STUDY ON IMPROVEMENT OF FISHING PORT FOR THE SEA FOOD HYGIENE CONTROL AND SUSTAINABLE UTILIZATION OF FISHERY RESOURCES

Jun YOKOYAMA[1], Masahiro KAMADA[2], Kaori OHATA[3], Akira NAGANO[4], Hisae KASAI[5] and Mamoru YOSHIMIZU[6]

[1] Agriculture and Fisheries Dept. Hokkaidou Regional Development Bureau, (Nishi 2-chome, Kita 8-jo Kita-ku, Sapporo, Hokkaido 060-8511 Japan)

[2] Engineering Division, Alpha Hydraulic Engineering Consultants Co., Ltd., (516-336 9-14 Hassamu Nishi-ku, Sapporo,Hokkaido, 063-0829, Japan.)

[3] Engineering Division, Alpha Hydraulic Engineering Consultants Co., Ltd., (516-336 9-14 Hassamu Nishi-ku, Sapporo,Hokkaido, 063-0829, Japan.)

[4] Japan Fishing Port Construction Society, (3-25-10 JR-Haccyoubori-Building, Haccyoubori, Cyuuou-ku, Tokyo 104-0032, Japan)

[5] Faculty of Fisheries Sciences, Hokkaido University, (Minato, Hakodate, Hokkaido 041-8611, Japan)

[6] Faculty of Fisheries Sciences, Hokkaido University, (Minato, Hakodate, Hokkaido 041-8611, Japan)

This paper presents the methods of the development of fishing ports for the supplying of safe seafood products, based on the some rules on food hygiene control and on the eco-label system which is useful for fishery resource management in Japan. First, we analyzed the issue of the hygiene control for fresh fish on the distribution process from the landing places to the consumers and proposed the method to estimate the hygiene level with the two factors; the water quality, control and the sanitary condition of the working areas at the fishing ports, landing places and the auction halls on the distribution process. Secondly, we proposed the method to select whether fishery products contribute to being sustainable or not, so as to secure the validity of the sea food hygiene control at the fishing ports.

Key Words: Sea Food Hygiene Control, Sanitary Condition, Water Quality Control, Fishing Ports

1. Introduction

The Food Sanitation Act was revised in 2003, since the public anxiety and distrust to food safety had increased because of BSE problems and mislabeling incidents. The control management made a revision on the standard of food sanitation and was totally revised in 2004, where a new guideline was stated for food business operators.

On the other hand, based on each hygiene control standard made by facility managers; the fishing port, which is the origin of supply chain from landing to consumer, the safety of supply and the security of seafood products have improved. But there is no objective regulation on hygiene control for fish ports, and ensuring the reliability of the consumer has not been accomplished.

In this paper, the current hygienic issues were gathered and suggestions to control the standards of fishing port were encouraged where the consumer can rate them objectively.

2. The transition of food sanitation related laws and the background

(1)Consumers' perspective to food sanitation

According to "A survey about safety of food"[1] researched by Central Research Services Inc. in August in 2007, 76% of the respondents experienced uneasiness in food safety. More than 20% respondents also expected that "government or local government" or "food manufacturer" take action to regain the public confidence in food safety. In addition, according to "An attitude survey about safety of food"[2] researched by Food Safety Commission, 76.9% of respondents answered that the production stage need to be improved to assure food safety, and 58.9% chose the consumption stage instead (Figure-3).

It means that a lot of public have uneasiness at food safety in response from mislabeling incidents at the production area, materials, or best-before-end date of late years. It also means that the government or local governments were expected to assure the safety of food.

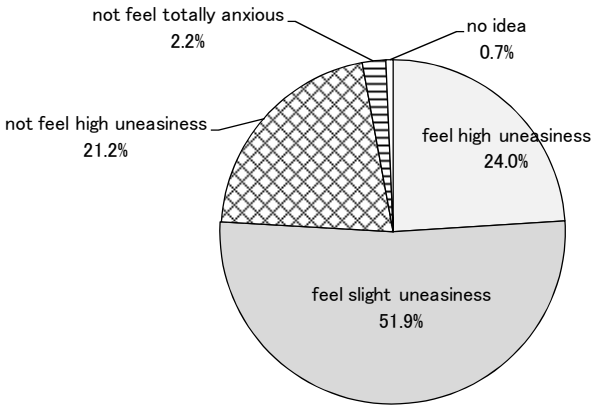

Figure-1 A complaint about food safety. (n=1,286)

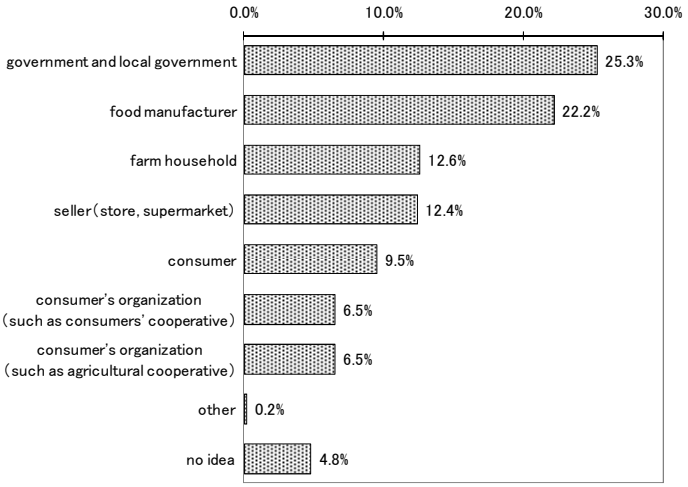

Figure-2 The key person or group desired to improve for the food safety (n=1,286)

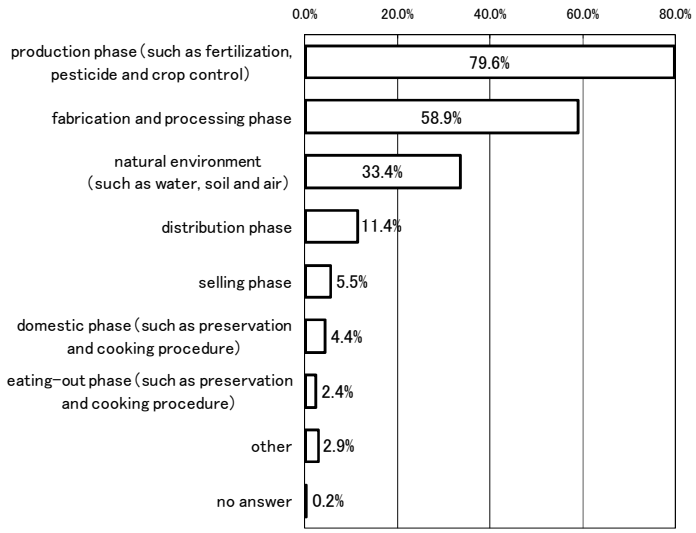

Figure-3 The phase to be improved for the food safety.

(2) The transition of food sanitation related laws

Public uneasiness at food safety was increasing, Food Sanitation Act was revised in 2004, and Food Safety Basic Act was instituted in the same year.

In 2005, revising Food Sanitation Act became a turning point, the Ministry of Health, Labor and Welfare (the MHLW) totally rethought "Standard Managed Regulatory Code" based on matters in

"General Principles of Food Hygiene CAC/RCP 1-1969, Rev.3-1999, And.1999" showed by Codex Alimentarius Commission in 2000. The MHLW also has focused on some policies on better quality control, for example the institution of "The Guideline about Priority Operational Management for the Food industry Worker".

(3)Approaches for the hygiene control of seafood products

On seafood products, EU developed "Sanitation Standard for Handling Facilities of Fishery Products" in 1991. This means a hygiene standard in mainly processing factories in exporting to the EU region. On this basis, European Commission inspected marine product factories in Japan. The result, it totally banned the seafood products made in Japan which were imported from April, 1995. The reason why it was banned was because the Japanese products were not appropriate to the EU standard. After that, the MHLW implemented provisions, like the revision of "The Handling Outline for Japanese Seafood Exported to European Union Nations", as a result, the ban on the import lifted in December, 1995.

On the other hand, "The Code of Federal Regulations for the Introduction of HACCP" to process marine food products was implemented in the U.S. in December 1997, and the products for export to the U.S. had to follow the standard. In response to this, the MHLW implemented "The Handling Outline for Japanese Seafood exported to the United Stated".

Thus, in cases of exporting to the EU or the U.S., the importance of hygiene control in the processing seafood products was increasing.

3. Hygienic control problems in supply chain from fish catch to consumer

The hazardous factors to seafood products safety were identified, and these are the following: ① biological hazardous factors (food spoilage bacteria, bacteria causing food-borne-diseases, virus, parasitic insects, etc.), ②chemical hazardous factors (natural poison, such as blowfish "*fugu*" poison or shellfish poison, food additives, harmful chemicals) and ③ physical hazardous factors (metallic strips, glass chips, wood chips)

Japanese customarily eat raw fish, and many non-heated foods as sashimi, sushi and vinegar dishes. In the supply chain from fish catch to the consumer, the possibility of considerable deterioration on raw fish products tends to be high as time passes, and sensitive handling was required especially in terms of biological hazards. By keeping on low-temperature conditions, this prevents the deterioration, and the need to practice control not to adhere, pollute and increase bacteria causing food-borne-diseases or food spoilage bacteria at each stage from fish catch to consumer.

A general supply chain from fish catch to consumer is the following:

> a fishing place → a fishing port → a wholesale market located in the production area → a processing factory → a wholesale market located in a consuming area → retail → consumer

In each stage from processing factory to consumer of this chain, hygiene control has to be practiced because of the background grasped in 2(2) and (3). But from the other stages (from fish catch to processing factory), each producer has to practice hygiene control.

So from the objective perspective, problems in hygiene quality control on the stages from fish catch to processing factories are overleaf.

The stages from fish catch to the processing factory are ①from catching to landing seafood products, ②landing seafood products on quay sides, ③ auction in a wholesale market located in a production area and disposing. Since all the stages are practiced in fishing port, we need to think of problems at each stage as hygienic problems in fishing ports.

(1) Problems in the stage from fish catch to landed seafood products

In order to solve problems on hygiene control in this process, the cleaning of fishing and parts of ship, control of water quality for the hold to use in catch landing and of ice to be loaded in ship, hygiene control of seafood products and so on are implemented.

These fishing ports make use of seawater in harbors to clean fishing implements and parts of ships. Usually used seawater is drained back to harbors again, and there is a high possibility that the seawater is polluted by coliform.

(2) Problems in the landing stage

In this stage, there are cleaning and purification of wharves, where landed seafood products are temporarily placed, the cleaning of the tires of the car taking seafood products from other fishing ports, the cleaning of middlemen' s work clothes and shoes were seen as problems. Also the cleaning of working and sorting table used in the processing stage of seafood products and the cleaning of the equipment like fish boxes. In these measures, the water quality in harbors as (1) is a problem. As the other problems; there are stagnant water on the floor (for instance, that of quay side), bird (sea gull) damage, pollution from bird dropping. And there is no measure taken to control the incoming trucks and carts.

(3)Problems on wholesale market located in production area

In this stage, there is pollution from the waste as residuum, arose in the market, changing of temperature of fish body, in disposal of goods and packing, exhaust gases emitted by forklifts, the pollution arising from the direct storage of seafood products on the floor surface, the pollution arose from work clothes and shoes from coming in and out of fishing ports are problems. These problems are grouped under problems on market equipment, problems on working-flow-lines management and problems on users' mind.

4. The importance of measures of hygiene quality control from fish catch to processing factory

Hygiene control in fishing port is an important factor affecting quality of seafood products as food product materials. In the previous section, we showed the problems on the hygiene control at each stage. We divide broadly these problems into " ① water quality in fishing port" and "working environment."(Table-1). Thus, in this section, the current problems and the measures to solve them are discussed.

Table-1 The perspective and evaluation items on hygiene control

perspective	category	evaluation items on hygiene control
Water environments	Harbor environments	Keeping harbor environments and handling drainage water
	Supplying waters	To keep working environments clean
		To clean equipment, fishing implements, etc.
		Sea water to use for seafood products
	Supplying ice	Supplying clean ice
Working environments , etc.	Landing and freight handling	Appropriate handling of waste, etc.
		Provision for the weather and dust
		Provision for birds, etc.
		Provision for incoming trucks, etc.
		Keeping environments of landing and freight handling clean
	Loading and out of ports	Keeping environments of loading and bringing out of ports clean
		Keeping delivery trucks and cars clean
	Keeping relevant parties clean	Control of the work lines
		Control of lavatory, etc

(1)The present situation of water environment in fishing port and measures

a)The present situation of water quality

Sea water in harbors is used for the hold, to clean parts of ships, seafood products and sorting table after landing, for primary cold storage (ice water). In most cases, these sea waters are taken from fishing ports without cleaning. Especially, we need to take care of handling the seawater because the seawater contains bacteria causing food-borne-diseases, which are a kind of biological hazard.

Table-2 illustrates the result of the water quality survey in harbors in prefecture and city governments researched in 2007. In this table, referring water quality based on the criteria of coliform bacteria count, we found out that coliform

bacteria count exceeded 1000 MPN/100ml[3)], which is an accepted level for coliforms in water used for marine products industry in Japan, at 33% of all fish ports studied.

Table-2 The result of the water quality survey in harbors

fishing port	pH	COD mg/L	SS mg/L	coliform bacteria count MPN/100mL	total nitrogen mg/L	total phosphorus mg/L
A	7.4	3.8	2.2	7,900	1.23	0.197
B	7.9	0.7	5	220	0.18	0.027
C	8.2	0.4	5	270	0.25	0.035
D	8.1	0.7	9	330	0.28	0.051
E	8.2	0.7	6	17	0.23	0.033
F	8.2	0.7	1	490	0.18	0.02
G	8.1	0.9	3	4	0.25	0.034
H	8.1	1.2	1	170	0.17	0.021
I	8.1	0.9	3	1,300	0.26	0.038
J	8.1	1.3	2	3,500	0.93	0.11
K	8.2	0.8	1	220	0.2	0.02
L	8.2	1	1	1,400	0.15	0.044
N	8.2	0.7	1	140	0.16	0.031
M	8.2	1	1	1,700	0.55	0.12
O	8.2	0.8	1	17	0.16	0.024

pH: hydrogen-ion concentration
COD: chemical oxygen demand
SS: amount of suspended solids

On the other hand, Figure-4 and Table-3 illustrate the points and results of the water quality survey that is different from table-2 (in November, 2004). St.1 means the intake point of sea water used in fishing ports, coliform bacteria count is satisfactory under 2.0～6.8 MPN/100mL and the accepted level. But on St.2, which is the point of the drainage flowed from disposal place, coliform bacteria count was 230,000 MPN/100mL and considerably exceeded the accepted level. And miscellaneous drainage affects coliform bacteria count materially, and it was 1,100 MPN/100mL on St.3, which is above, and was 700 MPN/100mL on St.4, which is on the river mouth. In most cases, the sea water exceeded the accepted level flows into fishing port from the river mouth, though coliform bacteria count decreases because of diffusion by sea water. Thus, it is little wonder that coliform bacteria count will increase in the sea water in harbors soon, unless we control the flow of drainage water from land and river water.

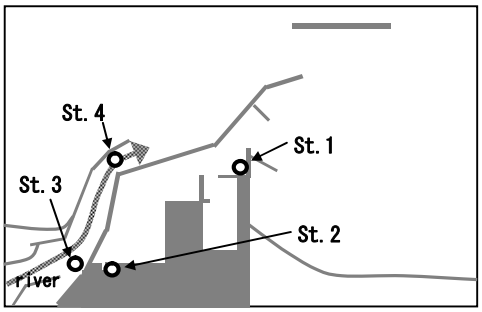

Figure-4 The points of water quality survey.

Tabel-3 The results of water quality survey

investigation spot	pH	COD mg/L	SS mg/L	coliform bacteria count MPN/100mL	total nitrogen mg/L	total phosphorus mg/L
St.1 (intake)	8.0	0.5	18	2	0.24	0.036
St.2 (drain outlet)	6.9	120	48	230,000	27.00	4.300
St.3 (river)	7.5	1.5	2	1,100	0.64	0.067
St.4 (river mouth)	7.5	1.3	3	700	0.46	0.039

(b) Water quality measures for hygiene control

We need to research seawater quality periodically and control the quality on standards as coliform bacteria count, since seawater used in harbors is usually taken from fishing ports and used in catch landing works and for cleaning up. And we also need to implement thorough measures to handle the water and improve drainage pipes not to flow drainage water, which is from the land, into harbors directly. In addition, it is said that there is a high possibility that coliform flows into harbors through rivers. We researched a distribution condition of coliform bacteria count in the Tokachi offing. As a result, we found that coliform spreading was affected by ocean stream (Figure-5). Thus, we need to change the fishing port layout to prevent river water from flowing into fishing port directly. Figure-6 and Table-4 show the water quality in harbors of the different layout and river mouth point, and show the comparison of the results in May, August and November, 2004. Seeing these, breakwater has a positive impact for reducing the coliform flowing into fishing port from river.

On the other hand, in some cases, even if there is no river near the fishing port, the improvement of calmness given by breakwater had a negative impact in deteriorating the water quality affected by

retention of water in harbors. In these cases, one of the measures is to change the architecture of the breakwater with easy exchanging seawater. Figure-7 shows the effects after the improvement work was done. This was the case of seawater quality improved at the same level as the open sea.

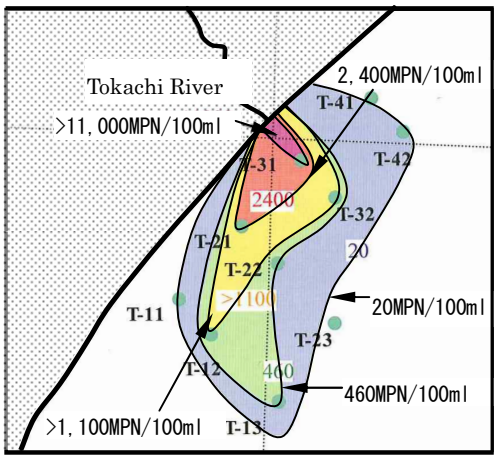

Figure-5 The spreading of coliform in the Tokachi offing.

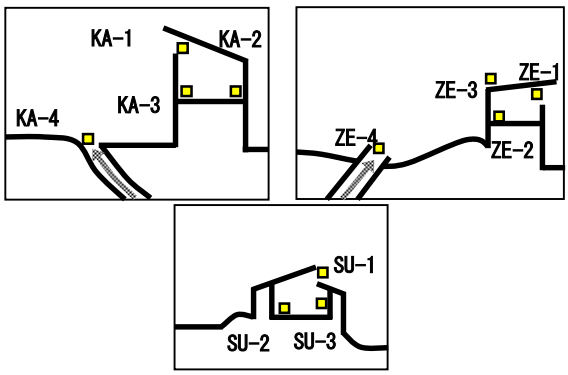

Figure-6 The layout of the sea ports, river mouth point and the points of the survey.

Table-4 The monthly variation of the coliform bacteria count and *Escherichia coli* count

spot	coliform bacteria count (MPN/100mL)			*Escherichia coli* count (MPN/100mL)		
	May, 2004	Aug, 2004	Nov, 2004	May, 2004	Aug, 2004	Nov, 2004
KA-1	1,500	>14,000	4,600	430	430	30
KA-2	750	>14,000	2,400	<3	390	<3
KA-3	2,400	11000	2,400	40	36	91
KA-4	11,000	>14,000	11,000	<3	91	30
ZE-1	<3	460	23	<3	93	<3
ZE-2	90	460	43	<3	3.6	<3
ZE-3	40～230	2400	150	<3	36	3.6
ZE-4	430	>14,000	4,600	<3	430	210
SU-1	90	43	93	<3	<3	3.6
SU-2	430	460	43	30	40	<3
SU-3	<3	15	4,600	<3	<3	<3

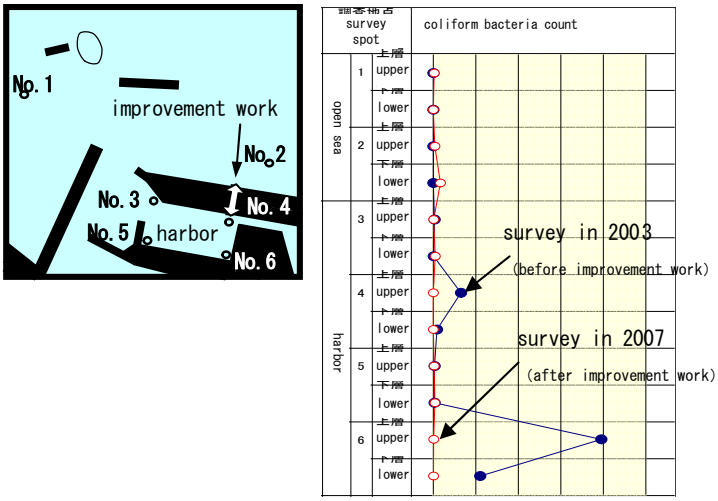

Figure-7 The change of water quality due to the improvement work of the breakwater.

However, when these measures are incomplete, as another measure, we propose that users handle water as the used water after coliform disinfection. General handlings are ultraviolet or chlorine disinfection[4], but these have issues on the addition to cost and the handling of chlorine. For the reasons, electrolysis of seawater has been discussed as a new handling[5] because of easy construction we can get seawater containing chlorine of low concentration, which is our agenda.

(2)The current condition of working environment etc. and the measures

a) The current condition of working environment

Works in the taking-out-stages from catch landing to processing factory are mainly at disposal places or quay sides of fishing port. These works are comparatively operated in open places, so we need to make a consideration on incoming trucks and cars with seafood products delivered on land, and on incoming many relevant parties as intermediate agent except for fishery. Especially most fishermen do not disinfect their boots and change clothes when they enter into areas in which seafood products are handled, from other areas including lavatory. These behaviors can cause physical and biological hazards to the fishing port.

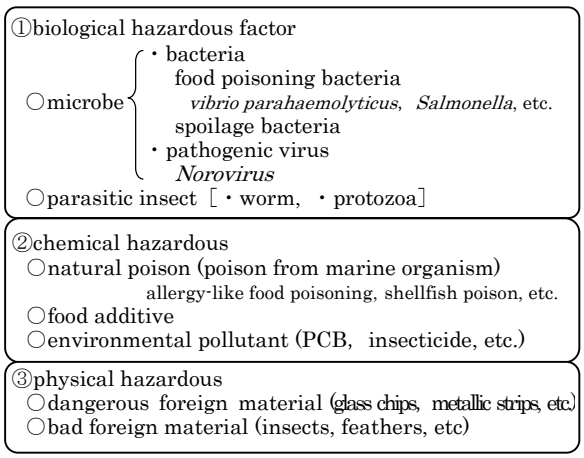

Figure-8 The factors to threaten health during the works

Also working styles from catch landing to taking-out of different fish species and fishing methods from the sea port are suggested; ① load seafood products into trucks or cars from ship, and take out, ② after taking seafood products out from net, load them into trucks or cars, and take out, ③land pre-screened seafood products into small lots, set them up, load them into trucks or car, and take out, ④after catch landing, sort out seafood products in fish species and sizes by fishermen, set them up, load them into trucks or cars, and take out. At all activities, "to load the products into trucks and cars" work is needed.

When seafood products are taken in on land from fishing port, even if these works, there is a high possibility that incoming trucks and cars bring physical and biological hazards in the fishing port. In addition, there is a possibility that bird droppings and waste products, like seashells or dead fish become feeds to animals and birds, and may cause development of hygiene pests such as flies.

b) Improvement for hygiene working environment

It is important to clean facilities and equipment for hygiene working environment. For that, appropriate water supply is needed for use.

On the other hand, processes from landing seafood products to transfer the products out of ports depend on ways of fishery and the sort of products to be handled. In these processes, it is important to set the line for the products, for people, and for the trucks and cars not to pass on flow lines. On this basis, it is necessary to build equipment to clean the trucks, the cars and people, on the port boundary, to prevent them from breaking into the lines. In addition, some measures are needed with consideration for hazards brought by weather. For instance, adding roof, windbreak fence and paint. And it is a positive effect for hazards by birds that roof on quay side builds, and bird nets or piano wires on the tip of roof or loft set.

As a measure to the wastes, it is effective that a center for seafood products is built completely far from the lines.

(3) A provision of hygiene control standards

Based on the previous, we organized the hygiene control items on fishing port and the standards (Figure-5).

Table-5 The hygiene control standard

Evaluation items on hygiene control	Hygiene control standers
To keep harbor environments and handling drainage water	・to upgrade drainage water from quay side, freight handling facility, etc. and the primary handling facility ・not to set up discharge opening on quay side to land ・to improve the facility with exchanging seawater and to dredge up for polluted mud
To keep working environments clean	・improvement of facility to supply appropriate drinking and sea water ※appropriate seawater : to satisfy the acceptable level of PH, SS, coliform, COD and T-N for seafood products industry in Japan. ※appropriate drinking water : to satisfy the acceptable level for drinking water based on Water Supply Act
To clean equipment, fishing implements, etc. Sea water to use for seafood products	・to improve supplying facility for cleaning seawater and drinking water ・to survey water quality and to check facility to sterilize regularly ・to set up hydrant where it should be ※appropriate seawater : to satisfy the acceptable level of PH, SS, coliform, COD and T-N and not to be detection of coliform
To supply clean ice	・to improve supplying facility for cleaning seawater and drinking water ・to survey water quality and to check facility to sterilize regularly ・to keep processes clean, which are from making ice to supplying the ice to seafood
Appropriate handling of waste, etc.	・to improve facility to separate wastes of seafood from the others (as necessary) ・to prevent waste from exposing, to bring out of port regularly and to clean containers, etc.
Provision for the weather and dust	・to improve facility for wind, rain and dust (roof, etc.) (as necessary)
Provision for birds, etc.	・to use apron and to clean floors in disposal place, etc. regularly (to remove bird dropping, feather and wastes of feed-to-be) ・to improve facility to prevent beasts and birds from coming in (roof, piano lines on roof, etc.) (as necessary)
Provision for incoming trucks, etc.	・to control work lines for trucks ・to prevent trucks from incoming to landing and disposal place thoroughly (when there is no choice to prevent from incoming because of ways of fishery, to satisfy the following three conditions: ①to clean tires, ②to set up cleaning facility for body of car, ③to prevent exhaust gas to seafood
To keep environments of landing and freight handling clean	・enough ventilation, to keep brightness ・to keep work lines without crossing ・to clean containers, floors, etc. by cleaning seawater or drinking water ・to control thoroughly drainage water after washing containers, floors, etc. ・to forbid cleaning of fishery implements, etc. and store on quay sides ・to use containers of appropriate lot ・to make plan to be old of shed (as necessary) ・to set up disinfection tank for boots ・to forbid placing seafood on the floor directly
To keep environments of loading and bringing out of ports clean	・to clean containers, machines, etc. by cleaning seawater or drinking water ・to separate landing and disposal place from loading and spots to bring out of port ・to prevent effects of exhaust gas emitted by trucks, etc. for seafood ・to prevent exposure when loading and bringing out
To keep trucks and cars deliver clean	・to clean trucks and cars in disposal place ・to clean tires ・cleaning body of car regularly ・to make plan for loading, roads to bring out of ports, paving of ground, rain and drainage water
Control of the work lines	・to be thorough of washing hands ・to enforce clean clothes ・to set up smoking area and thoroughly inform that thing etc.
Control of lavatory, etc	・to layout lavatory hygienically and completely ・to prevent bacteria come from a floor, which cause food-borne-diseases, from adhering

5. Conclusion

Hygiene control on fishing ports has been discussed but still there is no solution because of two reasons found; first, the improvement of calmness given by breakwater had a negative impact in deteriorating the water quality affected by retention of the water in harbors, and the seawater is used in the works. Second, it is difficult to distinguish seafood products landed in a fishing port from other ports and control them because some of the products in fishing ports came from other ports by trucks, cars and so on.

In this paper, we identified the incorporation route of coliform, which is one of water quality standards and proposed measures and offered directions in controlling the work lines. In addition, we showed that the control of water quality and work lines are important for hygiene control in fishing ports. And we proposed the standards as a guideline to improve hygienic managements of marine products.

For the future, we will directly attempt to propose a standard for the construction or layout of facilities to diffuse hygiene control in fishing ports.

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