PROCESS IMPROVEMENT ON FISH CLEANING IN FISH CRACKER PRODUCTION

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ABSTRACT

Fish cleaning is performed at the first stage in fish cracker processing. Slow production rate at the fish cleaning process give a negative impact to the production of fish cracker. Traditionally, fish cleaning process is done by inconsistent procedure. Therefore, a new fish cleaning layout is designed to improve the process of this section. By using WITNESS, the current practice of fish cleaning process is simulated to analyze the problem in fish cleaning section. Using simulation technique, the productivity of current practice process is improved and then the result is compared with the current practice of fish cleaning workstation. Reducing distance of workstation to another workstation in the new design layout makes the average total idle and blocked condition decreased. The efficiency of the fish cleaning process can be increase about 34.28 %. Changing type of operation from single to the batch also help in increasing productivity of fish cleaning workstations. It is about to 107 % increasing in the productivity in the fish cleaning operation, a significant increase in the percentage. This study shows that by changing the layout and process type can give the optimal output for the production. Furthermore, the prediction of the output can be obtained by using the simulation, it help entrepreneur in decision making to rearrange or develop the new layout and process in order to meet the demand from customer.

ABSTRAK

Proses penyucian ikan adalah process pertama di dalam pembuatan keropok ikan. Kadar produktiviti yang rendah pada process penyucian ikan memberikankan impak yang negatif kepada pengeluaran keropok ikan. Secara tradisionalnya, proses penyucian ikan dilakukan langkah kerja yang tidak teratur. Oleh itu, susun atur process yang baru dibuat untuk menambah-baik proses ini. Dengan menggunakan WITNESS, amalan proses sebenar disimulasikan untuk menganalisis masalah yang berlaku pada process ini. Dengan teknik simulasi, produktiviti amalan proses sebenar ditambah-baik dan keputusannya diperbandingkan dengan amalan process yang sebenar. Kecekapan process penyucian dapat ditingkatkan sebanyak 34.28 %. perubahan jenis operasi daripada satu kepada kumpulan juga membantu meningkatkan productiviti operasi. Sebanyak 107 % peningkatan terhadap produktiviti process penyucian ikan dan ianya adalah jumlah yang begitu bermakna. Pengajian ini menunjukkan dengan mengubah susun atur dan jenis proses, pengeluaran yang optimum dapat diperolehi. Selanjutnya, ramalan terhadap jumlah pengeluaran dapat diperolehi dengan simulasi, ia membantu pengusaha didalam membuat keputusan untuk menyusun atau membina susun atur dan proses baru untuk memenuhi kehendak pasaran.

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CAD	Computer-aided design
ECER	East Coast Economic Region
ECERDC	East Coast Economic Region Development Council
SMI	Small and Medium Industry
WIP	Work in progress

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The East Coast Economic Region **(**ECER) covering states in Malaysia, the states are Terengganu, Pahang, Kelantan and district of Mersing, in Johor as shown in Figure 1.1. Offering various opportunities to manufacturers and investors, it is ready to become dynamic region in South East Asia by taking advantage of the rich resources and raw materials already in its region.

Figure 1.1: ECER region

Source: ECERDC (2010)

The various economies of scale found in ECER will bring the benefit to the large-scale and small and medium industry from its cost-competitiveness. One of the ECER is the manufacturing strength. The manufacturing strength is mainly resource-based, led by petrochemical, wood-based and food processing sector. From the Table 1.1, can be concluded that the fishery based food industry got a big focus by ECER. Fish cracker is one of the products from fishery based products. So, this study is focused on this product processing

Table 1.1: The focus of the ECER on food processing and the main location

Location	Project focus
Pasir Mas	Halal Park (Food based) Incubator Centre for Micro Traditional and Specialty Food Processors
Gambang	Halal Park (Food and non-food based) Incubator Centre for Micro Traditional and Specialty Food Processors
Bachok	Fish Processing
Tok Bali	Integrated Fisheries Park Fish Processing
Kuala Krai	Food Processing (beef and poultry based)
Gua Musang	Food Processing (beef and poultry based), Herbal Biotech Industry
Chendering	Food Processing (fish and poultry based)
Kuala Kemaman	Food Processing (fish based)
Tanjung Api	Fish Processing

Source: ECERDC (2010)

1.2 FISH CRACKER PROCESSING

Nowadays, Small and Medium Industry (SMI) sector have grown extensively and plays an important role in the economy of Malaysia. SMI development has affected much local food for commercialization. Most of the local foods that have been produced are still not able to meet the standards and quality set by the international market. Therefore, SMI entrepreneurs need an affordable machine to increase their productivity and quality in order to meet market needs. Fish cracker is a famous traditional food in Malaysia, particularly in the eastern coast states of Malaysia Peninsular and it is one of the SMI products in Malaysia. Fish cracker is actually made from minced fish meat of marine fish mixed together with Sago flour and a pinch of salt. The whole ingredient will be kneaded together and hand rolled to sausage shape before it is boiled in hot water. Fish cracker can be eaten in two ways either fried or boiled and suitable at any time, especially in the evening. Currently, fish cracker industry is still using the traditional procedure methods, tools and inconsistent processing procedure it makes this product cannot go to the bigger market. An effort to design optimal processing procedure for entrepreneurs should be done to help this industry growth. From the visit to the fish cracker premise, it is found that the fish cleaning process still using traditional method with old technology. Fish supplies delivered without entrails. Generally, the traditional fish cleaning procedure that have been practiced in the premise are:

(a) Deicing process

(b) Salt water immerse

(c) Cleaning with clean water

Figure 1.2: Cleaning process procedures

(i) Deicing process is the first process of cleaning process. Water is filled into the box that contained the fish and ice to melting the ice. Figure 1.2a shows the deicing process in the fish cleaning workstation.

(ii) After the ice almost melted, fish in the box is scooped using metal shovel and have been transferred into plastic mesh container for the next process. Next, fish have been immersed into salted water at the same time melting the remaining ice as shown in Figure 1.2b.

(iii) Thereafter, fish have been washed with the clean water as a last procedure of cleaning process. Figure 1.2c shows the cleaning fish with clean water operation by worker. Cleaned fish have been left for a while to drain the remaining water before get transferred to the mincing section.

1.3 PROBLEM STATEMENT

Fish cracker is one of popular snack in Malaysia market and has great potential to be introduced internationally (Khaizura et al., 2009). Traditional, inconsistent processing method and improper equipment make this product does not reach the international level. Low of productivity in fish cracker production makes the manufacturer cannot meet the customer demand (Omar et al., 2011). In fish cracker processing, fish is the main raw material. During production, frozen fish is deiced in the mesh plastic container and immersed in salt water before being washed with clean water. All the cleaning process is done manually using traditional tools and methods of work. By using modern techniques and the traditional techniques, entrepreneur could increase the productivity. Therefore, this study is focused on development of systematic process sequence and designing equipment that to improve fish cleaning process.

1.4 OBJECTIVES

The objectives of this study are:

(i) To investigate current problem in fish cracker production.
(ii) To design new machine with combination of three processes, deicing, salted water soaking and final cleaning with clean water.
(iii) To propose better process sequence based on computer simulation.

1.5 PROJECT SCOPES

In order to meet the objectives listed, the scopes of this project have been defined as listed below:

(i) To determine actual process problem in fish cracker processing.
(ii) Design the new machine/workstation using CAD software.
(iii) Make a process simulation to define a better sequence using WITNESS

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses about the current research in fish cracker, cleaner process, thawing stage, deicing and washing stage, water consumption, engineering design, anthropometry and software description.

2.2 FISH CRACKER

Fish cracker is one of most popular Malaysia traditional food especially in a state at the east coast. There many kind of fish cracker, two of them is Keropok lekor and Keropok keping. It normally consumed with chili sauce as a morning and evening snack. It is made from a mixture of Sago flour, minced fish meat and salt as basic ingredients (Omar et al., 2011). The freshness of the fish, the type of fish, the ratio of primary substance and process that have been use can contribute to the quality of fish cracker. Nowadays, there are still many fish cracker entrepreneurs using the old and traditional procedure and equipment. Due to the growth on the demand and the requirement of quality and hygiene product, the industry needs more development on the production process, tool and machine that should be helped the entrepreneur to achieve the market needs.

2.3 FISH CLEANING PROCESS IN FISH CRACKER PRODUCTION

Figure 2.1 shows the flow of traditional fish cleaning procedure in fish cracker production.

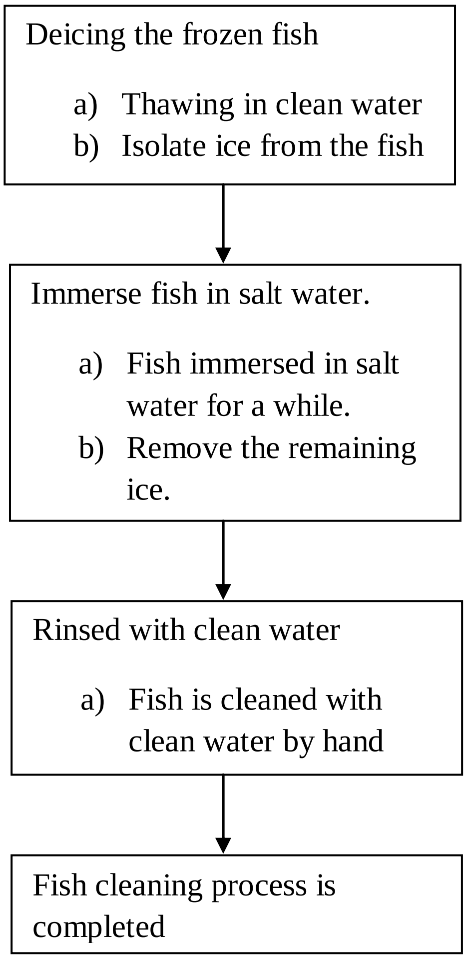

Figure 2.1: Traditional fish cleaning procedure flow chart

2.4 CLEANER PROCESS

Cleaner is defined as continuous application of a preventive, integrated, environmental strategy applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment (COWI, 2000). Their philosophy is 'anticipate and prevent', it is difference compare to the traditional 'pollution control' where the control is done after the event. Commonly, it is applied to production process, and it also can be applied throughout the cleaner production has most commonly been applied to production processes, by bringing about the conservation of resources, the elimination of toxic raw materials, and the reduction of wastes and emissions. However it can also be applied from the initial design phase, through to the consumption and disposal phase. Techniques for practicing cleaner production include improved housekeeping practices, raw material substitution, process optimization, new technology and new product design. Table 2.1 shows the type of option in implementing the cleaner production.

Table 2.1: Types of cleaner production options

Type	Options
Housekeeping	Improvements to work practices and proper maintenance can produce significant benefits. These options are typically low cost.
Process optimization	Resource consumption can be reduced by optimizing existing processes. These options are typically low to medium cost.
Raw material substitution	Environmental problems can be avoided by replacing hazardous materials with more environmentally benign materials. These options may require changes to process equipment.
New technology	Adopting new technologies can reduce resource consumption and minimize waste generation through improved operating efficiencies. These options are often highly capital intensive, but payback periods can be quite short.
New product design	Changing product design can result in benefits throughout the life cycle of the product, including reduced use of hazardous substances, reduced waste disposal, reduced energy consumption and more efficient production processes. New product design is a long-term strategy and may require new production equipment and marketing efforts, but paybacks can ultimately be very rewarding.

Source: COWI (2000)

2.5 THAWING STAGE

The most common method in thawing frozen fish is to immerse it in water. Thawing procedure must be done at the temperature below 5 °C to disallow food poisoning bacteria to grow (Queensland Health, 2008). Figure 2.2 and Table 2.2 is flow diagram of inputs and output for the process followed by table for key inputs and outputs data.

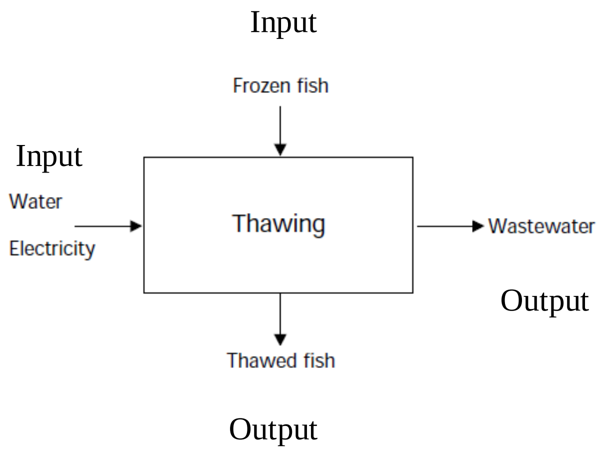

Figure 2.2: Inputs and outputs for the frozen fish thawing process

Source: COWI (2000)

Table 2.2: Input and output data for thawing of frozen fish

Inputs		**Outputs**	
Frozen fish	1000 kg	Thawed fish	950-990 kg
Water	5 m^3	Wastewater	5m^3
		COD	1-7 kg

Source: COWI (2000)

Thawing process also can be done by alternative method so-called *Lorenzo method*. Water is heated to 30-35 °C and then agitated with air sparse to giving a better contact between fish and water (COWI, 2000). The water consumption can be reduced about 40 percent, the moist air method utilize a warm, humid air stream and practically no water. Unfortunately, the high capital investment makes this method is not applicable to the small capital of SMI side (Bing and Wen, 2002). From the others studies there are some other kind of thawing method that can be applied:

(i) High-pressure Thawing

High-pressure thawing can reduce the thawing time (Makita, 1992). The thawing process is done at 200-400 MPa and it is more effective in texture improvement based on experiment that has been done by Teramoto and Fuchigami (2000). The high-pressure thawing method only need one-third of the time that use by conventionally method. Limitations on this application are mainly high cost.

(ii) Microwave Thawing

Microwave thawing needs smaller space and less time for processing and it reduces microbial problems and drip loss (Virtanen et al., 1997). Microwave property that penetrate and produce heat deep accelerating the thawing time (Tong et al., 1993). The localized overheating that cause by preferential absorption of microwave has limited this method to be applies in food systems. Thermal properties varying with temperature and irregular shapes factor make the thawing process by this method be more complicated (Taoukis et al., 1987).

(iii) Ohmic Thawing

In comparison, ohmic thawing is more efficient that the microwave heating because the energy enters the food as heat and no limitation of penetration depth. This method is done by applying the electric current through conducting food with high electrical resistance, the temperature of the food increase by generate heat instantly inside the food (Fu and Hsieh, 1999). The advantages of this method such as high heating rate and prevent the cell damage and softening to the food (Fuchigami et al., 1994). This method potentially to be used in supplying thawed food in high quality. However, the high cost to change electrostatic field to alternating electric field make this method not applicable for the low capital sectors. Much more research on this thawing method is needed.

(iv) High Power Ultrasound

The propagation of ultrasound through a biological material induces compressions and decompressions (rarefactions) of the medium particles, which imparts a high amount of energy (Awad et al., 2012). High power ultrasound can be applied using sonication baths or ultrasonic immersion probes with different lengths, diameters and tip geometries depending on applications. Acoustic streaming is the main mechanism in this method. It is the motion and mixing within the fluid without formation of bubbles and causes the liberation of high energy. Awad et al. (2012) reported thawing time is reduced and the quality is preserved instead using this method. Nowadays researchers were able to optimize many application of this method to the food product.

2.6 DE-ICING AND WASHING STAGE

Takes reference from the process of fish filleting. Boxes of fish containing ice and water emptied into the deicer tank and stirred to make ice float to the surface and the fish sink to the bottom of the tank. Overflow system skimmed the floating ice outside the surface. Table 2.3 provides data for the key inputs and outputs for de-icing and washing fish.

Table 2.3: The key inputs and outputs for de-icing and washing fish

Inputs		**Outputs**	
Ice and fish	1000 kg	Fish	980–1000 kg
Water	1 m^3	Wastewater	1 m^3
Electricity	0.8–1.2 kW.h	Solid waste COD	0–20 kg
		COD	0.7–4.9 kg

Source: COWI (2000)

Water is supplied to the de-iced tank to compensate for the water that overflows from the tank. The rate of water consumption is about 1 m^3 per tonnes of fish, but depends on the capacity of the machine. Water is also used at the grading equipment to keep the fish lubricated so that they slide down the grading incline. The rate of water consumption for this is about 0.3–0.4 m^3 per tonnes of fish. The wastewater discharged from these processes contains minor amounts of organic matter, the quantity of which depends on fish quality. Reducing the amount of water that overflows from the de-icing tanks can save water.

2.7 WATER CONSUMPTION

Most seafood processors have used high amount of water for cleaning plan and equipment. The water consumption increased rapidly in accordance with volume of the production escalation. Water are use in fish storage and transport , cleaning , freezing and thawing, equipment cleaning, brines preparation, floor cleaning an offal transport increases (Duangpaseuth et al., 2007) as shown in Figure 2.3.

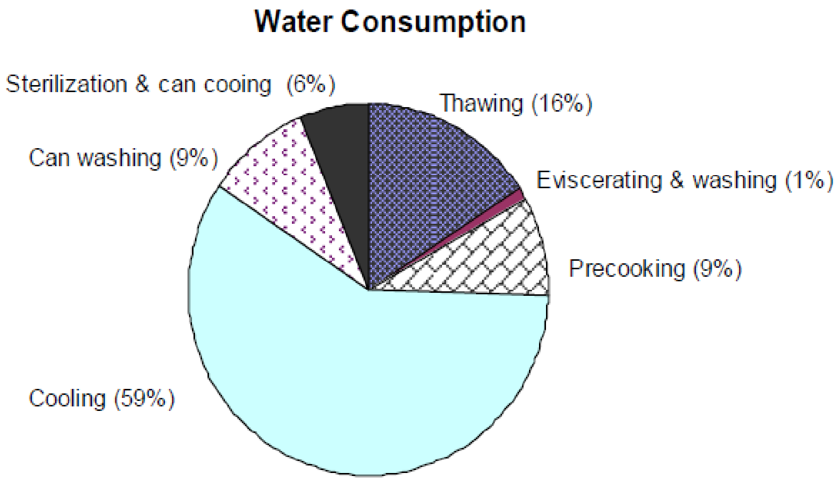

Figure 2.3: Pie chart of the water consumption in seafood processors

Source: Duangpaseuth et al. (2007)

Generally, water has been used in fish processing because the effectiveness of sanitation. The type of product processed, the level of water minimization practiced and the scale of the production are some of factor in water consumption. Water consumption in fish processing operations has traditionally been high to achieve effective sanitation. Several factors affect water use, including: the type of product processed, the scale of the operation, the process used, and the level of water minimization practices in place (Duangpaseuth et al., 2007). General cleaning contributes significantly to total water demand so smaller-scale sites lean to have big amount of water used per unit of production.

2.8 POLLUTANT LOAD OF FISH PROCESSING

Strategies for reducing the pollutant load of fish processing effluent focus on avoiding the loss of raw materials and products to the effluent stream. This means capturing materials before they enter drains and using dry cleaning methods. Some key strategies are listed below as stated by COWI (2000):

(i) Sweeping up solid material for use as a by-product, instead of washing it down the drain.

(ii) Cleaning dressed fish with vacuum hoses and collecting the blood and offal in an offal hopper rather than the effluent system.

(iii) Fitting drains with screens and/or traps to prevent solid materials from entering the effluent system.

(iv) Using dry cleaning techniques where possible, by scraping equipment before cleaning, pre-cleaning with air guns and cleaning floor spills with squeegees.

2.9 ENVIRONMENTAL IMPACTS

As for many other food processing operations, the main environmental impacts associated with fish processing activities are the high consumption of water, consumption of energy and the discharge of effluent with a high organic content. Noise, odor and solid wastes could also be concerns for some plants. A characteristic of fish that has a bearing on the waste loads generated, is its highly perishable nature compared with other food products (COWI, 2000). If not appropriately refrigerated it spoils rapidly, the flesh becomes soft and loose, and pieces are easily lost. As the quality of the fish deteriorates over time, product yield decreases and product losses contribute to the desecrate loads. These losses often find their approach into the effluent stream. Fish processing plants often have little direct control over the handling of the fish catch before it arrives at the plant, except where the fishing vessels are owned by the processing company. In this case, the processor can set quality standards and expect certain handling practices.

2.10 ENGINEERING DESIGN

Engineering design is the systematic, intelligent generation and evaluation of specifications for artifacts whose form and function achieve stated objectives and satisfy specified constraints (Dym, 1994). Generally, design can be divided into detail design and conceptual design and both are categorized as an engineering design. Dym (1994) conclude that the representation is the key element in engineering design. There are a design problem may require a multiplicity of representations, such as geometric or visual analysis, economic or quantitative models, needing analytic physics-based models, or verbal statements not easily captured by algorithms. All the requirements could be statements of intent or function. He also stated that the design process is evolutionary in nature with the option to be made and an alternative route to follow as it appears. Furthermore, according to Yousef and Tamer (2011), it is essential to include a variety of realistic constrains such as safety, reliability, aesthetic, ethic, social impact and economic factor. The process of designing may include a clarifying the requirements of the client, identifying the environment, modeling the behavior whether the device can be assembled or not, identifying the constraints in aspect of manufacturing, economic or marketing, testing and evaluating the proposed design, examination whether there is a more efficient or economic design and documenting the completed design for the client.

2.11 SOFTWARE DESCRIPTION

2.11.1 SolidWorks

Generally, SolidWorks software used to helps engineer in designing product and it is easier to the user to visualize and communicate a virtual design. SolidWorks is computer-aided design software using the Microsoft Windows platform. It is a tool that provides feature-based 3D modeling capability for mechanical design. Similar as industries requiring a precise definition of 3D shapes, it extremely works for mechanical designing. It consists of basic part modeling, assembly composition and from that drawing creation the designer can easily make changes to the design to validate the design to the requirements. Unprecedented balance of power and ease-of-use make this software popular for the mechanical designing work.

2.11.2 WITNESS

WITNESS software capable to set characteristic parameters for machines, forklifts and buffers, like the capacity, the processing times or the speed (for the forklift), allowing "What if" analysis on different scenarios (Briano et al., 2010). It is process simulation software and one of the most suitable software for simulating plant layout. The simulation is made to identify any criticalities in the system in order to validate a hypothetic plant layout considering a certain daily flow of materials, to dimension interpretative and machine buffers and to evaluate the saturation coefficient of the different types of productive machines.

2.12 ANTHROPOMETRY

Anthropometry is the art of application and the science of measurement that establish the strength capabilities, mass properties and physical geometry of human body (Leilanie and Prado, 2007). Anthropometry plays an importance role in the industrial design, ergonomic and architecture. Anthropometry is important in an ergonomic designing and it help in provided the collected statistic regarding size or dimension of human body (Karmegam et al., 2011). It help in the development of design by determine the appropriate overall size of the design that should be comfortable to the expected user.