP certificates
- Health certificates
- Beneficiary certificates
- Chemical test report
- Heavy metal test report
- Antibiotic test report
- Microbiological test report
- Loading report
- Shipment advice
- Packers QC report/inspection report
- Production supervision report
- Final inspection report
- Packaging checklist and
- Other relevant documents (if any).

[Note: Suppliers submit their documents as per buyer specification that is specified in their LC copy. Name of documents, number of copies, submission date, etc. are clearly specified in LC copy.]

11.4.1 Technical Documents of Frozen Goods

Documents	Remarks
Purchase order (PO):	PO stands for Purchase Order. It's a commercial document issued by the buyer after confirmation of the business deal. It's a formal written document of deal confirmation. It confirms the product description, volumes, prices, and specific terms and conditions. Values can be calculated by multiplying of unit price (USD) and total volume of goods (kg) (Appendix G A sample of PO).
Proforma invoice (PI):	It's a document from supplier side. Supplier issues their proforma invoice after confirmation of business deal. It is also a formal written document of the confirmation of business deal from supplier side. It confirms the product description, volumes, prices, and specific terms and conditions as same as a purchase order. It's also called a document of financial statements.
Packing list:	It's a broad description of goods. It confirms the quantity of goods and its unit weights, total weights, production date, freezing date, etc. It's a clear explanation of frozen weight, deglaze weight, and net weight of goods (Appendix H: A sample of packing list).
Shipment advice:	It explains the overall description of the consignment and shipment details in brief. It highlights the goods with carrying vessel, its position and time of arrival, etc. (see Appendix I: A sample of shipment advice).
GSP certificate:	GSP stands for Generalized Scheme of Preferences. It's like a quota for exporting country. GSP facilities are mainly awarded to developing countries for their sustainable economic growth and development. GSP ensure export duty-free access to exporting countries.
Beneficiary certificate:	The certificate is issued by the supplier stating that goods are shipped and not hazardous for consumption.
Health certificate:	The certificate is issued by the health authorities, making a guarantee that goods are not hazardous and safe for human consumption. Health certificates must be legible, accurate, and complete.
Certificate of origin:	They certify the goods' country of origin.
Test certificates/ reports:	The reports confirm that the goods are not hazardous and free from pathogenic organisms (*Salmonella, E. coli, V. cholera,* etc.), chemicals, heavy metals, antibiotics, and others (if required) and safe to eat.

11.4.2 Technical Specification/Guidance of Frozen Goods

Technical guidance means a clear specification of a product. It's a prerequisite for a business contract. Technical specification confirms what will be the final product, what are the ingredients, how to process, what are the instructions, and what are the limitations of the products. Every step of its origin to final consumption can be specified very clearly in technical specification. It's an important part not only for suppliers and buyers but also for the consumers. Normally, the supplier prepares technical guidance based on available facilities and buyer's requirement and sends it to buyer for confirmation. Buyer checks the guidance and confirms it by signature or

vice versa. If supplier violates the specification, product may not be accepted by the buyer/customers.

Buyers ask to provide technical specifications of their goods that help the buyers to convince their customers. It's a business strategy. Quality products, better presentation, and proper documents help to attract its customers. Customers choose their product by assessing its general appearance with labeling, proper documentation, certification mark, market reputation, safety assurance, and previous experience. Quality suppliers and buyers assure food quality and safety to a great extent and express everything as technical documents. The details of a technical specification of frozen shrimp are given below. The following information may be in a standard technical sheet of frozen shrimp:

- General information
- Product specification
- Product composition
- Allergen information
- Nutritional information
- Packaging information
- Organoleptic characterization
- Microbiological information
- Chemical information
- Heavy metal information
- Conservation and shelf-life information
- Precaution and others

[Appendix J: A sample of technical specification]

11.4.3 Supplier Checklist

Supplier checklist is a technical document related to a mini audit of the processing industry. It helps the buyer to identify the past and present scenarios of the processing industry. Different types of checklists are used for different purposes. Different buyers have different formats of supplier checklist. The following information should be in a supplier checklist:

- General information of the supplier
  - Name of the suppliers
  - Address and location
  - Factory approval no.
  - Supplier brand
  - Contact details, etc.
- Production management
  - Source of raw materials
  - Diversification of product

  - Production technology
  - Production capacity
  - Yearly target
  - Shipped volume, etc.
- Quality management system
  - Expert personnel
  - Quality assurance
  - Training
  - Traceability
  - Certifications, etc.
- Risk management
  - Risk identification
  - Risk evaluation
  - Risk validation
  - Limitation, etc.
- Sanitation management
  - Sanitation standard
  - Sanitation procedures
  - Sanitation application, etc.
- Facilities and maintenance
  - Modern equipment
  - Types of equipment
  - Maintenance
  - Calibration, etc.

11.4.4 Packaging and Labeling Checklist

Packaging and labeling checklist is prepared for the confirmation of accurate packaging. It helps in avoiding mislabeling and packaging failure. It also helps to minimize customer complaints and possible demurrage. Packaging and labeling checklist is prepared in two steps:

Step 1: Packaging and labeling checklist before printing

Step 2: Packaging and labeling checklist after printing

Checklists are prepared for both inner and outer packaging and labeling. All the information, design, dimension, and other parameters are considered during preparation of packaging and labeling checklist. The following information is checked carefully during preparation of packaging and labeling checklist:

- General information
- Product details
- Master carton labeling details
- Inner box/bag labeling details

- Rider/header card labeling details
- Packaging design, dimension, color, logo, sealing, specification, etc.
- Packaging industry details

If any kind of anomalies during preparation of the packaging and labeling checklist is found, it is possible to make correction before shipping of final products. A responsible person should be more careful; otherwise, suppliers/buyers should pay a great extent (Appendix E: A model template of packaging and labeling checklist).

11.4.5 Stock Intake

Stock intake is a document that makes comparison between purchased volume and shipped volume. It helps suppliers and buyers to know the following two parameters:

- How much quantity of goods is purchased?
- How much quantity of goods is shipped?

Stock intake is also called cold storage intake. It may include the following:

- General information (PO no., article no., brand, etc.)
- Product information (Size, count, net weight, expiry date, etc.)
- Shipment information (loading date, shipping line, container and seal no., ETA, etc.)

Sometimes suppliers are not able to ship the exact assortment as per deal. At that time, they try to make balance with plus or minus of some other products/grades. Changes of assortment may be the caused by the following:

- If landing of specific grades of shrimp is limited/excess
- If demand of some grades of shrimp is limited/excess
- If supplier sold more/less than their capacity
- If suppliers make balance their product among the buyers
- If price increased/decreased in local or international market

[Appendix K: A sample of stock intake]

11.4.6 Record Keeping

Record keeping is necessary for every step of shrimp processing. It should be started from stocking of shrimp and continued up to final consumption. Record keeping is maintained in two ways: (1) outside of the industry and (2) inside of the industry. It's an important part of the documentation process. The importer may ask suppliers for any kind of documents at any time. Responsible persons in processing industries

should keep records in every step of receiving, transportation, processing, storage, and shipment and preserve the record for documentation. It is necessary to analyze all the records once in a day to get a clear concept about the products. The record-keeping system helps suppliers to assess the quality of their product itself. Record keeping should be maintained in the following areas of processing of frozen shrimp:

- All steps of traceability.
- All steps of the processing line.
- All temperature (cold storage, anteroom, processing room, freezing room, equipment, products, and water). It is necessary to keep the temperature record in every hour.
- Daily production details.
- Additives and soaking details.
- CCP monitoring, corrective action, and verification details.
- Packaging details.
- Packer's evaluation and their QC details.
- Physical, chemical, and microbiological analysis details.
- Sanitation details.

Calibration details, maintenance, labor information, etc.

Audit, Certification, and Payment

12

Abstract

Audit means an official inspection and evaluation of an organization and/or its goods. A certificate is awarded after completion of successful audit program. Failure in audit suggests to address the failure points and re-audit. The chapter highlights different types of audits and certification programs like ASC, BRC, MSC, IFS, BSCI, BAP, HALAL, HACCP, ISO, etc., its importance, process, steps, and requirements. The chapter also includes the inquiry procedures and different types of payment system used in international seafood business.

Keywords

Letter of credit · Inquiry procedure · LC amendment

12.1 Audit and Certification

Audit means an official inspection and evaluation of an organization and/or farm that make sure the statements and records are fair and accurate as per specifications. It plays a key role in verifying proper food safety practices in shrimp processing industries, helps in supplier selection, demonstrates diligence for customers, and validates internal policies and procedures. Audit can be performed by typical independent certified bodies. Only accredited bodies have the right to perform an audit program. Different types of audits are performed in different aspects like new supplier assessment audit, process/scheduled audit, developmental audit, social audit, verification/follow-up audit, and so on. The reasons for an audit program are as follows:

- To review supplier's philosophies and practices
- To review supplier's production line and quality control system

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_12

Table 12.1 General process of audit and certification program

Year	First year		Second year	Third year	Fourth year
Activities	Step 1:	Pre-audit (optional)	Surveillance audit	Surveillance audit	Re-certification audit
	Step 2:	Certification audit (stage 1)			
	Step 3:	Certification audit (stage 2)			

- To review limitation and corrective action
- To improve the efficiency of operations
- To ensure the legal compliance

After completion of a successful audit program, a certificate is awarded to respective authorities/companies. Certificate is a law or written document or a true statement. Certificates are awarded to specific companies only, and the certificates acted like quality assessment indicators for the suppliers and buyers. It's a process of value addition for respective suppliers and/or buyers. It can offer excellent food quality, food safety, and customer satisfaction and seek a competitive advantage in their business policy by increasing value, better price, market demand, and company reputation. It also makes a brand image of quality products. Certificates are awarded in the following reasons (Table 12.1):

- To ensure local and global compliance and regulations
- To ensure a common standard and uniform evaluation
- To ensure comparability and transparency
- To ensure high-quality and safety products
- To ensure customer satisfaction
- To ensure business reputation

[Note: This is general certification process. It may change based on the requirements and the standards of the audit.]

Food safety elucidates as the state of food, free from harm or potential hazard to the consumer and related stakeholders. The following certificates are awarded after a successful audit program of food processing industries:

FSSC 22000:	FSSC 22000 stands for Food Safety System Certification. The standard implies a complete guideline for the auditing and certification of Food Safety Management Systems (FSMS). The standard provides a certification model that can be applied across the entire food supply chain to ensure international food industry requirements to obtain a certificate that assures that industry provide safe food to its final consumers. This standard helps to promote national and international recognition and general acceptance of food safety and food safety quality management systems. FSSC 22000 is recognized by the Global Food Safety Initiative.

(continued)

IFS (Food):	IFS stands for International Food Standard. The IFS food standard is a GFSI (Global Food Safety Initiative) recognized standard for auditing food suppliers. The main theme of this certificate is to confirm food safety and quality of suppliers and their manufactured products.
GLOBALG. A.P.:	The GLOBALG.A.P. Aquaculture Standard is an international standard for farm production. It satisfies a series of criteria including the protection of environmental and ecological safety, animal welfare, food safety, traceability, and legal compliance of farm production of fish, crustaceans, mollusks, and hatchery.
MSC:	MSC stands for Marine Stewardship Council. MSC works for wild capture fishery certification around the world. The certification addresses sustainable fishing practice, environmental standards, and responsible fisheries management and contributes to ensure healthy environment of the world's oceans.
ASC:	ASC stands for Aquaculture Stewardship Council. ASC works for certification program of responsible aquaculture. The ASC certification mark assures the quality and safety of aquaculture species (fish, crustaceans, shellfish, etc.).
BRC:	BRC stands for British Retail Consortium. It is a trade association for retail businesses. It's now recognized as a global food standard. The standards promote consistency across the supply chain for manufacturers, wholesalers, distributors, agents, and brokers as well to avoid product failure. The BRC Global Standards covered food safety and management of product quality in food and ingredient manufacturing, food packaging manufacturing, storage, distribution, transportation, and logistics.
BSCI:	BSCI stands for Business Social Compliance Initiative. BSCI is a leading business-driven initiative for industries committed to improve working environment in the global supply chain and promote workplace conditions in accordance with human rights, ILO conventions, and national labor law. BSCI is an initiative of the Foreign Trade Association (FTA) in order to create consistency and harmonization for companies and improvement of their social compliance in the global supply chain.
BAP:	BAP stands for Best Aquaculture Practices which is a comprehensive and proven aquaculture certification program based on achievable, science-based, and continuously improved standards. From 5.1 standard it includes the wild catch in the besides aquaculture and renamed as Seafood Processing Standard (SPS). BAP works with seafood farms, processing plants, hatcheries, and feed mills and tries to improve the environmental, social and economic performance of the aquaculture supply chain. BAP is a division of the Global Aquaculture Alliance (GAA).
HALAL:	Halal is an Arabic word meaning lawful. It refers to things or actions permitted by Shariah law. This certificate meets the demands of Muslim consumers and certifies that products are edible, drinkable, or usable by Muslims.
HACCP:	HACCP stands for Hazard Analysis and Critical Control Point. HACCP is a systematic approach to the identification, evaluation, and control of food safety hazards. It has been designed as a safeguard in all steps of the food industry like culture, harvesting, processing, handling, distribution, and consumption of the finished product. Successful implementation of the HACCP program depends on the strong commitment of management. Seven HACCP principles have been universally accepted by government agencies, trade associations, and food industries. The principles are as follows: Principle 1: Conduct hazard analysis (physical, chemical, biological)

(continued)

	Principle 2: Determine critical control points (CCP) Principle 3: Establish critical limits Principle 4: Establish monitor procedure Principle 5: Establish corrective actions Principle 6: Establish verification procedure Principle 7: Establish record-keeping and documentation procedure
GMP:	GMP stands for Good Manufacturing Practice. It is designed to minimize the risks involved during manufacturing and packaging to ensure the safety and purity of the products. A product that conforms to GMP guidelines is considered to be of high quality and will pose no risk to consumers. GMPs describe the methods, equipment, and facilities to control processed foods. Implementation of GMP helps to minimize losses and waste and protect impairment in final products, final consumer, and the industry.
ISO:	ISO stands for International Organization for Standardization. ISO promotes global standardization for specifications and requirements for materials, products, procedures, formats, information, and quality management. The ISO does not enforce regulations and is not a license that permits an activity. It merely certifies the management system, manufacturing process, and documentation procedure that assure the requirements and standardization of quality services. ISO award certificates in different fields and aspects are as follows: **ISO 9001:** Certificates awarded for quality management system (QMS). The ISO 9001:2015 standard implies how the organization operates to meet the requirements of its customers and provide quality product. **ISO 14001:** Certificates awarded for respect for the environment. **ISO 18001:** Certificates awarded for the involvement of safety and well-being of employees. **ISO 22000:** Certificates awarded for food safety management system.

A certificate is not just a written document. It's a judgment of quality standards. The seafood market is more competitive. So, proper initiatives should be taken immediately to upgrade the standard for sustainable business.

12.2 Inquiry Procedure

Inquiry means to ask something. It is the most important and mandatory process of the shrimp business. The purchase department of buyer asks price to packers, checks with their sales department, and confirms business deal. Actually, it's a purchase negotiation before going to business. The whole process continued through email. Buyer may ask directly to the packers, or sometimes the whole business deal can be done through agents. Agents are middlemen doing purchase negotiation with buyer and seller and charge commission for this negotiation. Some agents have their own quality control team. The steps of the inquiry procedure are as follows.

12.2.1 Step 1: Sending of Requirements

Once a buyer needs to buy some products, he or she sends his or her requirements directly to packers or through agent. Before sending requirement, the buyer thinks about the following;

- Lowest price
- Quality of their products
- Standards of the suppliers
- Certification mark of the suppliers
- Market reputation of the supplies
- On-time shipment history of the suppliers
- Non-shipment history of the suppliers

Based on their choice, buyers send their inquiry to supplier or suppliers. Sometimes buyers put an inquiry code in the subject line for the identification or to keep information secret. Buyers specify their product description and their quantity. See the following example for more clarifications.

Inquiry code: Black Tiger 2021
Product description and quantity

BT, HLSO, RAW, IQF, 80% NET WEIGHT, RC, STPP TREATED, BRAND 'AB'

Grade	Quantity
16/20----------	900 CTS
13/15----------	900 CTS
TOTAL----------	1800 CTS

12.2.2 Step 2: Supplier's Response

Suppliers receive the requirements and think about the following before going to quote their price:

- Availability of raw materials/landing
- Current market price of the products
- Facilities of their factory
- Pending shipment orders
- Characteristics of the buyer
- Payment terms and payment history of the buyer
- Buyer's market reputation
- Profit margin

Based on the above consideration, suppliers quote their price and available quantity against this requirement. For example:

BT, HLSO, RAW, IQF, 80% NET WEIGHT, RC, STPP TREATED, BRAND 'AB'

Grade	Quantity	Suppliers quotation
13/15----------	900 CTS--------	12.00 USD
16/20----------	900 CTS--------	10.10 USD
Total---------	**1800 CTS**	

[Note: Suppliers may change the break-up/assortments and offers as per their convenient shipment. Suppliers may not respond to inquiry if there is scarcity of raw materials or due to the worst market reputation of the buyer in the shrimp business world.]

12.2.3 Step 3: Price Negotiation

Price negotiation or bidding is the most important part of this procedure. After receiving of quotation (price) from supplier, buyer cross-checks with his or her respective sales department whether the prices are feasible or not. Sometimes buyer receives quotation from different suppliers for the same inquiry and analyzes the following before going to price negotiation:

- Lowest best price
- Top quality product
- Payment terms
- Best possible shipment date
- On-time shipment history of suppliers
- Strong commitment of the suppliers

After analyzing the above consideration, the buyer makes his or her decision whether he or she will purchase or not. If the buyer thinks the quoted price is not suitable or higher than market level, then buyer sends his or her counter price against supplier quotation. Supplier checks again the counter price, market situation, cost benefit or loss, etc. and informs the buyer whether it is workable or not or may quote counter price again. This procedure may continue up to the achieving of the target level for both parties. See the following example of bidding:

BT, HLSO, RAW, IQF, 80% NET WEIGHT, RC, STPP TREATED, BRAND 'AB'

Grade	Quantity	Suppliers quotation	Buyer quotation	Suppliers quotation
13/15 -------	900 CTS ---	12.00 USD ------	11.50 USD -----	11.60 USD
16/20 -------	900 CTS ---	10.10 USD ------	09.80 USD -----	10.00 USD
TOTAL-------	**1800 CTS**			

12.2.4 Step 4: Confirmation of the Deal

After a long bidding process, both parties confirm their business deal and send it to next step for formal documentation procedure. Supplier issues their purchase order (PO), and buyer issues their proforma invoice (PI). All documents must be signed by both parties. Buyer advises to supplier for quality product and on-time shipment.

12.3 Payment Terms

Payment is a vital part of the business. The following payment method/terms are used in the international seafood business.

12.3.1 Cash-in-Advance

Cash-in-advance is a payment method where exporters received their payment before their goods are transferred to the respective importer. It helps the supplier to avoid their credit risk. However, the cash-in-advance payment method is the least attractive option for the buyer because it creates unfavorable cash flow. Buyers are concerned that the goods may not be shipped if payment is made in advance.

12.3.2 TT Payment

TT stands for Telegraphic Transfer or wire/swift transfer which is the cheapest and fastest method of payment. It's a legal way of money transfer through the banking system, and it is necessary to make everything clear related to payment terms and conditions, i.e., payment date, limit, % in advance, % before shipment, % after shipment, etc. In this method buyers paid to the supplier at a certain percentage of credit (30% or 40% or 50% or 60%, etc.) in advance and rest of the credit to be paid after reaching original documents or goods as per agreement. This is the less common practice because like cash-in-advance, buyers are concerned that the goods may not be shipped if the supplier is not an honest one.

12.3.3 Letter of Credit (LC)

A letter of credit is the most effective and most commonly used financial tool that facilitates payments and transactions. It's one of the common and secure instruments used in international trades. A bank or a financial institution acts as a third party between the buyer and the seller and guarantees the payment of money based on specified terms and conditions. Letter of credit is a method of payment that protects buyer since no payment obligation arises until the goods have been shipped as promised. Again, suppliers are also safe because the bank makes the guarantee of

payment if everything is as per terms and conditions. A letter of credit has the following important elements:

- The buyer (an applicant who purchased goods)
- The beneficiary (supplier who will receive the payment)
- LC opening bank (issued letter of credit on behalf of the buyer)
- Negotiating/advising bank (received credit on behalf of suppliers)

[Appendix A: A reference copy of Letter of Credit (LC)]

Suppliers need to submit their documents for getting payment. Sometimes it is needed to forward documents to another bank for review. Payment will be done on the beneficiary's account after verification of all necessary documents and maturity of payment. The following are the types of letters of credit used in international trades:

- Commercial LC
- Export/import LC
- Transferable LC
- Un-transferable LC
- Revocable LC
- Irrevocable LC
- Standby LC
- Direct pay LC
- Confirmed LC
- Unconfirmed LC
- Revolving LC
- Back-to-back LC
- Red clause LC
- Green clause LC
- At sight LC
- Deferred payment LC

Descriptions of some important types of LC are as follows:

- **At Sight LC**
  LC at sight is the quickest form of payment. It demands payment subject to the submission of required documents. The bank reviews the documents and pays the beneficiary if documents meet the terms and conditions of the LC. A letter of credit that pays at sight is beneficial for sellers. Payment arrives more quickly. Exporters invest money to produce and ship the goods quickly. Some of the seafood buyers are doing their business through at sight payment, but percentages are very low. Suppliers prefer this system but risky for the buyer if the supplier makes it non-shipment.
- **Deferred Payment LC**
  Deferred payment is a type of letter of credit that ensures payment after a period of a long time. Based on the agreement, time frame may be as long as 30, 45, 60, 90,

or 180 days. Buyers will make their payment after the days of agreement have passed and the goods have arrived at the buyer's destination. Bank may review documents earlier, but payment goes to a beneficiary after the period of agreement passes (after maturity of LC). The bank charged a certain percentage of interest as per the terms and conditions of the letter of credit. The buyer prefers this type of payment system. Deferred payment gives the buyer more time to come up with funds. It can serve as a form of seller-financing, which would help to attract buyers. The buyer also has a chance to sell imported goods and generate revenue before making their payment. It's easier and good; no delay comes up for payment. There is a risk for the suppliers if the buyer is not honest or makes a late payment. Note that, the bank will increase their interest if the payment is getting late resulting in suppliers losing their profit.

- **Revocable LC**
  It is a letter of credit that can be altered any time by the issuing bank or the buyer without any notification to the suppliers/beneficiary. This LC may be amended or canceled any time by the buyer without the approval of the supplier. This kind of LC is used rarely because it doesn't provide any protection to the supplier.
- **Irrevocable LC**
  An irrevocable letter of credit is official correspondence from a bank that guarantees payment for goods or services. It cannot be canceled or modified without approval of all parties involved. It confirms the supplier of receiving payment because it is a guarantee by the issuing bank. The bank will make payment in the event that the buyer fails to do so.
- **Standby LC**
  A standby letter of credit is a guarantee of payment by the issuing bank on behalf of the applicant. It can be designed as a sign of good faith in business transactions and a proof of a buyer's credit quality and repayment abilities. A standby letter of credit confirms credit even payment was not made by the applicant. The beneficiary can draw the credit from the issuing bank if they can prove that promised payment was not made by the applicant. Payments are made subjected to submission of required documents as per maintaining the standby LC clause.
- **Confirmed LC**
  It is a letter of credit where an advising bank also guarantees the payment to the beneficiary. Only the irrevocable letters of credit are confirmed by the advising bank. The beneficiary has two promises to pay:
  – One from the LC issuing bank
  – The other from the advising bank

  This type of LC that adds the endorsement of the advising bank to that of the issuing bank. It provides the highest level of protection since both banks are involved in transaction guarantee.
- **Unconfirmed LC**
  A letter of credit is assured only by the issuing bank and does not need a guarantee by the second bank.

12.3.4 LC Amendment

Amendment refers to any kind of changes that are made in terms of LC clause after it has been authorized. An amendment can be made at any time after an LC has been authorized and before its expiry date. The following are the causes of LC amendment:

- If it is needed to change the shipment date, expiry date, goods, quantities, values, etc.
- If suppliers were unable to meet the requirements of the buyer.
- If buyer needs special requirements in special cases.
- If LC is opened with wrong policy or false statement.

An amendment is required for smooth shipment. Amendments are done by the negotiation of both parties. The bank claims an extra charge for making the amendment.

Frozen Shrimp and Other Seafood-Based Value-Added Products

13

Abstract

Value addition refers to any kind of technique that added extra value of the products by means of employing processing methods, specialization of ingredients, addition of additives, enhancement of nutrition, attractive packaging technique, or other means. Value addition may be subjected to cutting, cooking, freezing, buttering, breading, marinating, and novel packaging. Shrimp marinated with vegetables, herbs, or other nutritional and/or medicinal ingredients are mostly demandable items in current world. Forms of consumption are different for different products. Some of them are ready to cook or bake or broil or fry/deep-fry or grill. Some of them are ready to thaw, ready to heat, ready to serve, ready to consume, etc. The world is moving very fast, and the demand of seafood is increasing day by day. Consumers now demand ready products which means the product should be easy to cook or ready to eat. Value addition is a type of process that helps consumers for ready meals. It also increases the price value of the products. The chapter highlights some value-added products of shrimp like tempura and torpedo shrimp, filo shrimp, marinated butterfly shrimp, shusi, value-added crab, and some other value-added fish products as well as other value-added seafood and shrimp byproducts.

Keywords

Tempura · Torpedo · Shusi · Crab · Byproducts

13.1 Introduction with Some Value-Added Products

HLSO, HLSO-Easy Peel, PND, PUD, PDTO, PTO, skewer, shusi, nobasi, butterfly, fan-tail round, grilled cut, leaf cut, torpedo (breaded), tempura (buttered), filo, etc. are the different forms of value-added products. Variation of the above product

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_13

comes from employing a cutting, freezing, processing, and packaging technique. It also comes from the process of breading, buttering, and marinating. A variety of recipes (i.e., spring roll shrimp, cocktail shrimp, shrimp kabab, shrimp burger, shrimp soup, crusted shrimp, coconut breaded shrimp, buffalo shrimp, oriental breaded shrimp, popcorn shrimp, potato shrimp, etc.) are prepared from shrimp. Description of some value-added products is given below.

13.1.1 Tempura and Torpedo Shrimp

Tempura and torpedo are two forms of breaded and battered shrimp. Frozen peeled-deveined tail-on IQF shrimp enclosed in a crumbly, crispy film. It's a very popular snack for parties and celebration. There are two types of torpedo shrimp, i.e., torpedo shrimp (yellow panko) and torpedo shrimp (white panko), that are commonly observed.

Product description:	Raw frozen peel-deveined tail-on battered/breaded, IQF shrimp
General appearance:	Straight, coated thoroughly except tail fan and half of last segment
Packing:	20 × 500 g or 10 × 800 g or others as per specification
Ingredients:	Shrimp (STTP treated) and pre-dust
	Pre-dust includes: Modified starch, salt, shell calcium, vegetable oil, vegetable fat, emulsifier, rice powder, baking powder, soybean protein, wheat flour, modified starch, starch (corn), food color, batter mix, seasoning, spice extract, yellow/white panko (breaded crumb), sugar, east, emulsifier, or others as per specification
Defect:	Foreign materials, broken tail, broken body, excess spice, etc.
Shelf life:	2 years at −18 °C or below temperature

[Note: The difference between torpedo and tempura shrimp is nothing but battered and breaded.]

13.1.2 Filo Shrimp

Product name:	Filo shrimp
Product description:	Raw, IQF tail-on shrimp wrapped with filo pastry
Ingredients:	Shrimp and filo pastry
	Filo pastry includes: wheat, salt, sugar, flour, starch, pepper, stabilizer, palm oil, enhancer, gluten, etc. as per specification
Packing:	500 g or 800 g inner box or others as per buyer requirements
Defect:	Foreign materials, broken tail, broken body, excess spice, etc.
Shelf life:	2 years at −18 °C or below temperature

13.1.3 Marinated Butterfly Shrimp (Figs. 13.1, 13.2, and 13.3)

Product name:	Marinated butterfly shrimp
Product description:	Raw, IQF, HLSO butterfly marinated shrimp
Ingredients:	Marinated shrimp
	Shrimp marinated with vegetables/herbs/garlic/onion or others as per buyer specification
Defect:	Foreign materials, broken tail, broken body, excess spice, etc.
Shelf life:	2 years at −18 °C or below temperature

Fig. 13.1 HLSO butterfly cut

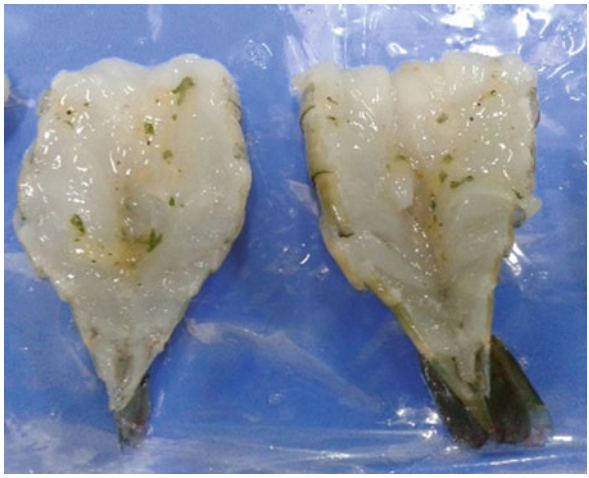


Fig. 13.2 Marinated with herbs

Fig. 13.3 Final product (IQF)

Table 13.1 Packing of shusi

Size	Length (cm)	Pcs/tray or pcs/bag	Tray/MC
2 L	07.6–8	30 pcs/tray	20 tray/MC
3 L	8.1–8.5		
4 L	08.6–9		
5 L	9.1–9.5		
6 L	9.6–10		

13.1.4 Shusi (Table 13.1, Figs. 13.4, 13.5, 13.6, and 13.7)

Product name:	Shusi
Product description:	Cooked peeled deveined tail on split frozen shrimp
Ingredients:	Shrimp and STTP/NP/salt
Shelf life:	2 years at −18 °C temperature
Defects:	Foreign materials, broken tail, broken body, excess spice, etc.

Except these a lot of variety of marinated and value-added and high-value products are available in market.

13.1.5 Value-Added Crab

Crab is another emerging potential resource of our seafood business. See the following details of value-added crab:

Forms of processing:	Crab, whole gutted, IQF Crab, whole, cooked, IQF Crab claws, cooked, IQF Breaded crab claws (Muslitos), etc.

(continued)

Fig. 13.4 Sushi in Styrofoam tray packing

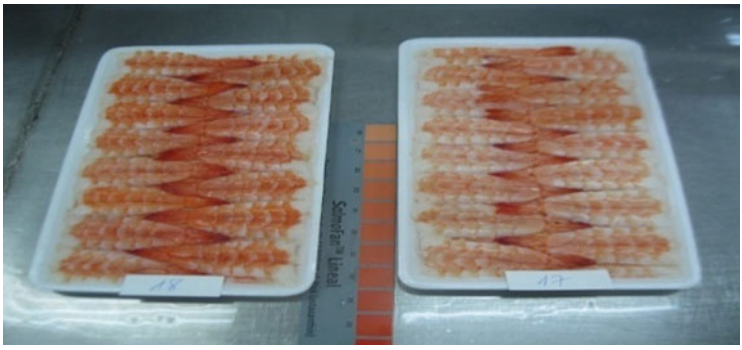


Fig. 13.5 Color measurement with SalmoFan

Fig. 13.6 Cutting process of shusi

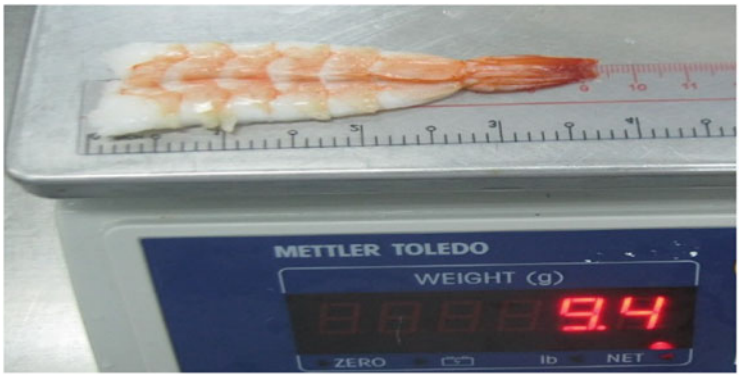


Fig. 13.7 Length and weight measurement

Size/grade:	6/10, 11/15, 16/20, 21/25, 26/30, 31/40 Pcs/kg
Packing:	1 kg/box, 10 kg/carton, 12 boxes/carton etc. as per requirements

Muslitos: Muslitos is a breaded crab claw with real pincers, a value-added product of crab

13.2 Value-Added Fish and Fish Products

Value-added frozen shrimp has great demand in export commodity. It's a nutritious and delicious item. Different forms of delicious items are made from these fishes. Fish frozen, fish pickles, fish curry, fish fillets, fish loins/fish steaks, fish fingers, breaded fillets, fish cooked, fish powder, fish soup, etc. are the forms of fish products. Fish is also good for surimi preparation and imitation products. Freezing, drying, smoking, and salting are the forms of fish processing. Some of our factories are doing business by exporting fish but not at a satisfactory level. Initiatives should be taken as soon as possible to develop this business for both freshwater and marine fishes. The following are the scope of fish exportation:

Available species:	Bola, Ayr, Rui, Catla, *Kalibaus,* Rani, Puti, Mola, Taki, Shol, Gozar, Koi, Singh, *Tilapia, Pangus, Tengra, Bele, Batashi, Gulsha, Gutum,* Baim, Mullet, Hilsa, Seabream, Milkfish, Silver Pomfret, Mackerel, Grouper (Reef Cod), Snapper (White/Red), Sea Bass (Barramundi/Coral/Vetki), etc.
Product type:	*Frozen whole* gut-less, head-on/headless clean, boneless or bone-in, skin on/off, sliced/steaks, *fillet, etc.*
Size of fillet:	*Fillet size depends on size, type and species of fish and buyer's requirements. The following are the examples of fillet size:* 25–30 g, 40–60 g, 60–80 g, 80–100 g, 100–120 g, 120–150 g, 100–200 g, 200–300 g, 300–400 g, 400–500 g, 500–700 g, 700–1000 g, 1000–1200 g, 1200–1500 g, 1500 g, or above

13.3 Other Value-Added Seafood

The following are the examples of other seafood:

• Baby squid:	Whole, cleaned, raw, IQF
• Baby octopus:	Whole, cleaned, raw, IQF
• Baby cuttlefish:	Whole, cleaned, raw, IQF
• Crayfish:	Whole/peeled, cooked, IQF
• Clams:	Whole, raw/cooked, IQF
• Lobster:	Popsicle, whole, raw/cooked, IQF
• Mussels:	Shell on/half shell/mussel meat cooked, IQF
• Queen scallops:	Half shell, roe on, raw, IQF
• Surimi scallops:	Imitation/breaded
• Squid tubes:	Cooked/blanched/raw, IQF
• Squid rings:	Blanched/raw/battered/pre-fried/IQF

13.4 Shrimp Byproducts

Shrimp is usually processed to obtain export-grade flesh. Besides, processing industries discharged a large volume of shrimp (head, shell, mussel, intestine, etc.) as waste products. Around 35–50% products are considered as waste materials in shrimp processing industries. The waste percentage depends on the type of product. It will be very good if we can use this waste as raw materials for other products. Normally, the byproducts are considered as waste and usually transported to landfill. Some are used in fishmeal production with low economic value. Nowadays, the trend is changed; the value of these byproducts has been realized. Byproducts of shrimp are valuable. It can be used as raw materials for valuable products like shrimp waste contains several bioactive compounds such as chitin, pigments, amino acids, and fatty acids astaxanthin flavor compound, calcium carbonate, lipid, protein, etc. These bioactive compounds have a wide range of applications including medical; therapies; cosmetics; paper, pulp, and textile industries; biotechnology; and food applications (Mao et al. 2017).

The major components of shrimp waste are:

- Protein
- Chitin
- Chitosan
- Glucosamine
- Carotenoprotein
- Minerals

Chitosan is a valuable product, which has many economically attractive applications in food, agriculture, biotechnology, cosmetics, medicine, and waste

treatment (Trung 2008). If we can incorporate it in our regular business, I think it will be a great achievement that creates more opportunity and employment. The government should take initiatives to establish such types of industries in Bangladesh to utilize the byproducts.

References

Mao X, Guo N, Sun J, Xue C (2017) Comprehensive utilization of shrimp waste based on biotechnological method. A review. J Clean Prod 143:814–823

Trung TS (2008) Report of the ministerial level project on combined biological method for improving the efficiency of chitin-chitosan production from shrimp processing waste. Food and Fertilizer Technology Centre

Recommendation and Conclusion

14

Abstract

Shrimp business in international market is very competitive. Scarcity of raw material, poor quality products, improper culture technology, lack of modern machinery facilities, competition with rival countries, fluctuation market price, fluctuation of currency, long time of shipment, etc. are the major problems in shrimp business around the world. Now, this is high time to take the necessary steps to overcome this situation. It should be mandatory that there is no defect that comes up in final products. It should be kept in mind that a single defect can spoil the whole product and make a negative impression on it. The chapter highlights the problems, solutions, and some recommendations for sustainable seafood business in future.

Keywords

Zero tolerance · Illegal practice · Business chain · Middlemen

The following recommendations may help to develop a sustainable business in shrimp processing industries.

- **Innovation of technology for sustainable shrimp business**
  The export market has huge demand of shrimp because of its boneless characteristics and unique taste. Scarcity of raw materials, higher operational cost, international and local market competition, etc. are the hindrances to sustainable shrimp business. Processing industries are going to declare themselves bankrupt because of unstable shrimp business. Shrimp farmers are also stopping shrimp production or switching to agriculture. New technologies should be adopted for increasing shrimp production. Besides *P. monodon* and *L. vannamei* technologies should be adopted for the production of harina,

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6_14

Fig. 14.1 Improper way (clump production)

chaka, cat tiger, or others species of shrimp. Intensification of shrimp production should be in sustainable way. Organic production is too much appreciated.

- **Zero tolerance of defects in final product**
  Defects that arise in final product are nothing but unconsciousness of the suppliers. The defects that are not accepted by the buyer can possibly be removed by increasing awareness. Hanging meat, vein, dropping/loose head, discoloration, improper grading, non-uniformity, soft shell, improper sealing, damaged master carton, etc. can be possibly removed by proper monitoring. Processing industries should adopt zero tolerance principle in final products.
- **Color separation**
  Color separation means production of shrimp at uniform color. It's not a serious problem but important for quality products. Uniform color of shrimp helps to look products very good. It should be a mandatory process for all shrimp processing industries. Mixed color shrimp makes a negative impression about the products although the product is of good quality. Color separation should be the mandatory requirement for all shrimp processing industries.
- **Removing of clumps**
  Clumping is not a big problem, but hammering on clump is a serious problem for IQF shrimp. Hammering breaks down the glazing of shrimp resulting in quality damage of the final product. A good arrangement of shrimp in the IQF belt can help to avoid clumping. Supplier should confirm that there is no clump shrimp present in final products. See the following pictures (Figs. 14.1, 14.2, 14.3, 14.4, and 14.5).
- **Illegal practice should be stopped**
  People involved in seafood businesses should be honest in their business. Receiving of raw materials containing metals and chemicals (i.e., water, jelly, potash alum, etc.) must be stopped strongly though these types of activities are very rare in practice. We must sure zero tolerance for these illegal activities. It would be better if processing industries collect raw materials directly from the cultured farm or the processing industries have their own cultured farm. It will reduce market price and wicked competition among the suppliers.

Fig. 14.2 Clump shrimp in final products

Fig. 14.3 Hammering on clumps to remove clumps

Fig. 14.4 Breakdown of glaze due to hammering

Fig. 14.5 A good practice, resulting no clumps and no hammering and no breakdown of clumps

Besides, excess additives, oversoaking, mixing of defect shrimp, mixing of lower grade shrimp, low quality packaging, etc. should be avoided strongly. Illegal practice may collapse seafood business. It must be assured during seafood production and will lead to sustainable seafood business. Some suppliers have already started to collect raw materials directly from cultured farm to avoid such type of activities.

- **Reduction of middlemen from business chain**
  It is necessary to avoid middleman from the business chain for sustainable seafood business. Engagement of middleman (commission agent, depot owner, broker, foria, etc.) in supply chain increases production cost. Shrimp farmers (getting lower price) as well as consumers (paying higher price) both are losers, but significant benefit goes to the middlemen of the supply chain. Reduction of selling price is very important for international seafood business competition. The following diagram explains the intervention of middlemen in supply chain and how intervention of middlemen can be stopped (Fig. 14.6).
- **Longtime stocking of raw materials should be stopped**
  Suppliers stock raw materials intentionally or unintentionally for higher price and off-season business or sometimes in an emergency. Quality of longtime stock products is not good because of thawing and reprocessing of shrimp. It should be mandatory that no one can stock raw materials in cold storage for a longer time. In case of emergency, stocking may be allowed for a short time. Longtime storage not only damages the quality of products but also makes the market unstable because of the scarcity of raw materials, market competition, and higher prices.
- **Make sure strong commitment in business dealings**
  Strong commitment is a prerequisite for any kind of business dealing. Overbooking should be avoided strictly. Wrong commitment, delay shipment, non-shipment, increment of price, etc. are not a good sign of quality business that makes the buyer confused and guided to leaving the country. Sometimes buyers have to pay a large amount of demurrage to their customers because of delay shipment or non-shipment that makes the buyer crazy. It's not only a problem for the buyers but also the same for the suppliers. Delay of payment, non-shipment is the problem of buyer also that makes the suppliers crazy. The percentage of such

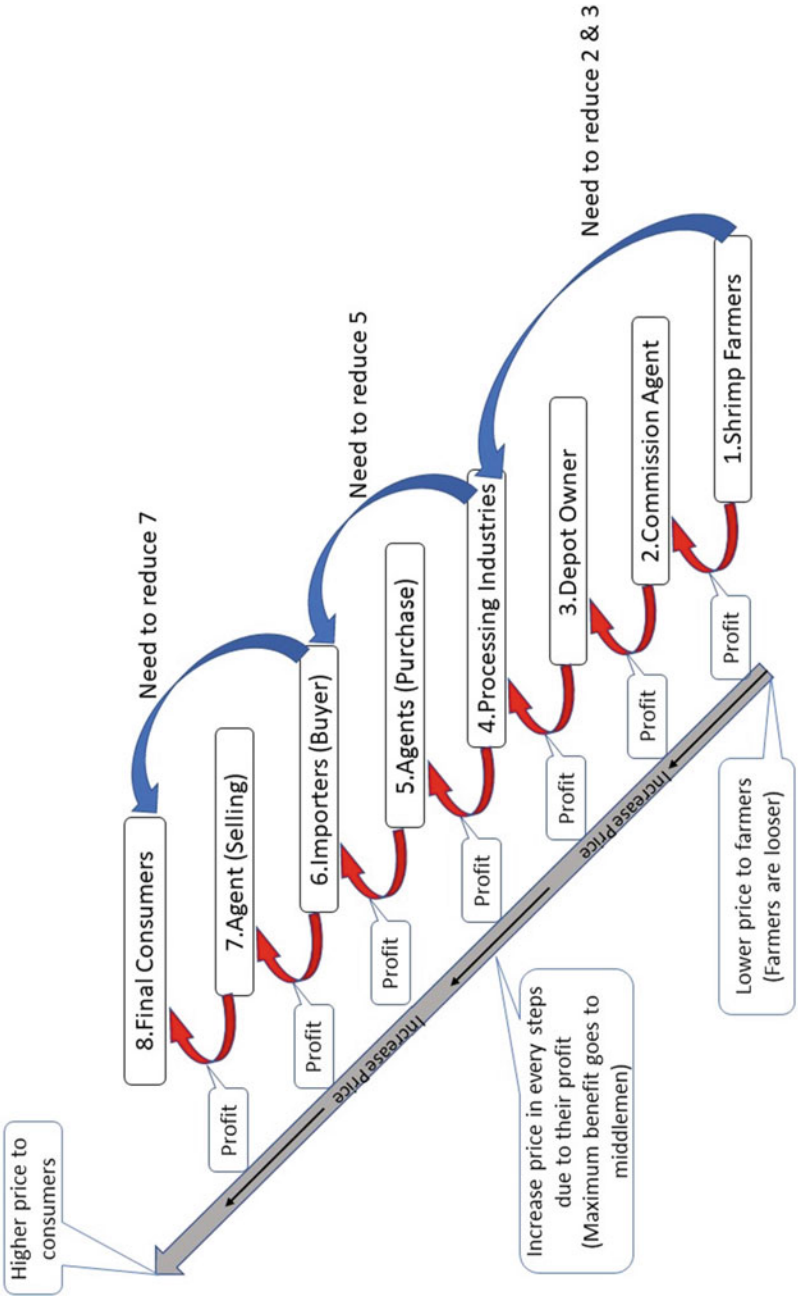


Fig. 14.6 Intervention of middlemen in supply chain

type of suppliers and buyers are very few; a maximum number are strict in their commitment and conduct their business smoothly. Everyone should co-operate with each other for sustainable and long-term business.

- **Diversifications of value-added products**
  Diversification of value-added products is creating new opportunity for shrimp business world. Initiatives should be taken for the preparation of value-added, marinated, and breaded products. Attractive packaging (Styrofoam packaging, box packaging, cane packaging, tray packaging) is another technique of value addition that may bring a positive result for the seafood business world.
- **Technology should be adapted for the utilization of byproducts**
  Technology should be adapted for the extraction of byproducts from shrimp processing waste (i.e., head, shell, mussel, intestine, etc.). Utilization of byproducts in meaningful may lead to a potential industry in shrimp processing countries. The following is the calculation of processing loss for black tiger shrimp (P. monodon) in processing industries.

Type of loss		Loss %
Head loss (HOSO to HLSO)	=	35%
Shell loss (HLSO to PND)	=	17%
Freezing loss	=	02%
Others	=	01%
Total loss	=	**55%**

[Note: Little bit plus or minus is considerable]

- **Processing industries should be well certified**
  Suppliers all over the world should be well certified like BAP, GMP, ASC, MSC, IFS, BSCI, BRC, HACCP, GMO, etc. Certificates are not just a document; it's a judgment of product quality and trust of customers. Steps should be taken as early as possible to make suppliers well certified. At least a minimum level of certification should be maintained for every supplier; otherwise, it will be difficult for shrimp processing industries to compete with other seafood-producing countries around the world. Well-certified suppliers are the first priority of buyers, and well-certified suppliers can charge high price for their quality products.
- **Seafood research institute should be established**
  Independent seafood research institute should be established for quality and variety development of exportable items. This type of research institute can help in developing new technology and variety of products, seafood monitoring, seafood processing, testing, quality assurance, business planning, market development, and training of stakeholders.
- **Need to protect wild stock of shrimp**
  The export market has a great demand for wild shrimp, but wild stock of shrimp is decreasing day by day. It's an alarming issue that characteristics of wild shrimp are also changing. Deviation came from its physiology, behavior, color, texture, and taste. It may cause hybridization, climate change, environmental impacts, or others that need to be investigated immediately. Variation of wild and farmed

Fig. 14.7 Wild shrimp (raw)

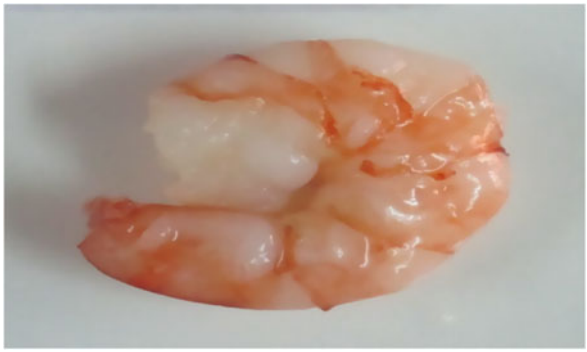


Fig. 14.8 Wild shrimp (cooked)

Fig. 14.9 Farmed shrimp (raw)

shrimp is also visible now. Color, texture, and taste are totally different in wild and farmed shrimp that may be affected negatively in the near future. See the following example (Figs. 14.7, 14.8, 14.9, and 14.10).

Finally, it can be concluded that the shrimp business around the world is a vital part of world food security as well as economy of the country. Everyone involved in this sector should be honest and strongly committed in their business deal. Personnel involved in this business should act in a win-win situation and must stop unfair

Fig. 14.10 Farmed shrimp (cooked)

competition. Shrimp production is going for intensification. Intensive culture of shrimp emerges different types of diseases and promotes uses of antibiotics and chemicals that are a main concern of health hazard. On the other hand, emphasis should be given on organic shrimp production wild stock preservation. Suppliers should maintain their promised quality in their final products. Quality product, traceability, on-time shipment, strong commitment, etc. are the prerequisites of sustainable business. If we can maintain this shrimp business in a sustainable way, then it can play a vital role in food safety and food security in near future. Concentration should be given on shrimp farmers; otherwise, they will stop shrimp production or switch to agriculture instead of shrimp production.

Appendix A: A Reference Copy of Letter of Credit (Terms and Condition)

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

Reference No.		12345
Planned ETD		Month/day/ year
40 A	Form of documentary credit	Irrevocable
31 D	Date and place of expiry	Port and Country name
32B	Currency code and amount	$ 300000,00
39 A	% Credit amount tolerance	Tolerance of 10 percent plus or minus in quantity and amount is acceptable.
39B	Maximum credit amount	Not exceeding
41 D	Available with	Any bank in (name of exporting country)
41 D	By	Negotiation
42 C	Drafts at	45 days after shipment date/sight
42 D	Drawee	Name of Buyer's bank
43 P	Partial shipments	Not allowed
43 T	Transshipment	Allowed
44 E	Port of loading/airport of departure	Any port in (name of exporting country)
44F	Port of discharge	(Name of importing country)
44C	Latest date of shipment	Month/day/ year
59	Beneficiary	ABCD Foods Ltd.
45 A	Description of goods	Art. No.: 33330 Black Tiger shrimps, HLSO-EZP, Raw, IQF, 75 percent net, size 13/15 FC, 10x750 g net weight and 10x1 kg gross weight, Brand: xx, 500 cartons, 5000 kg x 10,40 USD/kg for a total amount of 52000,00 USD
46 A	Documents required	3 original and 1 copies of signed commercial invoice. Invoice must mention purchase order number and contact no. And full address 3 original and 1 copies of packing list Full set of original on board bill of lading indicating the name of the carrier made out to order of negotiating bank in Bangladesh and endorsed to the order of LC opening bank, marked freight prepaid and showing notify. 3 copies certificate of origin GSP form a issued by export authorities of Bangladesh. Certificate of origin GSP form a must mention Latin name. BL is to evidence stored in refrigerated container set at -18°c temperature 1 original and 1 copy of health certificate for issued by dept. Of fisheries of Bangladesh stating name and address of the packer and their factory approval number and certified merchandise are fit for human consumption Pre-shipment survey report evidencing external condition of cargo temperature, temperature of the cargo and temperature of the container prior to loading, name of the vessel, number of cartons, etc. Beneficiaries certificate with clearly mentioning sample identification Following reports are sent by email to respective buyers: -packer qc report or inspection report showing clearly readable picture of master carton and inner bag/box with production date, expiry date and lot number etc. Page No. 1

		certificates of analysis issue by independent lab (iso-17025 accredited or equivalent) or by local competent authorities: Test results for heavy metals (arsenic, cadmium, lead and mercury), microbiological result (minimum: total plate count, salmonella, Vibrio's), antibiotics test result. Test results demonstrating negative for residues of Chloramphenicol, nitrofurans (AOZ, AMOZ, SEM, AHD), malachite green, Leuco-malachite green, tetracycline, oxytetracycline, Chlortetracycline and crystal violet. A full set of packaging and labelling checklist Email directly to buyer within 2 days of the shipment date with name of port of loading, name of the freight carrier, container reference, seal no, estimated time of arrival etc.
47A	Special instruction	Tolerance of 10 percent plus or minus in quantity and amount is acceptable. Rejection clause: Payment is subject to inspection and approval of the goods by the port of health authority. The applicant will give notice of approval or rejection to the issuing bank not later than 45 (in case of 45 days LC clause) days from bill of lading date. If the goods are rejected issuing bank is not obliged to pay as per the condition of LC and applicant will arrange to ship back the goods at the cost of beneficiary. If health clearance by the port of health authority has not passed at maturity, payment will be effected as soon as approval of the health authority has been obtained
48	Period for presentation	Documents to be presented 25 days after transport document
50	Applicant	Name and address of buyer Name and address of buyer bank, country name
57A	Advise through bank	Swift code: xxxxxxxxxxx
59	Beneficiary	ABCD Foods Ltd.
71B	Own charges	LC opening bank charges to be borne by applicant Advising bank charges to be borne by beneficiary
		Page No. 2

Note: LC clause may change through the discussion of both parties.

Appendix B: Size and Weight Table

1. Product description: BT, IQF, 20% Glaze, RC, 10 × 1 kg

Size/ grade	Minimum weight of Shrimp (g)	Maximum weight of Shrimp (g)	Minimum Pcs/Bag	Maximum Pcs/Bag
8/12	38	57	14	21
13/15	30	35	23	26
16/20	23	28	28	35
21/25	18	22	37	44
26/30	15	17	46	53
31/40	11	15	55	70
41/50	9	11	72	88
51/60	8	9	90	106
61/70	6	7	107	123
71/90	5	6	125	159

2. Product description: BT, IQF, 20% Glaze, FC, 10 × 1 kg

Size/ grade	Minimum weight of Shrimp (g)	Maximum weight of Shrimp (g)	Minimum Pcs/Bag	Maximum Pcs/Bag
8/12	30	45	18	26
13/15	24	28	29	33
16/20	18	23	35	44
21/25	15	17	46	55
26/30	12	14	57	66
31/40	9	12	68	88
41/50	7	9	90	110
51/60	6	7	112	132
61/70	5	6	134	154
71/90	4	5	156	198

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

3. Product description: BT, Block, 20% Glaze, RC, 6 × 1.8 kg

Size/ grade	Minimum weight/ Shrimp	Maximum weight/ Shrimp	Minimum Pcs/Bag	Maximum Pcs/Bag
8/12	38	57	25	38
13/15	30	35	41	48
16/20	23	28	51	63
21/25	18	22	67	79
26/30	15	17	82	95
31/40	11	15	98	127
41/50	9	11	130	159
51/60	8	9	162	190
61/70	6	7	193	222
71/90	5	6	225	285

4. Product description: BT, Semi-IQF, 20% Glaze, FC, 10 × 1 kg

Size/ grade	Minimum weight of Shrimp	Maximum weight of Shrimp	Minimum Pcs/Bag	Maximum Pcs/Bag
8/12	67	100	8	12
13/15	53	62	13	15
16/20	40	50	16	20
21/25	32	38	21	25
26/30	27	31	26	30
31/40	20	26	31	40
41/50	16	20	41	50
51/60	13	16	51	60
61/70	11	13	61	70
71/90	9	11	71	90

Appendix C: A Model Template of Production Supervision Report/On-line Supervision Report

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

General Information					
Reference No./PO No.			Brand		
Name of Supplier			Packing		
Name of Importer			Produced Quantity		
Lot No./Batch No.			Ordered Quantity		
Date of Supervision			Hygienic Standard		
Product Analysis					
Parameters	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
Product Description					
Size and Count					
Glaze (%)					
Frozen Weight (g)					
Deglazed Weight (g)					
Thawed/Net Weight (g)					
Pcs per Bag/Box					
Frozen count/*lb*					
Deglaze count/*lb*					
Weight of 10% Largest (g)					
Weight of 10% Smallest (g)					
Uniformity Ratio					
General Appearance					
Freshness					
Texture					
Odor/Smell					
Cooked Test					
Defects					
Back Broken					
Black Spot					
Broken Pcs					
Clumping					
Deep Cut					
Dehydration					
Decomposition					
Discoloration					
Foreign Materials					
Hanging Meat					
Improper Peeling					
Loose/Dropping Head					
Odor					
Soft Shell					
Tail Broken					
Vein					
Other (s)					

(CONTINUED)			
Raw materials Information			
Receiving Date and Time		Mode of Transport	
Traceability Tag		Icing Ratio	
Traceability Documents		Traceability Code	
Grading, Peeling, Deveining			
Grading Method		Grading Defects	
Peeling Method		Peeling Defects	
Deveining Method		Deveining Defects	
Additives Information			
Soaking Method		Additive %	
Starting Time		Salt %	
Ending Time		Gain %	
Name of Additive		Remarks	
Origin of Additive			
Temperature Record (°c)			
Ante Room		Soaking Water	
Chill Room		Freezing	
Raw Material		Hardening	
Chill Water		Storage	
Laboratory Analysis			
Chemical		Dye	
Heavy Metal		Microbiological	
Packaging Information			
Parameters	**Inner Bag/Box**	**Master Carton (MC)**	
Dimension (mm)			
Sealing			
Labeling			
Color Specification			
Damaged			
Metal Detector	☐ Active	☐ Inactive	
Factory Personnel		Buyer Personnel	
Designation		Designation	
Signature & Stamp		**Signature & Stamp**	

Appendix D: Pre-shipment Inspection Report/Final Inspection Report

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

General Information						
Lot No./Batch No.			Reference No./PO No.			
Supplier Name & Address			Importer Name & Address			
Contact Person			Contact Person			
Contact No. & Email			Contact No. & Email			
Ordered Quantity			Inspected Quantity			
Date of Inspection			Sampling Unit			
Arrival Time			Departure Time			
Findings of Inspection						
Parameters	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Sample-6
Product Description						
Brand						
Production Date						
Best Before Date						
Packing (kg)						
Art. No.						
Size and Count						
Weight Measurement						
Gross Weight (g)						
Deglazed Weight (g)						
Net/Thawed weight (g)						
Glaze (%)						
Pcs Count						
Total Pcs per Bag/Box						
Frozen Count (Pcs/*lb*.)						
Deglaze Count (Pcs/454g)						
Deglaze Count (Pcs/363g)						
Uniformity						
Weight of 10% Largest (g)						
Weight of 10% Smallest (g)						
Uniformity Ratio						
Organoleptic Observation						
General Appearance						
Freshness						
Texture						
Smell						
Cooked Condition						
Smell/Odor						
Texture						
Color						

Lab Findings			
Government/Third Party Testing Lab		**Suppliers Own Lab**	
Chemical		Chemical	
Heavy Metal		Heavy Metal	
Dye		Dye	
Microbiological		Microbiological	
Sampling Standard		Sampling Standard	

(CONTINUED)						
Defects						
Back broken						
Black spot on meat						
Black spot on shell						
Broken pcs						
Clumping						
Deep cut						
Dehydration						
Discoloration						
Foreign material						
Freeze burn						
Hanging meat						
Discoloration						
Improper peeling						
Dropping/loose head						
Odor						
Shell broken						
Soft Shell						
Tail Broken						
Vein						
Other (s)						

Findings of Packaging		
Parameters	**Inner Bag/Box**	**Master Carton (MC)**
Dimension		
Thickness		
Color		
Labeling		
Sealing		
Wax Coating		
Found Damaged Unit		
Packaging as per EU Law		

Others			
Hygienic Standard		Cold Storage Temperature (^{O}C)	
Cleanliness of factory		Product Temperature (^{O}C)	
Calibration of equipment		Metal Detection	
Product Conformity		Rejection	
Remarks			
Factory Personnel's Name Signature & Stamp		Inspector's Name Signature & Stamp	

Appendix E: A Model Template of Packaging and Labeling Checklist

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

PACKAGING AND LABELING CHECKLIST (MC)			
Lot No./Batch No.		Reference No./PO No.	
Supplier Name & Address		Importer Name & Address	
Contact No. & Email		Contact No. & Email	
Date of Inspection		Name of Inspectors	

Checklist for Master Carton (MC)		
Parameters	**Yes**	**No**
Article/Lot/Reference No.		
Name of Manufacturer		
Factory Approval No.		
Product Name		
Scientific Name		
Origin		
Product Description		
Brand		
Logo		
Master Carton with Sticker		
Pre-Printed Master Carton		
Size/Grade		
Count		
Frozen Instruction		
Gross Weight		
Net Weight		
Packing		
Aquaculture/Marine Catch		
Production date		
Best before date		
Instruction		
Do not Refreeze after Defrosting		
Barcode Scanner Ok?		
Barcode Number		
Color Specification		
Name of Importer		
Certification Marks, BRC/MSC/ASC/BAP/GMP/…….		
Condition of Master Carton (MC)		
Excellent/Good/Normal/Poor		
Carton Dimensions		
Carton Dimensions Suitable for Packing		
Strong Enough to Protect Product		
Fully Closed Top and Bottom		
Present Transparent Tape/Non-transparent Tape		
Straps on Master Carton		
Languages	English-German-French –Dutch-Swedish-Finish	

PACKAGING AND LABELING CHECKLIST (INNER BAG/BOX)		
Parameters	**Yes**	**No**
Article/Lot/Reference No.		
Name of Manufacturer		
Factory Approval No.		
Product Name		
Scientific Name		
Origin		
Product Description		
Brand		
Logo		
Inner Box with Sticker		
Inner Bag with Rider		
Pre-Printed Inner Box/Bag		
Size/Grade		
Count		
Frozen Instruction		
Gross Weight		
Net Weight		
Packing		
Aquaculture/Marine Catch		
Production Date		
Best before Date		
Special Instruction		
Frozen Instruction		
Barcode Scanner Ok?		
Barcode No.		
Color Specification		
Name of Importer		
Certification Marks-MSC/ASC/BAP/GMP/……..		
Condition of Inner Box/Bag		
Excellent/Good/Normal/Poor		
Dimensions of Inner Bag/Box		
Dimensions Suitable for Packing		
Strong Enough to Protect Product		
Present Top and Bottom Part (HOSO)		
Present Window		
Shrink Wrapped		
Damaged Bag/Box present		
Languages		

Appendix F: A Model Template of Loading Report

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

LOADING REPORT

General Information

Brand	ABCD	
Packer	ABCD SEA FOOD	
Product	BT PND IQF, BT HLSO BLOCK, BT HLSO EZP IQF	
Packing	6 X 1.8 KG, 80%, 70% NET, 10 X 1 KG 75% NET	
Loading start at port	8.00 PM	
Loading finish at Port	9.00 PM	
PO No.	8600	
LOADING INFORMATION		
B/L No.	NYKSDACS02555500	
On Board Date	December 15, 2019	
Container No.	NYKU7922200	
Seal No.	BD1000033	
Invoice No.	BSFL/32/2019	
Invoice Value	$226,600.00	
Shipping Line	NYK	
Feeder Vessel	KOTA HALUS	VOY - 0399E
Date of Stuffing	December 6, 2021	
Departure Bangladesh	December 19, 2021	
Mother Vessel	BASLE EXPRESS	VOY - 017W57
Departure Singapore	December 29, 2021	
ETA Antwerp	January 20, 2022	

LOADING PLAN

Product Description	BT HLSO EZP IQF	BT HLSO BLOCK	BT PND IQF	BT HLSO BLOCK	Total
Brand, NW, Count	AB-75% FC	CD-80% RC	AB-75% FC	AB-70% RC	
Line\Grade	8/12	13/15	16/20	31/40	
1	82	0	0	0	82
2	82	0	0	0	82
3	81	0	0	0	81
4	81	0	0	0	81
5	0	0	74	0	74
6	0	0	74	0	74
7	0	0	74	0	74
8	0	0	74	0	74
9	0	0	0	69	69
10	0	0	0	66	66
11	0	0	0	66	66
12	0	66	0	0	66
13	0	61	0	0	61
Total	**326**	**127**	**296**	**201**	**950**

Appendix G: A Sample of Purchase Order (PO)

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

DATE:

PURCHASE ORDER (PO)

REFERENCE NO.: 002
ISSUE DATE: DD/MM/YYYY
DELIVERY DATE: DD/MM/YYYY

NAME OF PACKER: ABCD FOODS LTD. ADDRESS:	NAME OF BUYER: ADDRESS:

INSURANCE COVERED BY THE BUYER
FREIGHT PREPAID
TERMS OF PAYMENT: 100% PAYMENT BY LC AT 90 DAYS AFTER SHIPMENT
PORT OF DESTINATION :

Code No.	Product Description	Cartons	Total volume (kg)	Unit price (USD)	Total value (USD)
12345	BT, HLSO, Raw, 80% Net weight, IQF product, STPP Treated Size/Count: 13/15 RC Pcs/Bag: 23-26 Brand: xx Packing: 10x1 kg	500	5000	10.00	50000.00
23456	BT, HLSO, Raw, 80% Net weight Block product, STPP Treated Size/Count: 16/20 RC Pcs/Box: 51-63 Brand: xx Packing: 6x1.8 kg	700	8640	9.00	68040.00
34567	BT, HLSO, Raw, 80% Net weight, Semi-IQF product, STPP Treated Size/Count: 21/25 RC Pcs/Box: 21-25 Brand: xx Packing: 10x1 kg	600	6000	8.50	51000.00
	TOTAL				169040.00

IN WORDS: A TOTAL OF ONE HUNDRED SIXTY NINE THOUSAND FOURTY ONLT (VALUE IN USD)

SPECIAL INSTRUCTION:

SHRIMP SHOULD BE IN FRESH, AND GOOD UNIFORMITY.
FINAL PRODUCT MUST BE IN EXCELLENT QUALITY.
DECOMPOSED & REDDISH COLOR SHRIMPS ARE NOT ACCEPTED.

AUTHORISED SIGNATURE

HEAD OFFICE:
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

SALES OFFICE:
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

PURCHASE OFFICE :
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

Appendix H: A Sample of Packing List

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

(SAMPLE COPY OF PACKING LIST)

ABCD FOODS LIMITED

EXPORTER QUALITY FROZEN SHRIMPS

ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED

PACKING LIST

INVOICE NO.	: ABCD/12/2017/001	ABCD FOODS LTD. :
BUYER'S NAME & ADDRESS	: XX SEA FOODS (ADDRESS)	ADDRESS :
NAME OF MOTHER VESSEL	:	
NAME OF FEDDER VESSEL	:	
PORT OF LOADING	:	
PORT OF DESTINATION	:	
B/L NO.	:	
CONTAINER NO.	:	
SEAL NO.	:	

DESCRIPTN OF GOODS :

LOT NO. 1234 SS BRAND, BLACK TIGER SHRIMPS, HLSO, RAW, BLOCK FROZEN, STPP TREATED, 6 X 1.8 KG NET WEIGHT, 21/25 REAL COUNT,100 MASTER CARTONS, 600 INNER BOXES AT 19.08 USD/BLOCK FOR A TOTAL AMOUNT OF 11,448.00 USD.

LOT NO.2345 SS BRAND, BLACK TIGER SHRIMPS, HLSO, RAW, BLOCK FROZEN, STPP TREATED, 6 X 1.8 KG NET WEIGHT, 26/30 REAL COUNT,200 MASTER CARTONS, 1200 INNER BOXES AT 18.18 USD/BLOCK FOR A TOTAL AMOUNT OF 21,816.00 USD.

LOT NO.3456 SS BRAND, BLACK TIGER SHRIMPS, HLSO, RAW, BLOCK FROZEN, STPP TREATED, 6 X 1.8 KG NET WEIGHT, 31/40 REAL COUNT,100 MASTER CARTONS, 600 INNER BOXES AT 16.74 USD/BLOCK FOR A TOTAL AMOUNT OF 10,044.00 USD.

LOT NO. 4567 SS BRAND, BLACK TIGER SHRIMPS, PDTO, RAW, IQF, STPP TREATED, 10 X 800 GR NET /DEGLAZED WEIGHT, 16/20 FROZEN COUNT,100 MASTER CARTONS, NET WEIGHT : 800.00 KGS, 1000 BAGS AT 9.20 USD/BAG FOR A TOTAL AMOUNT OF 9,200.00 USD.

LOT NO. 5678 SS BRAND, BLACK TIGER SHRIMPS, PD, RAW, IQF, STPP TREATED, 10 X 800 GR NET /DEGLAZED WEIGHT, 8/12 FROZEN COUNT,100 MASTER CARTONS, NET WEIGHT : 800.00 KGS, 1000 BAGS AT 14.60 USD/BAG FOR A TOTAL AMOUNT OF 14,600.00 USD.

LOT NO.6789 SS BRAND, BLACK TIGER SHRIMPS, HEAD ON, SHELL ON,RAW, SEMI IQF, 10 X 800 GR NET WEIGHT, 8/12 FROZEN COUNT,50 MASTER CARTONS, NET WEIGHT : 400.00 KGS, 500 BOXES AT 12.70 USD/BOX FOR A TOTAL AMOUNT OF 6,350.00 USD.

LOT NO. 7890 SS BRAND, BLACK TIGER SHRIMPS, HEAD ON, SHELL ON,RAW, SEMI IQF, 10 X 800 GR NET WEIGHT, 16/20 FROZEN COUNT, 100 MASTER CARTONS, NET WEIGHT : 800.00 KGS, 1000 BOXES AT 8.30 USD/BOX FOR A TOTAL AMOUNT OF 8,300.00 USD.

LOT NO. 8901 SS BRAND, BLACK TIGER SHRIMPS, HEAD ON, SHELL ON,RAW, SEMI IQF, 10 X 750 GR NET WEIGHT, 16/20 FROZEN COUNT, 200 MASTER CARTONS, NET WEIGHT : 1500.00 KGS, 2000 BOXES AT 7.40 USD/BOX FOR A TOTAL AMOUNT OF 14,800.00 USD.

COMMODITY	SIZE/GRADE	QUANTITY			TOTAL GROSS WEIGHT IN KGS.
		IN MC.	IN KGS.	IN BOX/BAG.	
BT HLSO BF.	21/25	100 MC.	1,080.00 KGS.	600 BOXES	11,250.00 KGS.
	26/30	200 MC.	2,160.00 KGS.	1200 BOXES	
	31/40	100 MC.	1,080.00 KGS.	600 BOXES	
BT PDTO IQF	16/20	100 MC.	800.00 KGS.	1000 BAGS	
BT PD IQF	8/12	100 MC.	800.00 KGS.	1000 BAGS	
BT HOSO S. IQF	8/12	50 MC.	400.00 KGS.	500 BOXES	
	16/20	100 MC.	800.00 KGS.	1000 BOXES	
BT HOSO S. IQF	16/20	200 MC.	1,500.00 KGS.	2000 BOXES	
	TOTAL	950 MC.	8,620.00 KGS.		11,250.00 KGS.

AUTHORISED SIGNATURE

(SAMPLE COPY OF PACKING LIST)

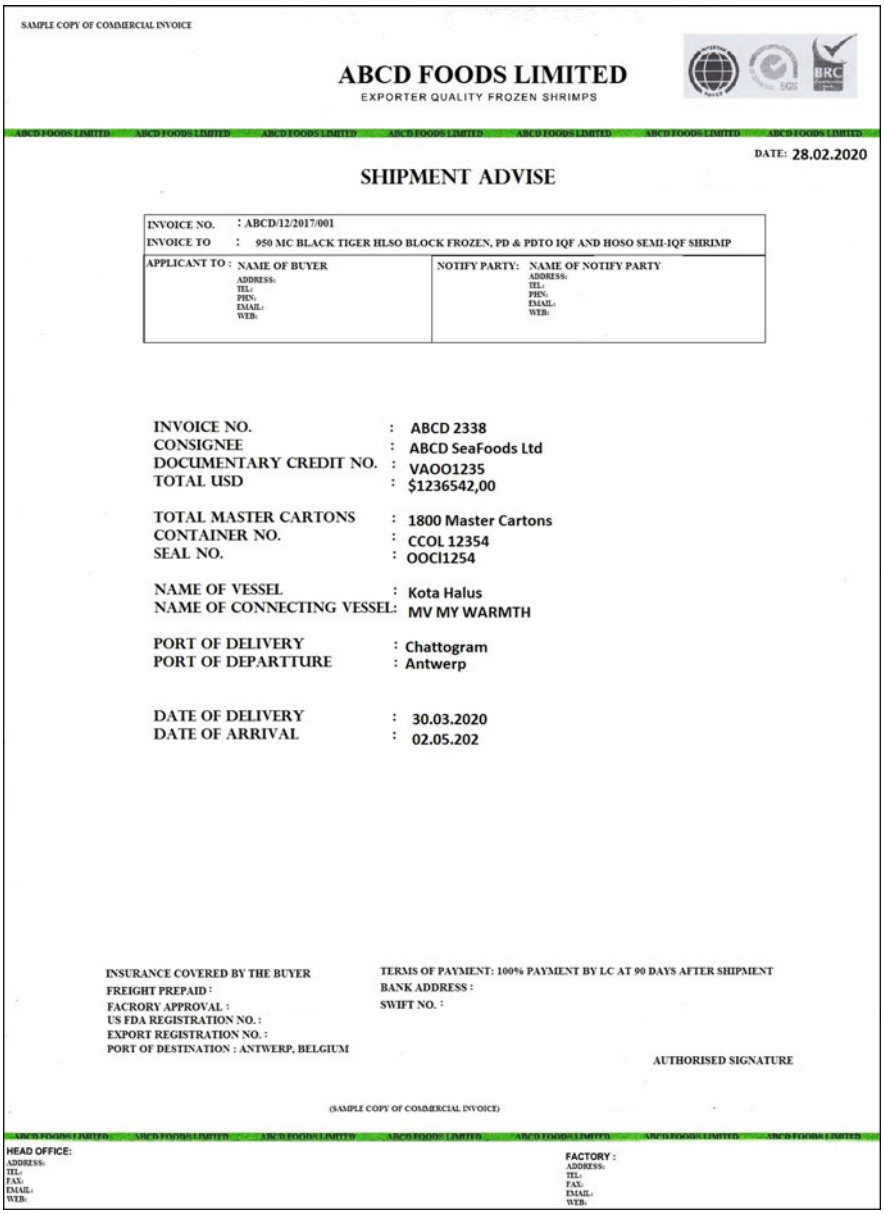
ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED

HEAD OFFICE:
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

FACTORY :
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

Appendix I: A Sample of Shipment Advise

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6



SAMPLE COPY OF COMMERCIAL INVOICE

ABCD FOODS LIMITED

EXPORTER QUALITY FROZEN SHRIMPS

ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED

DATE: 28.02.2020

SHIPMENT ADVISE

INVOICE NO.	: ABCD/12/2017/001
INVOICE TO	: 950 MC BLACK TIGER HLSO BLOCK FROZEN, PD & PDTO IQF AND HOSO SEMI-IQF SHRIMP

APPLICANT TO :	NOTIFY PARTY:
NAME OF BUYER ADDRESS: TEL: PHN: EMAIL: WEB:	NAME OF NOTIFY PARTY ADDRESS: TEL: PHN: EMAIL: WEB:

INVOICE NO.	:	ABCD 2338
CONSIGNEE	:	ABCD SeaFoods Ltd
DOCUMENTARY CREDIT NO.	:	VAOO1235
TOTAL USD	:	$1236542,00
TOTAL MASTER CARTONS	:	1800 Master Cartons
CONTAINER NO.	:	CCOL 12354
SEAL NO.	:	OOCI1254
NAME OF VESSEL	:	Kota Halus
NAME OF CONNECTING VESSEL:		MV MY WARMTH
PORT OF DELIVERY	:	Chattogram
PORT OF DEPARTTURE	:	Antwerp
DATE OF DELIVERY	:	30.03.2020
DATE OF ARRIVAL	:	02.05.202

INSURANCE COVERED BY THE BUYER
FREIGHT PREPAID :
FACRORY APPROVAL :
US FDA REGISTRATION NO. :
EXPORT REGISTRATION NO. :
PORT OF DESTINATION : ANTWERP, BELGIUM

TERMS OF PAYMENT: 100% PAYMENT BY LC AT 90 DAYS AFTER SHIPMENT
BANK ADDRESS :
SWIFT NO. :

AUTHORISED SIGNATURE

(SAMPLE COPY OF COMMERCIAL INVOICE)

ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED

HEAD OFFICE:
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

FACTORY :
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

Appendix J: A Sample of Technical Specification

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

TECHNICAL SHEET				
General Information				
Product Description	**Black Tiger, HLSO, Raw, Block Frozen, 80% Net Weight, Real Count**			
Article Code	ABCD123	Product Name	Black Tiger Shrimp	
Size/Grade	8/12	Scientific Name	*Penaeus monodon*	
Block/IQF/Semi-IQF	Block	Packing	6 x 1.8 kg	
Brand	ABCD	Raw/blanched/frozen/cooked	Raw	
Fishery/Aquaculture	Farmed Raised	Treated/Non-treated	STPP Treated	
Glaze	20%	Frozen Weight	1800 g	
FAO/Country	-	Net Weight	1440 g	
Origin/Product of	-	Ingredients	Shrimp, Water, Salt	
Intrastat code	xxxxxxx	Stabilisers	E450, E451, E452	
Allergen information		**Microbiological Parameters**		
Cereals (gluten)	Absent	Result (colony-forming unit (cfu)/g		
Crustaceans	Present	Parameters	Present	Limit
Egg	Absent	Total aerobic bacteria	< 100,000	< 1,000,000
Fish	Absent	*E. coli*	< 10	< 100
Peanuts	Absent	Enterobacteriaceae	< 100	< 1,000
Soybeans	Absent	*Staphylococcus aureus*	< 100	< 1,000
Molluscs	Absent	Total coliform	<100	< 1,000
Milk (lactose)	Absent	*Salmonella spp.*	absent /25g	absent /25g
Nuts	Absent	*Listeria monocytogenes*	absent /25g	absent /25g
Celery	Absent	*Vibrio cholerae*	absent /25g	absent /25g
Mustard	Absent	Yeasts	< 100	1,000
Sesame seeds	Absent	Moulds	<100	1,000
Nutritional value (per 100 g)		**Hard metals (Acceptance limit)**		
Energy	73 kcal/310 kJ	Lead (Pb)	0.5 mg/kg	
Fat	0,8 g	Mercury (Hg)	0.5 mg/kg	
Of which saturated	0,1 g	Cadmium (Cd)	0.5 mg/kg	
Carbohydrates	0 g	**Organoleptic Characteristics**		
Of which sugars	0 g	Smell	Fresh/Typical	
Fibers	0 g	Taste	Fresh/Typical	
Protein	16,5 g	Texture	Firm/Typical	
Salt	1,5 g	Color	Natural/Typical	
Conservation & Shelf life		**Packaging & Labeling**	**MC**	**IC**
Refrigerator	24 hours	Dimension (mm)	270x190x60	390x275x185
freezer at -6° C	1 week	E.A.N. Code	xxx6400004	xxxx6400060
freezer at -12° C	1 month	Unit	1 MC	6 IC/MC
freezer at -18° C	24 months	Label specifications	Approved by the buyer	

Appendix K: A Sample of Stock Intake

STOCK INTAKE

Delivery Date	:	16/03/2021
Reference No.	:	1230
Shipment Date	:	30/03/2021
Suppliers Name		ABCD Fish Ltd.
ETD Mongla	:	03/5/2021
ETA Antwerp	:	02/05/2021
Container No.	:	STLU 1211320

UFISH

Sl. No.	Art. No.	Product Description	Brand	Expiry Date	Packing	Purchase Quantity		Shipped Quantity	
						Cartons	kg	Cartons	kg
1	2030	BT, HLSO-BLOCK R, 8/12 RC, 80%	AB	28-03-20	6x1.8kg	100	1080	95	1026
2	2040	BT, HLSO-BLOCK R, 13/15 RC, 80%	AB	28-03-20	6x1.8kg	100	1080	100	1080
10	4050	BT, PD, R, 16/20 FC, IQF 20%,	CD	25-05-20	10x1kg	100	1000	80	800
11	4060	BT, PD, R, 21/25 FC, IQF 20%,	CD	25-05-20	10x1kg	100	1000	90	900
12	4070	BT, PD, R, 26/30 FC, IQF 25%,	EF	30-05-18	10x1kg	400	4000	430	4300
13	4051	BT, PD, R, 16/20 FC, IQF 25%,	EF	30-05-18	10x1kg	100	1000	102	1020
14	4091	BT, PD, R, 41/50 FC, IQF 25%,	EF	30-05-18	10x1kg	100	1000	113	1130
TOTAL						**1000**	**10160**	**1010**	**10256**

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

Appendix L: Commercial Invoice

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6

SAMPLE COPY OF COMMERCIAL INVOICE

ABCD FOODS LIMITED

EXPORTER QUALITY FROZEN SHRIMPS

ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED

DATE:

COMMERCIAL INVOICE

INVOICE NO. : ABCD/12/2017/001

INVOICE TO : 950 MC BLACK TIGER HLSO BLOCK FROZEN, PD & PDTO IQF AND HOSO SEMI-IQF SHRIMP

APPLICANT TO : NAME OF BUYER
ADDRESS:
TEL:
PHN:
EMAIL:
WEB:

NOTIFY PARTY: NAME OF NOTIFY PARTY
ADDRESS:
TEL:
PHN:
EMAIL:
WEB:

DESCRIPTION OF GOODS:

SHIPMENT TERMS : CFR ANTWERP INCOTERMS 2017 BLACK TIGER SHRIMP AS PER PURCHASE ORDER 0002

LOT NO. 1234 SSBRAND, BLACK TIGER SHRIMPS, HLSO, RAW, BLOCK FROZEN, STPP TREATED, 6 X 1.8 KG NET WEIGHT, 21/25 REAL COUNT,100 MASTER CARTONS, 600 INNER BOXES AT 19.08 USD/BLOCK FOR A TOTAL AMOUNT OF 11,448.00 USD.

LOT NO.2345 SS BRAND, BLACK TIGER SHRIMPS, HLSO, RAW, BLOCK FROZEN, STPP TREATED, 6 X 1.8 KG NET WEIGHT, 26/30 REAL COUNT,200 MASTER CARTONS, 1200 INNER BOXES AT 18.18 USD/BLOCK FOR A TOTAL AMOUNT OF 21,816.00 USD.

LOT NO.3456 SS BRAND, BLACK TIGER SHRIMPS, HLSO, RAW, BLOCK FROZEN, STPP TREATED, 6 X 1.8 KG NET WEIGHT, 31/40 REAL COUNT,100 MASTER CARTONS, 600 INNER BOXES AT 16.74 USD/BLOCK FOR A TOTAL AMOUNT OF 10,044.00 USD.

LOT NO. 4567 SS BRAND, BLACK TIGER SHRIMPS, PDTO, RAW, IQF, STPP TREATED, 10 X 800 GR NET /DEGLAZED WEIGHT, 16/20 FROZEN COUNT,100 MASTER CARTONS, NET WEIGHT : 800.00 KGS, 1000 BAGS AT 9.20 USD/BAG FOR A TOTAL AMOUNT OF 9,200.00 USD.

LOT NO. 5678 SS BRAND, BLACK TIGER SHRIMPS, PD, RAW, IQF, STPP TREATED, 10 X 800 GR NET /DEGLAZED WEIGHT, 8/12 FROZEN COUNT,100 MASTER CARTONS, NET WEIGHT : 800.00 KGS, 1000 BAGS AT 14.60 USD/BAG FOR A TOTAL AMOUNT OF 14,600.00 USD.

LOT NO.6789 SS BRAND, BLACK TIGER SHRIMPS, HEAD ON, SHELL ON,RAW, SEMI IQF, 10 X 800 GR NET WEIGHT, 8/12 FROZEN COUNT,50 MASTER CARTONS, NET WEIGHT : 400.00 KGS, 500 BOXES AT 12.70 USD/BOX FOR A TOTAL AMOUNT OF 6,350.00 USD.

LOT NO. 7890 SSBRAND, BLACK TIGER SHRIMPS, HEAD ON, SHELL ON,RAW, SEMI IQF, 10 X 800 GR NET WEIGHT, 16/20 FROZEN COUNT, 100 MASTER CARTONS, NET WEIGHT : 800.00 KGS, 1000 BOXES AT 8.30 USD/BOX FOR A TOTAL AMOUNT OF 8,300.00 USD.

LOT NO. 8901 SS BRAND, BLACK TIGER SHRIMPS, HEAD ON, SHELL ON,RAW, SEMI IQF, 10 X 750 GR NET WEIGHT, 16/20 FROZEN COUNT, 200 MASTER CARTONS, NET WEIGHT : 1500.00 KGS, 2000 BOXES AT 7.40 USD/BOX FOR A TOTAL AMOUNT OF 14,800.00 USD.

COMMODITY	SIZE	QUANTITY			PRICE CFR USD.	TOTAL VALUE IN US DOLLAR.
		IN MC.	IN KGS.	IN BOX/BAG.		
BT HLSO BLOCK FROZEN	21/25	100 MC.	1,080.00 KGS.	600 BOXES	$. 19.08/BOX	$. 11,448.00
	26/30	200 MC.	2,160.00 KGS.	1200 BOXES	$. 18.18/BOX	$. 21,816.00
	31/40	100 MC.	1,080.00 KGS.	600 BOXES	$. 16.74/BOX	$. 10,044.00
BT PDTO IQF	16/20	100 MC.	800.00 KGS.	1000 BAGS	$. 9.20/BAG	$. 9,200.00
BT PD IQF	8/12	100 MC.	800.00 KGS.	1000 BAGS	$. 14.60/BAG	$. 14,600.00
BT HOSO S. IQF	8/12	50 MC.	400.00 KGS.	500 BOXES	$. 12.70/BOX	$. 6,350.00
	16/20	100 MC.	800.00 KGS.	1000 BOXES	$. 8.30/BOX	$. 8,300.00
BT HOSO S. IQF	16/20	200 MC.	1,500.00 KGS.	2000 BOXES	$. 7.40/BOX	$. 14,800.00
	TOTAL	950 MC.	8,620.00 KGS.			$. 96,658.00

IN WORDS: A TOTAL OF NINETY SIX THOUSAND FIVE HUNDRED FIFTY EIGHT ONLY (VALUE IN USD)

INSURANCE COVERED BY THE BUYER
FREIGHT PREPAID :
FACRORY APPROVAL :
US FDA REGISTRATION NO. :
EXPORT REGISTRATION NO. :
PORT OF DESTINATION : ANTWERP, BELGIUM

TERMS OF PAYMENT: 100% PAYMENT BY LC AT 90 DAYS AFTER SHIPMENT
BANK ADDRESS :
SWIFT NO. :

AUTHORISED SIGNATURE

(SAMPLE COPY OF COMMERCIAL INVOICE)

ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED ABCD FOODS LIMITED

HEAD OFFICE:
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

FACTORY :
ADDRESS:
TEL:
FAX:
EMAIL:
WEB:

Reference

WHO (2009) WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland. https://www.ncbi.nlm.nih.gov/books/NBK144035/figure/partii_ranking.f2/?report=objectonly

M. A. Hannan et al., *Post-Harvest Processing, Packaging and Inspection of Frozen Shrimp: A Practical Guide*, https://doi.org/10.1007/978-981-19-1566-6