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REVIEW OF FOOD SAFETY ASSURANCE AND APPLICATION OF HACCP IN PRODUCTION OF SEA FROZEN SQUID IN DPR OF KOREA

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ABSTRACT

The production of squid (*Todarodes pacificus*) has a great proportion in fisheries and export of fish products in DPRK. The squid is a migratory species that travels through the west and east seas of Korea from June-December every year. The main methods of the squid capturing are the otter trawling, purse seine, gill net, jigging and manual hook. It is general to use middle-sized boats (600-650hp) equipped with blast freezing and storage facilities for fishing squid and packing in bulk. Most of the squid production is at sea were it is processed frozen and exported directly. In light of future development of fish processing and export from DPRK it is suggested that HACCP should be introduced to the fish industry in the country. The paper reviews the HACCP system as it is internationally accepted and suggests and a generic HACCP model for the production of squid, frozen at sea in DPRK freezing vessels. Application of the HACCP system in production of frozen squid on the fishing boat is significant to understand effective food safety management system and generalize HACCP system in DPRK.

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1 INTRODUCTION

The Democratic People's Republic of Korea is a marine country bordered by sea on both east and west coast. The total coastline of 2,495 km has different characteristics; the west coast is rougher and more affected by the tidal than east coast. The conditions on the west coast provide good environment for seaweed aquaculture as well as shrimp and different kinds of shellfish such as mussels, scallops and oysters. The area of the continental shelf is 26,251 km², territorial sea (up to 12 nautical miles) is 12,654 km² and EEZ is approximately 73,000 km². The marine ecosystem of DPR of Korea has both warm and cold-water stream that are desirable condition for propagation of many fish species and has good potential resources for fishery development.

In 1970s, the fishing industry began to expand rapidly, receiving increased investment in vessels, equipment, and port facilities. Total marine products increased from about 400,000 tons in the middle of 1960s to 1.14 million tons in 1980, recording an annual growth rate of 9.4%. In 1982-1983 fishing production peaked, but then started to decline from beginning of 1990s (Figure 1).

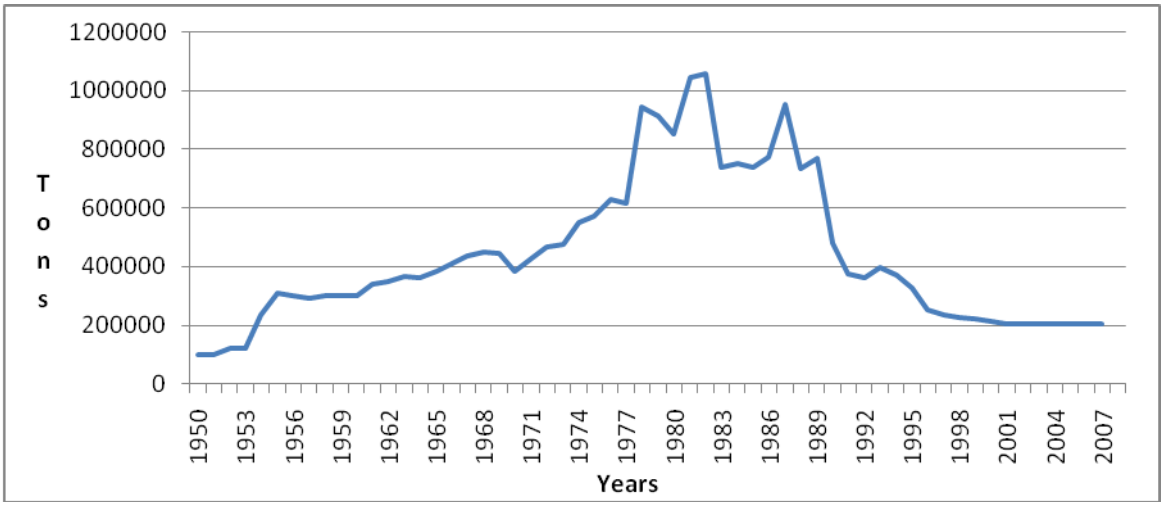

Figure 1: Fish production in DPRK from 1950 – 2007 (FAO 2008).

The main reasons are related to the stocks of two fish species (Atlantic Pollack and sardine) that made up the majority of the fishery productions disappearing abruptly because of overfishing and changed ecosystem (FAO 2005). The economic crisis combined with the lack of oil, is another reason for the low fishery production in the late 1980s. Of about 650 fish species in DPRK, the main capture species are marine fishes such as Pollack, Anchovy, Herring, Sardine, Haddock and crustaceans (crabs, shrimps) and molluscs (octopus, squid) and different types of shellfishes including scallop, mussel, and clams. In the west coast, yellow covina and hair tail are the most common species. The catch of the marine fish was about 181,000 mt in 2000 and the catch of molluscs and crustaceans was about 29,500 mt in 1997 (EarthTrends 2003).

Aquaculture fish production was 200,000 mt in 2000, and the main aquaculture species include sea cucumber, sea urchin, shellfishes including scallop and shrimp, and fresh water fishes such as carps, catfish, sturgeon, salmon and rainbow trout that grows well in the northern region. Production of freshwater aquaculture was about 5,000 mt and 3,530 mt in 1987 and 1997 respectively. In 2000, per capita food supply from fish and fishery products was up to 8 kg in DPRK (EarthTrends 2003).

The number of fishing vessels in the DPRK has been increasing over several decades. In the 70s the fleet expanded to meet the increasing demand of the population for fish. The number of 14,000-ton class processing ships increased as well as 3,750-ton class stern-trawlers, 1,000-ton and 480-ton class fishing vessels. At the same time the state introduced modern fishing technology and rationalized the fishery labour system. Improvements were also made in the expanding and modernizing the cold storage and processing facilities in order to meet processing of catches. However, as mentioned above general fishery status has declined from the late 1980s and early 1990s because of the economic crisis and the shortage of oil.

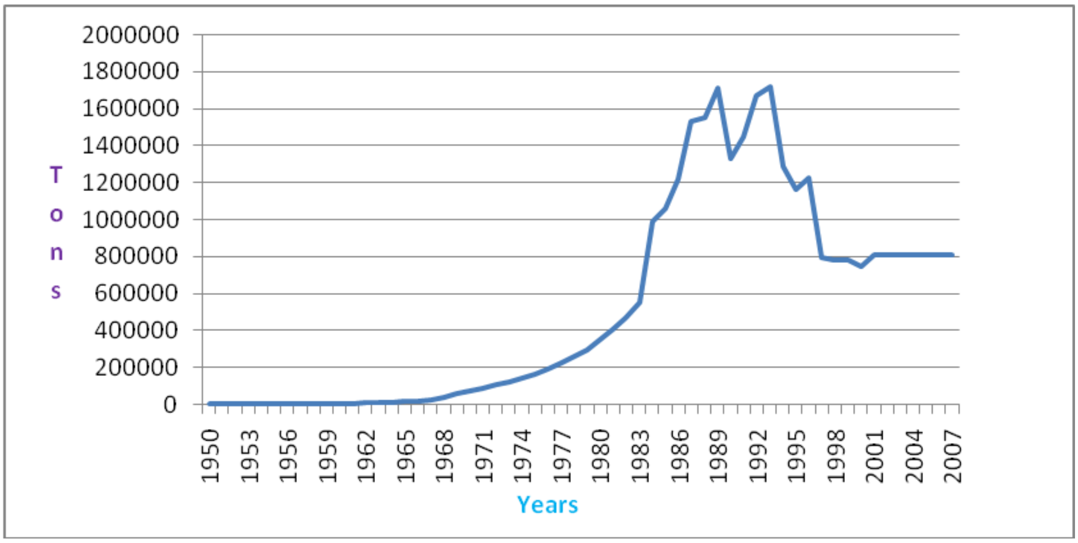

Figure 2: Total aquaculture production in DPRK from 1950-2007 (FAO 2008).

The highest recorded aquaculture production was about 1.7 million tons in 1992-1993 and most of the product was seaweed like kelp that is growing well in the west sea of Korea. Aquaculture is, at present, the most prominent part in the development fisheries in DPRK. Recently, the state put forward policy to develop aquaculture technology for breeding fresh water fishes using the country’s good conditions of hot and cold springs. Trade of sea products has increased and many of the fish are exported to the countries around Korean peninsula such as China and Russia, and some species of shellfishes are exported to these countries live (Figure 3).

Figure 3: Exports and imports of fish and fish products in DPRK 1980, 1990, and 2000 (EarthTrends 2003).

Today, seafood production is the most important export commodity and has the greatest proportion in earning foreign currency in trade of DPRK. In 2002-2005 the exporting value of fishery product was between 200-400 million USD and was by far the most important export commodity in 2009 (Figure 4).

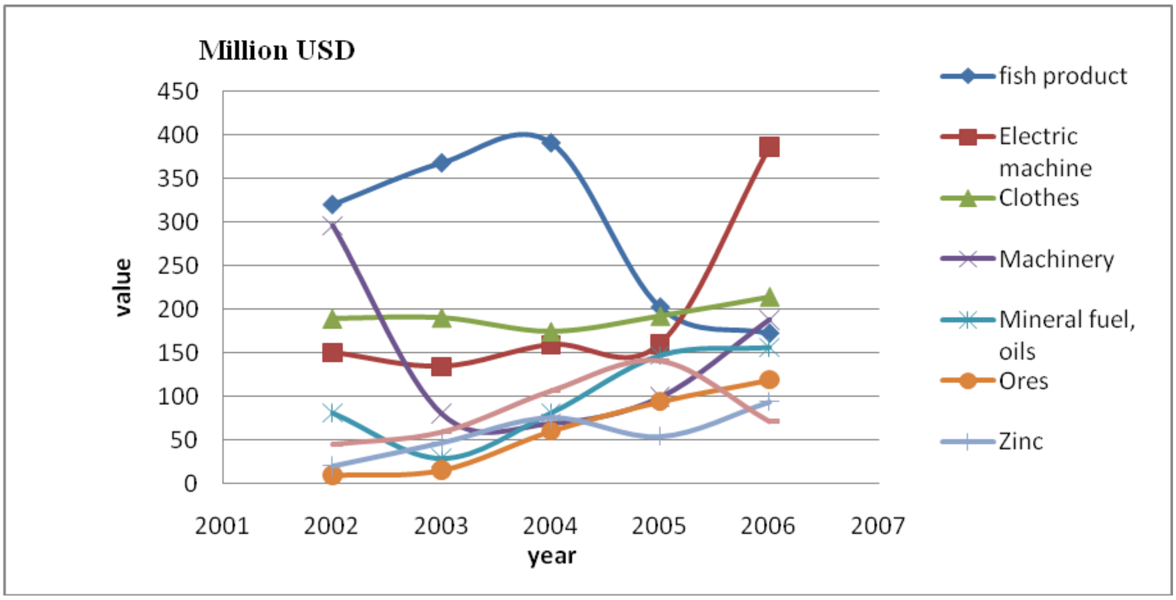

Figure 4: Export commodities in DPRK from 2001-2007 (WTS 2009).

For that reason, a good knowledge of both catching and processing of fish are playing an important role in ensuring its high value, and with increasing aquaculture, good handling practices will also have great production potential.

The most suitable quality control system for handling and processing of fish is the HACCP (Hazard Analysis and Critical Control Point System).

The main goal of this study is to review the principles and roles of HACCP in food safety assurance by identifying potential hazards in the squid production, which is of great value in DPRK.
The specific objectives were:

- Review the development of HACCP in the food industry.
- Identify the main principles of HACCP.
- Make a generic HACCP plan for the production of squid, frozen at sea in DPRK.

The HACCP system has an important role in protecting the consumer from potential hazards in food and facilitates trade of food and fish products.

2 FOOD SAFETY ASSURANCE

Food security and protection against food-borne diseases has been considered as one of the important part of the people's daily life (FAO/WHO 1998). Today, however, food safety can no longer be the luxury of the rich. It is becoming a universal right for all, and therefore the consumers are constantly raising their expectations with regards to food safety. They demand that food producers guarantee the safety of their production and that the competent authorities secure sufficient monitoring in order to assure consumers health and well-being. Food safety assurance was approached for many years through codes for Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP) and conformation of food safety and identification of potential problems was obtained by end product testing (FAO 2004). This approach to food quality and safety are often called the "traditional quality control system". Codes of GHP and GMP are still the basis of food safety systems. Although these codes are essential part of food safety they only provide for the general requirements without considering the specific demands of the food and the processing of specific foods. Furthermore, imprecise terms are frequently used for describing requirements that lack specifics and leaves the interpretation to the Quality Assurance staff and/or inspectors who may over or underestimate the requirements leading to uncertainty to food quality and safety (FAO 2004).

2.1 Food safety based on sampling

Detecting problems in food is a challenge and requires carefully planned sampling. Figure 5 shows the probability of accepting a lot (Pa) related to the number of defective units in that lot (Pd), and the number of samples (n). The figure shows that if the number of defective units in a lot is low there is a high probability that the lot will be accepted, even though a number of samples are relatively high. It is further demonstrated, that high value of "n" and low value of "c" reduces the risk of accepting lots with same number of defective units. It can be seen that testing of foods for the presence of contaminants offers very little protection even when large numbers of samples are pulled. A food safety management system that relies on end product testing can therefore not provide acceptable security for the consumer against food borne disease.

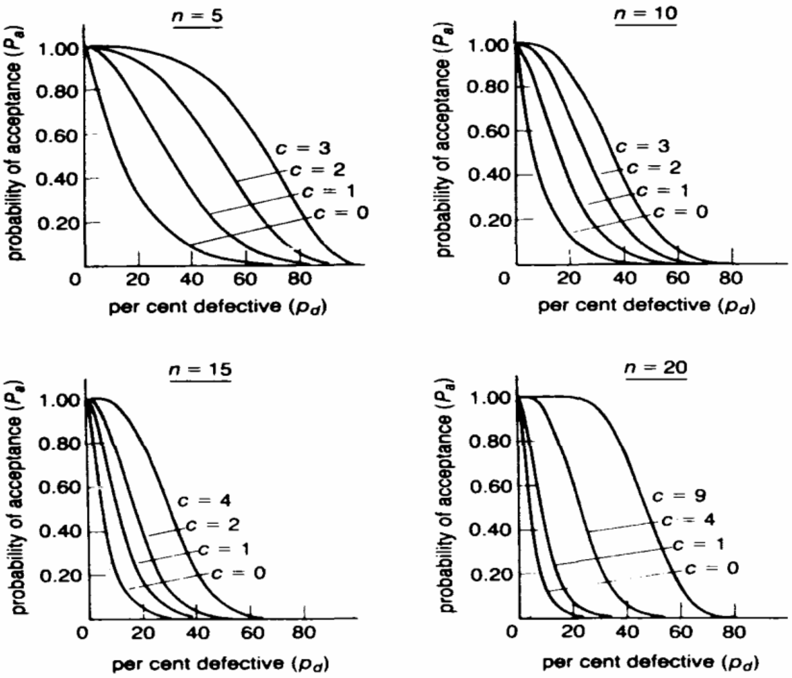

Figure 5: Operating characteristic curves for different sample sizes (n) and different criteria of acceptance (c) for 2-class attributes (ICMSF 1986).

The traditional quality control system relied heavily on end product testing for food safety. Test results determined weather potential hazards were present or absent in the lot tested. In this way the consumer's safety was solely dependent on the sampling plan used for determining the safety of the lot in question. Food safety management system that relies on end product testing can therefore not provide acceptable security for the consumer against food borne disease.

2.2 Problems encountered in food safety

Food borne illnesses are of major concern to human health and well being worldwide. Over 200 known diseases are transmitted in food through viruses, pathogenic bacteria, parasites, toxins, metals and other chemicals and substances. The effects of these can range from gastroenteritis to death. In the United States alone it is estimated that over 76 million persons get food borne illnesses annually causing about 300 thousand peoples hospitalizations and about 5.000 deaths (Mead *et al*. 1999). Pathogens are the main cause of food borne illnesses and in some cases they can cause outbreaks that are in most cases due to changes in the consumer habits or environment such as changes in eating habits, immigration / travel, globalisation of the food supply or centralisation of the food production. These variations are difficult to control with a traditional food safety system as it does not address the root of the problem and therefore does not have specific solutions to the changing hazard (Sun 2000).

2.3 The development of a hazard based food safety assurance

As the traditional food safety methods were not able to secure the consumers safety a new approach to food safety assurance was needed. In the 1960's the Pillsbury Company had developed a food safety management system for the US space program with good results and in 1973 the first document on the HACCP concept and technique was published by the company "The Hazard Analysis and Critical Control Point System" (Charisis 2004).

The HACCP system that is now applied in the food industry worldwide is a scientific based food safety control system that identifies and controls specific hazards during any food processing, from receiving of raw materials to delivery of end product. If correctly applied all possible hazards are eliminated or reduced to an acceptable level during processing rather than conventional system relying on final production testing.

The HACCP system is a management system which food safety is conducted through the analysing and controlling of biological, chemical and physical hazards from raw material production, supplying and handling to processing, distribution and consumption of the final product. Integrated management of the HACCP system is the main guarantee of its successful implementation (Charisis 2004). The application of the HACCP system provides many advantages over traditional approaches, both in terms of a food safety and food inspection (Motarjemi *et al.,* 1996).

The main advantages of the HACCP system are (Sciortino and Ravikumar 1999):

- Control is ahead by securing that actions are taken before a hazard is identified.
- Control is cheap in comparison with detailed chemical and microbiological analysis.
- Persons directly control the operation.
- It can be used to forecast potential hazards.

These advantages became the driving force that the HACCP system has developed to a universally recognized and accepted method for food safety assurance within four decades after it was conceptualized.

Before the implementation of the HACCP system, preventative measures in the food quality control management system was based on hygiene control such as GHP (Good Hygienic Practices) and GMP (Good manufacturing Practices), which include sanitary facility design, proper pest control procedures personal hygiene and cleaning Sanitary Standard Operating Procedures (SSOP) is another term of the GMP/GHP and used frequently in USA. These food control methods focused mainly on inspection of personal hygiene, production facilities, operations and end product testing.

Now these conventional food safety control systems are used as prerequisite program for HACCP and are still an important framework in implementing a food safety control system (FAO/WHO 1999). This means that the HACCP system cannot be implemented successfully without a prerequisite program. It is clear that prerequisite programs are practices and /or conditions that have to be in place before developing a HACCP plan. Both prerequisite programs and HACCP work together as a comprehensive approach to ensure of the food safety of the productions (FAO/WHO 2004).

Even though in many countries including EU, the HACCP system is mandatory, its implementation is poorly developed (Vela and Fernandez 2003). Some of the barriers in implementations of HACCP and issues that could facilitate proper implementation can be summarised as follows:

- Government awareness of food-borne disease data or the need for ensuring food safety is important in the application of HACCP.
- Governmental interest and an active help in providing technical, scientific and educational support in implementing HACCP system are necessary for success.
- Experts and technical supports are necessary in the food industry.
  The lack of management practices and understanding of HACCP are the most severe problems in the application of the HACCP system.
- Appropriate infrastructure and facilities within the business and the communities are necessary to implement the HACCP system itself.
- Customer and business demand is an important force for encouraging businesses to implement the HACCP system. Customers should only buy food from reliable suppliers, transporters and retailers.
- In training HACCP experts and to equip with new facilities needs the fund by the government (Charisis 2004).

The Pillsbury Company published the first document on HACCP “The Hazard Analysis and Critical Control Point System” in 1973. Twenty years later, this system was internationally recognised and accepted for desirable food safety assurance not only controlling microbiological hazards in safety of foodstuffs but also chemical and physical hazards. Since then, the HACCP system has been used in food industries in many countries including EU and Asian countries. Before 1995, the term of “HAZARD ANALYSIS CRITICAL CONTROL POINT” was used by the industry, until it was changed into: “HAZARD ANALYSIS AND CRITICAL CONTROL POINT system” at the WHO/Geneva Convention in 1995. In 1997, the Codex Alimentarius Commission adopted officially this term to translate it into other languages.

Today, the HACCP system has been made mandatory in most countries, such as the member states of the European Union, American and some Asian countries. WHO has also recognised the importance of HACCP for the prevention of food-borne diseases and has played a significant role in the development and propagation of HACCP.

The Codex Alimentarius also includes provisions of practices, guidelines and other recommended measures to assist in achieving HACCP implementation to the world (Charisis 2004). The milestones of HACCP are listed in Table 1.

3 FOOD SAFETY MANAGEMENT

The hazard based food safety management system has been developed through many trials and different approaches to secure food safety. The number of incidences of food borne illnesses on the journey towards the current food safety management system indicated that the traditional system was not able to control the complex hazards that can find their way to the consumer through different food sources. This does not mean that the traditional system was a total failure but rather that it was lacking the ability to identify specific hazards in the food or its processing environment and to structure a control system to prevent or to reduce the identified hazard to an acceptable limit. The traditional system is the foundation of HACCP and its role is to secure that environmental factors are not introducing hazards into the food during processing while the HACCP identifies possible hazards in the raw material, ingredients and in processing and sets up control measures to eliminate or reduce the hazards to an acceptable lever for the consumer. Figure 6 illustrates how the current food safety management is structured.

Table 1: Milestones showing the global development of HACCP (Charisis 2004).

Year	Contents
1960s	Pillsbury Company develops the HACCP concept for use by NASA
1971	Concept presented at first by National Conference of food protection in USA.
1973	used in canning production by Food Drug Administration (FDA).
1980	World Health Organization/International Commission on Microbiological Specification for Foods)WHO/ICMSF reports on HACCP
1983	World Health Organization (WHO) recommends HACCP
1985	Natural Resources Community (NRC) in USA recommends HACCP
1988	International Commission on Microbiological Specification for Foods (ICMSF) Book on HACCP
1989	National Advisory Committee on Microbiological Criteria for Foods (NACMCF) published the first major document on HACCP. (the 7-principle)
1991	Codex includes HACCP in codes
1992	National Advisory Committee on Microbiological Criteria for Foods (NACMCF) published revised HACCP principle.
1993	Codex issues HACCP guidelines
1993, 1994, 1995	World Health Organization and Food and Agriculture Organization (WHO and FAO) consultations
1997	Codex AND National Advisory Committee on Microbiological Criteria for Foods (NACMCF) issues revised document
1998	World Health Organization and Food and Agriculture Organization (FAO/WHO) provide guidance for regulatory assessment of HACCP
2005	ISO 22000 standard on Food safety management systems (HACCP) issued.

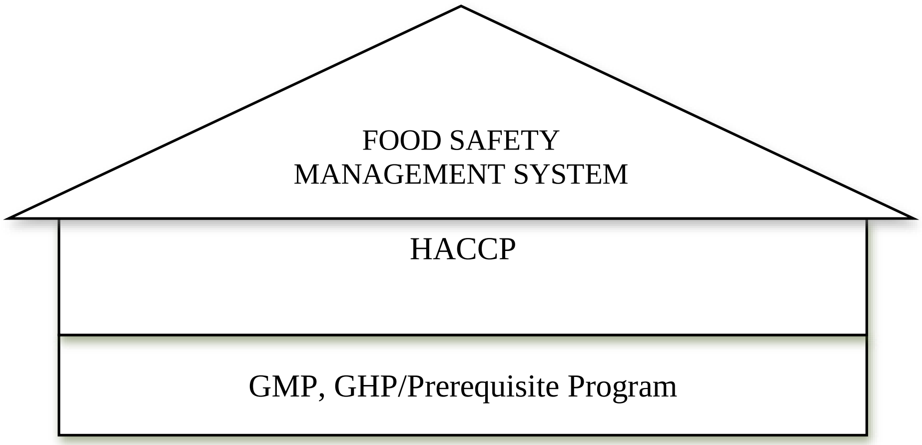

Figure 6: The structure of the food safety management system.

3.1 The prerequisite programs

Prerequisite program is one of the bases of food safety system and the HACCP system is not stand-alone system. When it is combined with a solid prerequisite program the HACCP system can exploit its ability to the full. The prerequisite programs include the Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP). The prerequisite program controls, not only all the sanitary procedures from primary production to final consumption but also the environmental and personal hygiene and design of the plant and layout of the facilities.

3.1.1 Primary Production.

Environmental Hygiene
The environment can be a potential source for food contamination, therefore plant location and facility layout should be considered in regard to food safety. The raw material for food processing should not enter through areas that can cause contamination or lead to its spoilage. It is important to control possible contamination from plant surroundings like from soil, animals and plants.

Location
Location of the plant and facilities should be considered in conjunction with any potential risk of contamination from the surroundings. Establishments should be located away from environmental polluted areas or areas prone to pests, flooding and where waste removal could be inefficient.

Design and layout
Internal design and layout of food processing facilities should facilitate proper hygiene and include protection of cross-contamination during processing. It should provide strict separation of areas where probability of cross contamination is high.

Internal structure
Internal structure should be made with durable materials to facilitate cleaning. The surfaces of ceilings, floors, windows, doors and instruments should be made with harmless materials to the food and smooth for easy removal of stained parts and keep clean.

Equipment and containers
The location of the equipment should be in a way to that adequate cleaning and maintenance is possible, and placed where they will function in accordance to intended use and facilitate good hygiene practices. Equipment and containers should also be made from endurable materials and be movable or to facilitate the controlling of pests. Containers used to keep by-products and waste should be made from impermeable material that are identified as such and located in isolated spot.

Water supply
Potable water should be used in processing food products and the quality of the water should be in accordance to the latest edition of WHO Guidelines for Drinking Water Quality. Potable water should be separated non-potable water systems, and not allowed re-circulated.

Drain and waste disposal
The proper system and facilities for drainage and waste treatment should be established and designed so as to avoid contaminating food or the potable water system.

Personnel facilities and toilets
Personnel hygiene facilities should be designed for maintaining hygiene and avoid cross-contaminating the food. Facilities should include sufficient means of hygienically washing and drying hands including washbasin and supply of hot and cold water and well-equipped lavatories.

Ventilation
Suitable air circulating system should be provided to reduce the air-borne contamination of food at the minimum and control the atmosphere temperature, suitable odor of food and humidity. It is important to prevent that the part of the ventilation system that contains contaminated air does not go into the clean area.

Lighting
Natural and artificial lighting should not influence the color of the products. The brightness should be adjusted and lighting fixture should be used to protect the safety of food.

Storage
Suitable facilities for the storage of food, ingredients and non-food chemicals should be provided. Food storage facilities should be designed and constructed (if appropriate) to:

- Permit adequate maintenance and cleaning.
- Avoid pest access and harborage.
- Enable food to be effectively protected from contamination during storage.
- Where necessary, provide an environment that minimizes the deterioration of food.

The type of storage facilities required will depend on the nature of the food.

Cleaning Facilities
Adequate cleaning facilities should be equipped with hot and cold potable water systems, which provide for cleaning food, utensils and equipment.

3.1.2 Control measures in prerequisite program

Control of hazards
Control of the hazard should be introduced through HACCP. Food industry manager should identify the critical operations to the safety of food in all the steps, which apply effective control procedures. They should also control the procedures to ensure their continuing effectiveness and review them regularly. These systems should be adopted throughout whole food chain.

Time and temperature controls
Time and temperature controls of cooking, cooling, processing and storage should take all possibilities into account such as the natural character such as water activity and ph and so on. The shelf life and method of packaging and processing should also be considered.

Specific Process Steps
The other steps such as chilling, thermal processing, irradiation, drying, chemical preservation and vacuum or modified atmospheric packaging is all contributing to food hygiene.

Specifications
Management systems described in the control of food hazards offer an effective way of ensuring the safety and suitability of food. Microbiological, chemical or physical specifications can be used in a food control system; the system should be based on scientific principles.

Chemical and Physical Contamination
The systems should prevent contamination of food from foreign materials such as glass or metal fragments from facilities, harmful fumes and chemicals. Reliable detectors or apparatus should be used in manufacturing and processing**.**

Incoming Materials
Raw materials or ingredients should be accepted after it is identified. If it is known to contain parasites, organisms, pesticides etc. that would not be removed to limited by normal sorting and/or processing it shouldn‘t to be allowed to enter. Only sound, suitable raw materials or ingredients should be used.

Packaging
Packaging should be designed to protect the product and minimize contamination, prevent damage, and contribute suitable labelling materials. Packaging materials used must be non-toxic and safe and meet the specified conditions of storage and use.

Water and ice
Only potable water should be used in food processing and handling. Non-potable water can be used for steam production and fire control and other similar purposes that are not connected with food. Re-circulated water, which has not received further treatment, and water recovered from processing of food by evaporation or drying may not be used unless properly treated. Ice should be made from potable water.

Management and Supervision
Managers and supervisors should have enough knowledge of food hygiene principles and practices to be able to judge potential risks, take appropriate preventive and corrective action, and ensure that effective monitoring and supervision takes place.

Documents and Records
Records of processing, production and distribution should be kept and retained for a period that exceeds the shelf life of the product. Documentation can enhance the credibility and effectiveness of the food safety control system.

Recall Procedures
Recalled products should be held under supervision until they are destroyed, used for purposes other than human consumption, determined to be safe for human consumption, or reprocessed in a manner to ensure their safety.

Maintenance
Establishments and equipment should be kept in a suitable state of repair and condition to facilitate all sanitation procedures and prevent contamination of food, e.g. from metal shards, debris and chemicals.

Cleaning
Cleaning should remove food residues and dirt which may be a source of contamination and cleaning chemicals should be handled and used carefully and in accordance with manufacturers' instructions and stored separated from food, in clearly identified containers to avoid the risk of contaminating food. Cleaning and disinfection programmes should be continually and effectively monitored for their suitability and effectiveness and documented

Pest Control
Good hygiene practices should be adopted to avoid creating an environment conducive to pests. Sanitation, inspection of incoming materials and monitoring can minimize the likelihood of infestation. Buildings should be kept in good repair and condition to prevent pest and to eliminate potential breeding spots. Potential food sources should be protected and stored above the ground and away from walls. Areas both inside and outside food premises should be kept clean. Waste should be stored in covered, pest-proof containers whenever possible. Pest contamination should be dealt with immediately and without affecting food safety or suitability.

Monitoring of Sanitation
Sanitation systems and food contact surfaces should be monitored periodically and regularly reviewed.

Personal Hygiene
All employees should be responsible for using safe food handling methods as trained and instructed, and for practicing good personal hygiene so as to eliminate food-borne illness and injury, and to give the guarantee to customers and inspectors. Any person who has an illness that could contaminate food shall not be permitted to work. If an employee's illness is not severe and symptoms are not clear, the employee can work, but should not handle food directly. Clean all cuts and abrasions using soap and disinfectant under the water with a brush. When the

uncovered hand gets dirty, take the glove off, wash hands and put on a fresh glove frequently. Never handle food with an infected cut or abrasion.

An employee should:

- Maintain individual cleanliness by bathing daily and using mild perfumes that do not interfere with the aroma of food. Keep hands free of foreign perfume odours.
- Wear clean uniforms and closed-toed shoes. Replace clothing if it becomes dirty while working.
- Store clothing and personal belongings away from food production or equipment and utensils washing areas.
- Keep fingernails neatly trimmed, not protrude end of fingertips to make them clean easily.
- Restrain or cover their hair at all times with hair restraint such as hairnet, headbands, caps and beard covers.
- Do not wear jewellery on the hands, wrist, neck, or ears and don’t carry hard objects in outside pocket.
- Never carry a handkerchief or facial tissue when working with food.
- Do not chew gum when working and smoking in the food production area. Food and beverages are only consumed in break room.
- Keep proper covering gloves regulations.
- Maintain hand washing policies

Transport of product

During the transport of food, care should be taken to protect food from contamination, damage and provide an environment, which controls the growth of micro-organisms and the production of toxins in food. Food must be protected during transport properly. The type of carriers or containers required depends on the nature of the food and the conditions. They should be kept in suitable state of cleanliness. They should be also designated and marked for food use only and be used only for that purpose.

Product Information

Products should cover appropriate information to ensure that correct information is available to the next consumer in the food chain to enable them to handle the product safely. Consumers should have enough knowledge of food hygiene and make informed choices appropriate to the individual and prevent contamination and growth or survival of food borne pathogens by storing, preparing and using it correctly. Inadequate knowledge of general food hygiene, can lead to products being mishandled in the food chain and such mishandling can result in illness. The foods was packaged already should be labelled with clear instructions for the next person in the food chain to handle, display, store and use the product safely. Health education programmes should include general food hygiene and enable consumers to understand the importance of any product information and to follow any instructions accompanying products. In particular, consumers should be informed of the relationship between time and temperature control and food borne illness.

Labelling

Pre-packaged foods should be labelled with clear instructions to enable the next person in the food chain to handle, display, store and use the product safely. Each container of food should be permanently marked to identify the producer and the lot.

Training
All personnel should be aware of their role and responsibility in protecting food from contamination. Food handlers should have the necessary knowledge and skills to enable them to handle food hygienically. Periodic assessments of the effectiveness of training and instruction programmes should be made. Managers and supervisors of food processes should have the necessary knowledge of food hygiene principles and practices to be able to judge potential risks and take the necessary action to remedy deficiencies. Training programmes should be routinely reviewed and updated where necessary. Systems should be in place to ensure that food handlers remain aware of all procedures necessary to maintain the safety of food.

3.2 The HACCP system

The HACCP system, which is based on scientific evidences, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating changes, such as advances in equipment design, processing procedures or technological developments.

The HACCP system can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health. As well as enhancing food safety, implementation of HACCP can provide other significant benefits. In addition, the application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.

The successful application of HACCP requires the full commitment and involvement of management and the work force. It also requires a multidisciplinary approach; this multidisciplinary approach should include, when appropriate, expertise in agronomy, veterinary health, production, microbiology, medicine, public health, food technology, environmental health, chemistry and engineering, according to the particular study." (from Codex code of practice) „prerequisite programs such as good hygienic practices according to the Codex General Principles of Food Hygiene, the appropriate Codex Codes of Practice, and appropriate food safety requirements. These prerequisite programs to HACCP, including training, should be well established, fully operational and verified in order to facilitate the successful application and implementation of the HACCP system. For all types of food business, management awareness and commitment is necessary for implementation of an effective HACCP system. The effectiveness will also rely upon management and employees having the appropriate HACCP knowledge and skills.

During hazard identification, evaluation, and subsequent operations in designing and applying HACCP systems, consideration must be given to the impact of raw materials, ingredients, food manufacturing practices, role of manufacturing processes to control hazards, likely end-use of the product, categories of consumers of concern, and epidemiological evidence relative to food safety. The intent of the HACCP system is to focus control at Critical Control Points (CCPs). Redesign of the operation should be considered if a hazard which must be controlled is identified but no CCPs are found.

HACCP should be applied to each specific operation separately. CCPs identified in any given example in any Codex Code of Hygienic Practice might not be the only ones identified for a specific application or might be of a different nature. The HACCP application should be reviewed and necessary changes made when any modification is made in the product, process, or any step. The application of the HACCP principles should be the responsibility of each individual businesses. However, it is recognised by governments and businesses that there may be obstacles that hinder the effective application of the HACCP principles by individual business. This is particularly relevant in small and/or less developed businesses. While it is recognized that when applying HACCP, flexibility appropriate to the business is important, all seven principles must be applied in the HACCP system. This flexibility should take into account the nature and size of the operation, including the human and financial resources, infrastructure, processes, knowledge and practical constraints.

Small and/or less developed businesses do not always have the resources and the necessary expertise on site for the development and implementation of an effective HACCP plan. In such situations, expert advice should be obtained from other sources, which may include: trade and industry associations, independent experts and regulatory authorities. HACCP literature and especially sector-specific HACCP guides can be valuable. HACCP guidance developed by experts relevant to the process or type of operation may provide a useful tool for businesses in designing and implementing the HACCP plan. Where businesses are using expertly developed HACCP guidance, it is essential that it is specific to the foods and/or processes under consideration. More detailed information on the obstacles in implementing HACCP, particularly in reference to SLDBs, and recommendations in resolving these obstacles, can be found in “Obstacles to the Application of HACCP, Particularly in Small and Less Developed Businesses, and Approaches to Overcome Them” (document in preparation by FAO/WHO). The efficacy of any HACCP system will nevertheless rely on management and employees having the appropriate HACCP knowledge and skills, therefore ongoing training is necessary for all levels of employees and managers, as appropriate.

HACCP is based on seven principles that act as a blue print in setting up a HACCP system for a production. The principle prototype a step wise guide in to identify hazards record keeping and whom an actions is taken. These principles are:

Principle 1: Conduct a hazard analysis. The first step in establishing a HACCP system is to identify all hazards, biological, physical, or chemical, which can be associated with the product. The hazard must be in acceptable levels to prevent, eliminate, or reduce and is essential to the production of a safe food.

Principle 2: Identify the CCPs in the process.
A critical control point (CCP) is defined as a point, step, or procedure where control can be applied and a food safety hazard can be prevented, eliminated, or reduced to an acceptable level. All significant hazards identified during the hazard analysis must be addressed. CCPs include cooking, chilling, specific all sanitation procedures, prevention of cross contamination, product formulation controls, employee and environmental hygiene. All CCPs must be carefully developed and documented.

Principle 3: Establish critical limits for preventive measures associated with each identified CCP. A critical limit is defined as a criterion that must be met for each preventive measure associated with a CCP and often based on process parameters such as temperature, time physical dimensions, humidity, moisture level, water activity, pH, acidity and salt concentration, etc.

Principle 4: Establish CCP monitoring system and procedures for using monitoring results to adjust processes and maintain control. Monitoring consists of observations and measurements assessed whether a CCP is under control or not. Monitoring is used to determine when a deviation occurs at a CCP and, if it is not continuous, needs to be led to ensure that the CCP is under control.

Principle 5: Establish corrective actions to be done when monitoring indicates that there is a deviation from an established critical limit. HACCP systems are designed to identify potential hazards and to establish strategies to prevent their occurrence. However, ideal circumstances will not always come out in a processing operation and deviations will occur. So the corrective action plans must be in act to determine the status of the non-desirable product, and to identify and correct the cause of the deviation to find control of the CCP.

Principle 6: Establish procedures to verify that the HACCP system is working correctly. Verification must be act in that the HACCP system and its records to ensure are effective, corrective actions and records were undertaken and occasional testing has been maintained.

Principle 7: Establish effective record keeping procedures that document the HACCP plan. Record keeping procedures must meet the needs of the business and be adequate to show that the food safety program is working. And it also must be maintained on items at the establishment including records on incoming ingredients, product processing, packaging, storage, and distribution, and deviations and corrective actions.

3.3 Application of the HACCP system

The application of HACCP principles consists of the following tasks as identified in the Logic Sequence for Application of HACCP (FAO/WHO 1999).

Assemble HACCP team

The HACCP team should include a manager, quality assurance manager, or supervisor responsible for the process and also include an engineer or microbiologist and should members of staff who have experience with the product and process. The food operation should assure that the appropriate product specific knowledge and expertise is available for the development of an effective HACCP plan. The scope of the HACCP plan should be identified. The scope should describe which segment of the food chain is involved and the general classes of hazards to be addressed (e.g. does it cover all classes of hazards or only selected classes).

Describe the products and processes

A full description of the product should be drawn up, including information on what it contains, how it is made or prepared, stored and distributed. That is, the information should be including the contents of composition, physical/chemical structure (including Aẁ, pH, etc.), microbial/static treatments (e.g. heat-treatment, freezing, brining, smoking, etc.), packaging, durability, conditions and method of distribution.

Identify intended use (Consumer)
The "intended use" of the food product is the expected use of the product by the end user or consumer. In some cases, it should be considered that elderly, infantry and patients are particularly at risk from contaminated food. For example, pregnant women and unborn children are seriously at risk from *Listeria monocytogenes*. The intended use should be based on the expected uses of the product by the end user or consumer.

Construct a flow diagram
The flow diagram describes the process and shows the raw materials, processing steps, packaging, and storage and distribution stages. The flow diagram should be constructed by the HACCP team and include the information needed for hazard analysis such as microorganisms that may be associated with the product. The other information includes process times and temperatures, product acidity (pH), premises conditions and hygienic design, cleaning, equipment characteristics, storage conditions, and instructions for consumer use.

On-site confirmation of flow diagram
The HACCP team should confirm the processing operation against the flow diagram during all stages and hours of operation and amend the flow diagram where appropriate and watch the process with a critical eye and with the flow diagram.

Identify all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards (see Principle 1)
The HACCP team should check all of the potential hazards, microbiological chemical and physical, have been considered for each steps from primary production, processing, manufacture, and distribution to the end of consumption. In conducting the hazard analysis, the following should be included:

- The likely occurrence of hazards and severity of their adverse health effects.
- The qualitative and/or quantitative evaluation of the presence of hazards.
- Survival or multiplication of microorganisms of concern.
- Production in foods of toxins, chemicals or physical agents.
- Condition leading to the above.

The team must then consider what control measures can be applied for each hazard.

Determine Critical Control Points (see Principle 2)
There may be more than one CCP at which control is applied to address the same hazard. It should be used for guidance when determining CCPs. If a hazard has been identified at a step where control is necessary for safety, and no control measure exists at that step, then the product or process should be modified at that step, or at any earlier or later stage, to include a control measure.

Establish Critical Limits for each CCP (see Principle 3)
Critical limits must be specified and validated if possible for each critical control point. In some cases more than one critical limit will be elaborated at a particular step. Criteria often used include measurements of temperature, time, moisture level, pH, Aẁ, available chlorine, and sensory parameters such as visual appearance and texture.

Establish a Monitoring System for Each CCP (see Principle 4)
Monitoring is the scheduled measurement or observation of a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP. The adjustments should be taken before a deviation occurs. A designated person with knowledge and authority to carry out corrective actions when indicated must evaluate data derived from monitoring. Most monitoring procedures for CCPs will need to be done rapidly because they relate to on-line processes and there will not be time for lengthy analytical testing. All records and documents associated with monitoring CCPs must be signed by the person(s) doing the monitoring and by a responsible reviewing official(s) of the company.

Establish Corrective Actions (see Principle 5)
Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur. The actions must ensure that the CCP has been brought under control. Actions taken must also include proper disposition of the affected product. Deviation and product disposition procedures must be documented in the HACCP record keeping.

Establish Verification Procedures (see Principle 6)
Establish procedures for verification. Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP system is working correctly. The frequency of verification should be sufficient to confirm that the HACCP system is working effectively. Examples of verification activities include:

- Review of the HACCP system and its records.
- Review of deviations and product dispositions.

Establish Documentation and Record Keeping (see Principle 7)
Efficient and accurate record keeping is essential to the application of a HACCP system. HACCP procedures should be documented. Documentation and record keeping should be appropriate to the nature and size of the operation.

Documentation examples are:

- Hazard analysis.
- CCP determination.
- Critical limit determination.

Record examples are:

- CCP monitoring activities.
- Deviations and associated corrective actions.
- Modifications to the HACCP system.
- An example of a HACCP worksheet is attached as.

4 A GENERIC HACCP PLAN FOR FROZEN AT SEA PRODUCTION OF SQUID IN DPRK.

World production of squid is not well documented. The artisanal fleet catches most of the catch and 20-30% of the catch is not identified to species. The squid fisheries took off in the 70s when the catch was about one million tons and in 2006 the world squid catch was estimated about 3.5 million tons (FAO 2009) (Figure 7). The world catch comprises mainly of 11-12 species from two families and the catch area seems to be divided according to the main species caught. The family *Ommastrephidae* is caught mainly on the west coast of both north and the south-America and also in northern Atlantic. The family *Oastrephidae* is caught in most of the main oceans of the world. The flying squid, which is the species caught by the DPRK is harvested in eastern part of the Atlantic Ocean, all the way into the Barents Sea.

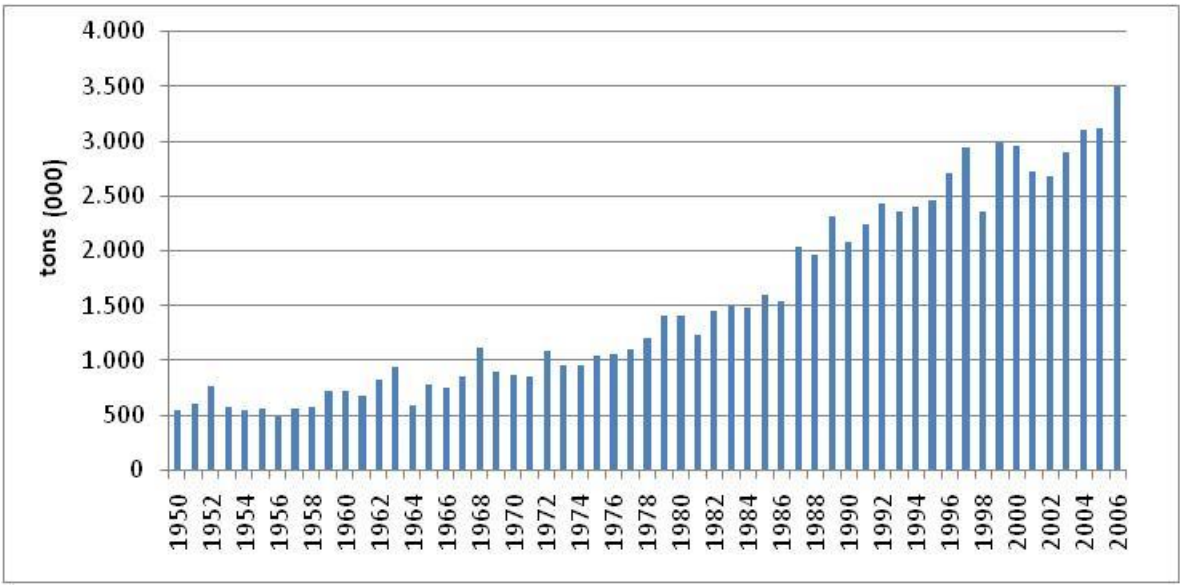

Figure 7: World production of squid from 1950 – 2006 (FAO 2009).

4.1 Squid catch in DPRK

The flying squid (*Todarodes pacificus*) is the main squid species caught in the waters of DPRK. It is a short lived species (1 year) and can be found in a temperature range of 5-27 ºC and from 100 m down to 500 m. The Koreans have fished it for the past 15 – 20 years and the most common size in 100 g – 300 g. The fishing season starts in early July and ends in October/November (Figure 9).

The main method of catching is jigging, gill net, purse seine and trawling. When jigging (hooks and line) is used the squid is lured to the hook with the help of lamps. Smaller vessels use mainly this method and are both white and green lights used for the fishing (FAO 2005)

The distribution of the squid stock is in the east and south of the Korean Sea but also in the Sea of Japan (Figure 9), but the squid migrates seasonally in this area.

Since 1998 the catch of squid in DPRK has been around 10,000 tons (FAO 2009) (Figure 8). For the past 6 years (since 2004) joint fishing has been in place between the China and much of the catch has been exported to China for the price of 600-700 USD per ton of squid.

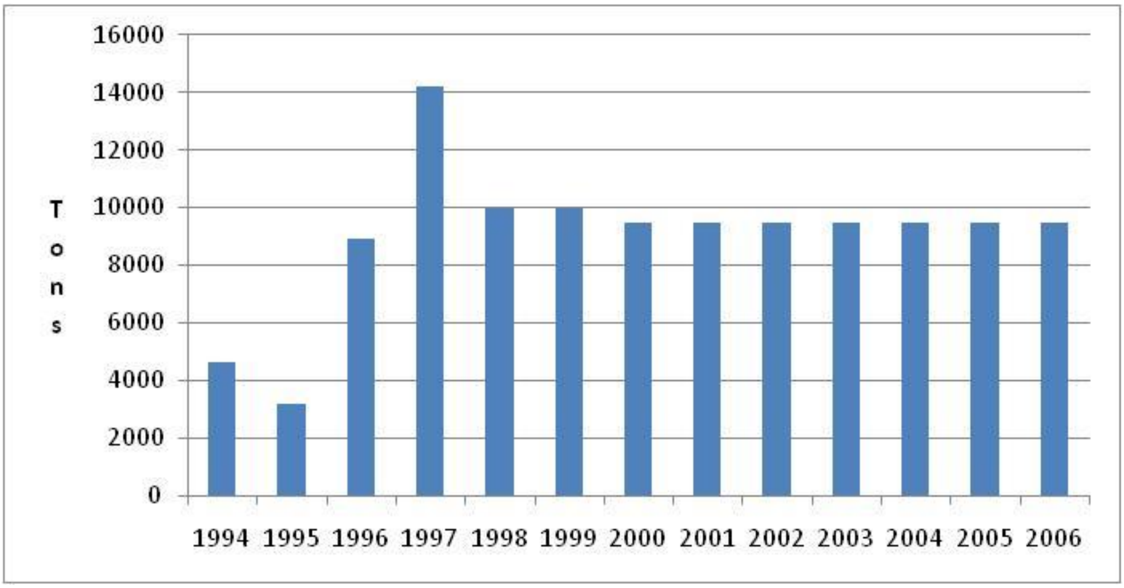

Figure 8: Squid production in DPRK from 1994-2006 (FAO 2009).

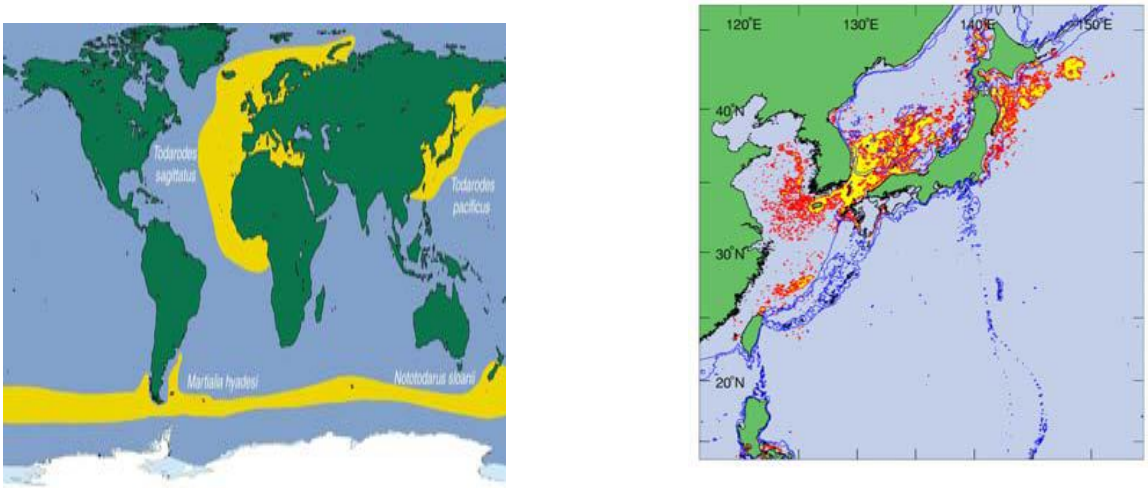

Figure 9: Fishing area for Squid (FAO 2005).

Frozen squid production is one of the important seafood products for the domestic consumption and foreign trade in DPRK. Every year a number of vessels are capturing squid in bulk during the fishing season from early of June to the end of December. The squid fisheries reached its peak in July- August during the hottest season, when consequently the seawater temperature is very high. These natural environments give the possibility for rapid bacteria growth, which is main cause of food-borne diseases. It is therefore important to control hazards in seafood production successfully during this season. As mentioned in chapter 4, the HACCP system is a systematic approach to food safety control. It can be applied to all the food chain from raw materials to final consumers.

4.2 The application steps of the HACCP system in squid production

At first, the assembled HACCP team describes the product and process. In small and medium-sized food businesses can confidently conduct food safety control system without the help of HACCP team but it is advisable to involve key personnel to secure their proper involvement once the HACCP system is implemented. In a product description and processing the HACCP team should identify and document all the important aspects of the product including the raw material name, harvesting area and location of the catch/region area and the intended use (Table 2).

The HACCP team then construct a flow diagram that describes the process and shows all main processing steps. The flow diagram should be simple but still be accurate enough for identifying any critical aspects of importance (Figure 8).

The HACCP team then confirm the flow chart to secure that it is in accordance to the diagram. This should include all ingredient added or packaging material used. Each processing step of the flow chart is analysed for possible hazards by the HACCP team. In this stage, all potential microbiological, chemical and physical hazards are considered in each step from receiving raw materials to final products (Table 2).

Table 2: Product description for Squid production.

Product name	**Squid (*Todarodes pacificus)***
Fishing area	The east sea of Korea
Finished Product:	Frozen whole squid. Frozen at sea Packed into 15kg plastic bags and labelled with a cotton strip
Food additives, ingredients, processing aids:	Sea water for glazing
Shipping	Shipped in refrigerated trucks or iced in non-refrigerated trucks
Handling before consumption:	The product is cooked before consumption
Intended use:	The product is intended for the general public

4.3 Flow chart for squid frozen at sea

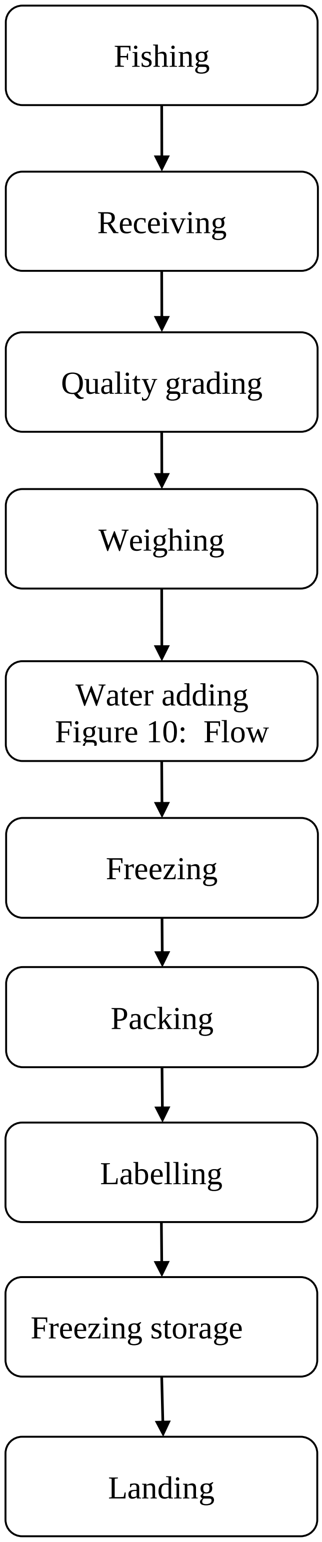

Figure 10: Flow chart for production of squid, frozen at sea.

Fishing
In DPRK the fishing method for squid is mainly otter trawling, which can capture a lot of the squid in a short time during limited catching season. Two fishing boats drag one net for 3-5 hours in general, but the captain who controls the trawling by sonar techniques will determine the dragging time. The trawling time influences the damage of the squid because with longer trawling time the squid bite each other. Each boat is equipped with quick freezing equipment or plate freezers and a freezing storage hole with a temperature between -18 to -20°C. When the captain signals the fishermen prepare to pull the net. Then one captain who will load the products on his deck controls two boats. The captain, who is responsible for guiding the two boats, operates to adjust with dragging speed of the net. The time of pulling the net out is different depending on the depth. It may take 20 -30 minutes to handle a net from 10 to 80 m depth. When the main mass of the squid in the net comes to the surface behind the boat the captain moves the ship backward carefully to be able to lift it by the crane on to the front deck. If the quantity of the products in net is heavy (over 10 tons) the lifting takes longer.

Receiving and storage
The front deck of the boats is often used to load and store sea productions, but the area is little. The front deck is blocked with wooden panels or other materials from parts of the boat to keep the product clean. The squid will stay there until it is processed, for 2-5 hours. Tent or seawater spraying methods on the deck are used during the hottest summer days of over 30°C.

Quality grading
This is the first step in the squid processing. The catch on the deck includes several other fish species such as puffer, anchovy and shark. The fish is sorted away from squid and then the squid is evaluated according to skin quality. The skin can be damaged because they bite each other during long hauls. Processers (fisher men) pick up the damaged squid and other species fishes and sort out the good quality squid.

Weighing
The processors weigh the undamaged squid and put them in the iron box of 15 kg net weight for freezing and then it will be put on balance of 15 kg net weight.

Water adding
Iron box is filled with squid and then water is added to make it be more solid and glazed.

Freezing
The iron box of squid goes into the fast freezer for approximately 5 hours.

Packaging
After the squid is frozen it is taken out of the freezer and removed from the box with the help of water. The frozen block of the squid is then put in plastic sack.

Labelling
The plastic sacks are labelled with a tag when the product is described.

Frozen storage
Under the deck there are cabins to keep the frozen squid at -18°C. Packaged and labelled frozen squid will be kept in frozen storage until unloading to the customer or further processing.

4.3.1 Hazard Analysis Worksheet for squid

To establish a plan that effectively prevents food-safety hazards, it is crucial that all significant safety hazards and the measures to control them be identified. As previously stated, a hazard is a biological, chemical or physical agent that is reasonably likely to cause illness or injury in the absence of its control. The term hazard, when it is used in the context of HACCP, is limited to safety. The potential significance of each hazard should be assessed during the hazard analysis, by considering the likelihood of occurrence and severity. This is based upon a combination of experience, data and research information in technical literature. Factors that may be beyond the immediate control of the processor must be considered during the hazard analysis.

To be able to identify hazard at each operational step for squid a flow diagram was set up (Figure 8) for squid process from fishing to the release of the finished product. During hazard identification there was need to consider all potentially significant hazards that are reasonable likely to occur and likely to result in an unacceptable health risk to consumers if not controlled.

On the hazard-analysis worksheet (Table 3) is hazards identified for squid. In the first step the processing step is explained. In step 2, identifying potential hazards is introduced, controlled or enhanced. Step 3 shows if there are any potential food safety hazards significant (Yes or No). If the answer in step 3 is yes then you need to justify your decision in step 4 and furthermore in step 5 what control measures can be applied to prevent the significant hazard. The answer in step 6 is then either Yes or No for the critical control point.

Control Measures

On the hazard-analysis worksheet for squid, the hazards that are identified for fishing is algae poison (Table 3). According to the research done on the sea of Korea (Ashjian 2005) the fishing ground has high contaminating possibility because of the algal booming and therefore it's necessary to monitor the fishing ground regularly for such algae toxin. If that is done it is not considering critical control point. Although algae booming are evident in the fishing area no evidence could be found whether poison is absorbed by the squid and that should be researched further.

Receiving/Storage is an identified potential hazard because of pathogen growth and it is considered a potential hazard in terms of long processing time in hot weather, which entails pathogen growth. To control that it is necessary to keep a continuous spray of fresh seawater on the squid to reduce the temperature and to keep the squid alive until processing. This will reduce the probability of pathogen build up. Lubricants/glass is also an identified potential hazard in the process because lubricants from machinery and glass fragments may be present on the deck. Prerequisite program must therefore address and check these properly, to be considered not critical control point. Furthermore, metal fragments are identified as potential hazards because bolt and nuts from the machines can exist on the deck. To control that and prevent the significant hazard prerequisite program must be addressed and checked properly so there is no critical control point there.

In quality grade and weighing there are no significant hazards because the processing is very simple and fast, where undamaged squid are picked up and put into iron boxes and weighed.

In seawater adding, there are some biological hazards of significance such as pathogen growth and algae poison. The seawater in tank is used in adding, so pathogen will grow when the weather is hot and it takes long processing time. In summer June -August, outside temperature is almost over 30°C in DPRK and seawater temperature is also over 25°C. The control measures should maintain the continuous seawater changing system and operate it properly. It is important to use identified sea water that was addressed control measured to fishing ground, so it is not critical control points.

Blast freezing is identified the hazard due to pathogen growth if the freezing machine doesn't work properly and maintain the time plan. Proper working plan (Table 3) must be conducted and strictly kept for control measure, reducing the probability of bacteria growth to an acceptable level.

Packaging and packaging materials are seen as potential hazards. Identifying the character of processing method of the packaging materials it is considered that the potential hazard is not likely to occur.

In labelling, the ink from the maker could contaminate the products. It is important to select suitable writing instrument and work properly with it for control measure of significant hazard. This will be controlled in the prerequisite program.

Frozen storage is not identified as a significant hazard as the product would have to thaw up before pathogens are able to grow and that is not likely to occur.

5 DISCUSSION

This project is mainly focusing on the concepts of the food safety management system, especially the HACCP system that is generalizing in the world and can be applied to every step of the food chain. And it also emphasises the application of the HACCP system in squid production and processing on the boat in DPRK. The traditional food safety system is the abject to search on the superiority of the HACCP system over the conventional system, which is mainly dependent on the end product test system. So identifying the disadvantages of the traditional food safety management system is significant in explaining the advantages of the HACCP system economically and financially. And the traditional food safety system also includes the Good Manufacturing practices (GMPs) and Good Hygienic Practices (GHPs), which are the basis of the HACCP system. So in chapter 2 it is also to express the structure of the HACCP and prerequisite program, which are inseparable parts to HACCP system.

The HACCP system is common international regulation which is adopted in many countries of EU as well as the developing countries including Asian, Latin American Caribbean and so on. In chapter 3, 4 main contents of the HACCP system are explained; 7 principles and 12 steps of HACCP application according to codex code. The main goal of the project was to find out the methods for applying the HACCP system to the practises in DPRK. The squid production has most proportion among the sea production and combined fishing methods are used in squid capturing in DPRK. To establish the application methods of HACCP system in squid processing is the ideal way to understand and generalize this system more easily in DPRK. So the project emphasises the practical way through to settle the critical control points on every step of the fishing and processing for the squid. It is also significant to set up the model, which can be generalized in the fisheries of DPRK.

Table 3: Hazard Analysis Work Sheet**.**

(1) Ingredient/ Processing step	**(2) Identify potential hazards introduced, controlled or enhanced at this step**	**(3) Are any potential food-safety Hazards significant? (Yes/No)**	**(4) Justify your decision for column 3**	**(5) What control measure(s) can be applied to prevent the significant hazard**	**(6) Is this step a critical control point? (Yes/No)**
Fishing	Algae poison	Yes/NO	Fishing ground is known to contain booms. No evidence of algae poisoning due to squid consumption	Monitoring of fishing ground must be addressed	No
Receiving/ Storage	Pathogen growth Lubricants /glass Metal fragment	Yes Yes Yes	Long processing time in hot weather will make pathogen growth. Lubricants from machine sand glass fragments could existed on deck. Bolts and nuts from the machine could be existed on the deck.	Keep continuous spraying fresh sea water on surface of the squid to reduce the temperature and keep squid alive -Controlled by the Prerequisite program -Controlled by Prerequisite program	No No No
Quality Grade		No			
Weighing		No			
Water adding	Pathogen growth Algae poison	Yes Yes	Pathogen can grow if sea water in tank gets high temperature in hot weather for a long time. Fishing ground has high contaminating possibility by the algae booming	Prepare continuous sea water pumping system and work it properly in tank Monitoring for fishing ground must be addressed	No No
Blast Freezing	Pathogen growth	Yes	Delay of the freezing will allow grow pathogen	Maintain proper operating procedures	No
Packaging	Chemical contaminants (Packaging materials)	Yes	Chemical elements of packaging materials could give contaminate the products	Packaging materials must be identified strictly and correctly. Only approved packaging material is used	No
Labelling	Chemical contaminants (Writing instrument e.g. Magic maker)	Yes	Makers used do not contain harmful chemicals.	Keep proper operating for writing instrument	No
Frozen storage	Pathogen growth	No	Pathogen will not grow in frozen products	Maintain proper time and temperature of freezing	No

6 CONCLUSION

The HACCP system is the most suitable food safety system, which has been trimmed and accomplished for four decades in the world so far. This system is based on science and a systematic approach, and can be applied at every step of the food chain to protect the people's life from the hazards effectively, and facilitate the foreign trade by increasing confidence in food safety.

The HACCP system also reduces the economic losses coming from food production and consumption by overcoming many limitations of the traditional systems in food safety controlling. The HACCP system can be applied effectively in every field of food industry and has no complexity in implementation and corrective action against hazard.

The HACCP system is applied in many countries, not only developed countries, but developing ones including DPRK.

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