DEVELOPMENT AND IMPROVEMENT OF VALUE-ADDED AND FUNCTIONAL FOOD FROM FISHERY PRODUCTS IN MALAYSIA

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ABSTRACT

Malaysia is known as a fish eating nation; with a good reason. Fish and fishery products will continue to form important component sources of protein, essential fatty acids, mineral and vitamins to Malaysian diet. At present, fish constitutes about 60% of the animal protein intake with per capita consumption of almost 60 kg per annum. In year 2008 the fisheries sector produced 1.75 million tonnes of fish with a value of RM 7.5 million (Malaysian Ringgit). Basically the fish processing industries in Malaysia can be divided into traditional, small and medium scale and commercial. Small and medium scale enterprises have dominated the fish processing in Malaysia, while the commercial scales are export-oriented and encompasses the processing of prawns, canning of fish, and the production of surimi and surimi-based products. Export values exceed RM1.7 billion per annum of which frozen shrimps and prawns constitute more than RM 1 billion. Some companies have moved into the production of higher value-added products including breaded and battered products, as well as food supplements. Demand for the high value added product is expected to increase in future due to increasingly conscious of fish and fishery products as health food items. The key areas for growth and development in the food processing industry in Malaysia will focusing on the functional food, convenience food, food ingredients and halal food. This is in line with the government policy to implement of zero waste concepts, optimum utilization of by products from the fishery industry and promoting value added of healthy food. Fishery industries generate huge amount of fish processing wastes and by products that contain highly valuable bioactive compounds. Researchers have been conducted by universities on the functional food are such as chitosan, fish gelatine, fish collagen, on the functional properties of surimi powder and fish oil (omega 3 and 6), fish soup gelatine, fish skin gelatine from marine and fresh water fishes. A new area will be focussed on the seaweed and seaweeds value added products.

Key words: Functional food, fisheries, fish, fish by product

INTRODUCTION

Fish is nutritious and rich in micronutrients, minerals, essential fatty acids and proteins. Fish demand in recent years has been growing, not only because of the increasing needs of the growing population especially from developing countries, but also due to the growing demand for fish, especially from developed countries as a nutritional and functional food. Recently, there are strong interests by the industries as well as the researchers on the functional foods which are derived from fish or fish by-products. This phenomenal was driven when the market and consumption of functional foods are increasing over the years. Fish and others aquatic animal have often been classified as a good source of raw material for functional foods because they are easily digested protein, vitamins and minerals.
CURRENT STATUS OF FOOD PROCESSING IN MALAYSIA

Fish and fisheries products will continue to form important component sources of protein, essential fatty acids, mineral and vitamins to Malaysian diet. At present, fish constitutes about 60% of the animal protein intake with per capita consumption almost 60 kg per annum. In year 2008 the fisheries sector produced 1.75 tonnes of fish with a value of Malaysian Ringgit (RM) 7.5 million (DoF Annual Fisheries Statistics, 2008). The fisheries sector also plays an important role for foreign exchange, generating income and providing employment to the country. It’s contributed about 1.2 percent to Gross Domestic Product (GDP).

Basically the fish processing industries in Malaysia can be divided into traditional, small and medium scale and commercial. Small and medium scale enterprises are dominated the fish processing industry in Malaysia. While the commercial are export-oriented and encompasses the processing of prawns, canning of fish, and the production of surimi and surimi-based products. Export values exceed RM1.7 billion per annum of which frozen shrimps and prawns constitute more than RM 1 billion.

Some companies have moved into the production of higher value-added products including breaded and battered products, as well as food supplements. The demand of the high value added product is expected to increase in future not only because of the increasing population but due to increasingly conscious of fish and fishery products as a health food items. Currently, the key areas for growth and development in the food processing industry in Malaysia are focussing on the functional foods, convenience foods, food ingredients and halal foods. This is in line with the government policy to implement of a zero-waste concept, optimum utilization of fish by products from the fishery industry and promoting value added of healthy food. At these points the fishery industries generate huge amount of fish processing wastes and by products that contain highly valuable bioactive compounds. Research on utilization of the fish processing waste and by products and the technology for producing functional foods is ongoing conducted by government agency and university.

GLOBAL PICTURE OF FUNCTIONAL FOOD

The global functional foods sectors are tremendously growing all over the world. It is a multi-billion dollar industry. It has been focussed that about 50% of its multi-billion dollar foods market can be from the nutraceutical and functional foods (Belem, 1999). The functional food and nutraceutical industry represents in excess of a $75.5 billion US industry (Just-Food, 2007) with prospects of growing to $167 billion by 2010. The United States of America currently possesses the largest and most rapidly expanding functional food and nutraceutical market in the world (World Nutraceutical, 2006). The fastest growing category in the US at present is sport nutrition, which consist mainly sport drink containing vitamin, minerals, protein amino acids, electrolytes or nucleic acids.

The Functional food and nutraceutical markets in the EU have grown over the past eight years, from about $1.8 billion out of a $ 5.7 billion global market in 1999 (Kleter et al., 2001) to 8 billion (Datamonitor, 2007) out of a global market of $75.5 billion (Just-food, 2007).

In Asian region, Japan regarded as the birthplace of the functional food is the world’s largest market at US$ 11.7 billion (Codex, 2007). In total, more than 1700 functional foods products have been launched since 1988. In Japan the term of functional food has been used since 1984 and was created to describe foods fortified with specific ingredients imparting certain health benefits. Actually the Japanese people invented use of modern functional foods in the early 1970’s and ever since the Japanese functional foods industry has been leading in the global marketplace. While growth in this market has been significant, it appears also on other part of the of the world such as China, Thailand, Middle East as well as Malaysia are streamline with this development. This trend is likely to continue as changing population demographics, consumer affluence, increased education, life expectancy and the effects of
lifestyle diseases create greater demand for the products targeting health and wellness (Codex, 2007; Saikat, 2007).

The markets for functional foods are expected growing and dynamic over the worlds. While the market of the functional foods products are growing and enjoying the huge volume sale, yet the term of ‘Functional Foods’ is still not defined and accepted universally. Actually the term of functional foods has already been defined several times, so far no unitary accepted definition for this group of food. The International Food Information Council (IFIC) defines functional foods ‘foods that provide health benefits beyond basic nutrition’; in Japan which was the first national authority to establish a specific regulatory framework for functional foods, classed as ‘Foods for specific Health Use (FOSHU)’, functional foods are defined as those containing ‘effective substances in addition to providing basic nutrition and taste’ (Food Facts Asia, 2003).

There are many definitions of functional foods, representing various sectors, including market science and regulatory domains. Malaysia also having similar problem because there are variety of terms appeared in the market segment other than the functional foods such as nutraceutical, pharmaceutical, dietary supplementary and fortified foods.

**DEVELOPMENT OF FUNCTIONAL FOOD PRODUCTS IN MALAYSIA**

Functional foods are not entirely new to the local food industry and consumers in Malaysia. Basically the functional foods are considered as those foods which are intended to be consumed as part of the normal diet and provide specific health benefit which is beyond its normal nutritive values. The market segment of the functional food in Malaysia is comparatively small when compare into the entire world food market or in the Asian region. Functional food is a new area and is still actively being researched. To date, not many of the processing establishments produced functional foods using the raw material from fish or wastes from the fish processing plants.

With the growing awareness and demand for functional foods in Malaysia, there are opportunity to develop and improve the functional foods from fish and fish by–products. The functional food products are very selective depending on the availability of the raw materials. There are two categories of functional foods product can be considered in Malaysia that is in the form of conventional food or natural and possess sensory characteristics including appearance, colour, texture, consistencies and flavours. Among the functional food fall under the category to be considered conventional, is consuming of fresh snake head for the purpose healing of wounds. Snake fish or locally known as ‘ikan haruan’ is recognized in the Asian and Pacific countries as a remedy for healing of wounds. Snake head used to be eaten with rice in form of soup with the purpose to enhance dermal wound healing, reduce post–operation pain and discomfort. The efficacy of wild type snakehead has made it a common food served to women after childbirth or those who undergo surgical operation. Study have been done by Lay et al., (2006) on analysis of protein composition shows that the smaller fish yielded protein more contents as compared to the bigger fish. The major group of protein in snake head fish enzymes and followed by structural protein.

The new product develops from snake head branded as collagen snake head soup is very popular in the Malaysian market. This due to functional properties from the snake heads that people believe as remedy healing wound in internal organ. The product was undergone heat treatment process and packed in a cup.

The second categories is a functional food contents nutrient and possess functional benefits that can be scientifically proven to be safe over long term usage for the intended target population based on the existing science. Its more advance and used modern technology for modern functional foods. They are become the major player in the market. This category may prove more useful and trendy over the traditional category. Quality and safety of functional foods will be emphasized during production of the products. Its more advanced or modern functional foods, from high technology food manufactures, have become major players in the market. These functional food products are including:>
Chitin and Chitosan

Chitin and Chitosan are natural products derived from the polysaccharide comprising copolymers of glucosamine and N-acetylglycosamine, and can be obtained by partial deacetylation of chitin (Illum 1998, Nunthanid and others., 2001). Chitin is found in the exo-skeleton of shrimp, crabs and other shellfish. Chitosan has been widely used vastly diverse fields, ranging from waste management’s to food processing, medicine and biotechnology. Chitosan has the unique ability to attach itself to lipid and fat. Chitin is one of major structural components of these shell waste and can be identified as a biologically active polysaccharide and thus valuable for many application. These shell wastes are potential source to isolate chitin and currently utilized for commercial-scale chitin production as well as production of chitosan.

In Malaysia, formal research into chitin and chitosan has been on-going for no less than 20 years under the aegis of the Chitin-Chitosan Research Center (CCRC) of the National University Malaysia (UKM). The research and development facilities available in this CCRC are recognized as being among the best in the world. Based on the crustacean and molluscan landing as well as production from aquaculture, sources of chitin-chitosan in Malaysia are sufficient to support chito-industries for this region. The Chito-Chem Sdn Bhd is the pioneer and one as well as the only producer of chitin-chitosan raw materials. Its produced various grades of chitosan as raw material is joint company with others between Eastern Global and Perfect Pursuit (an Ample Effect Sdn. Bhd affiliated company). Its commercialization of chitosan began primarily with the weight reduction. ChitoChem Sdn. Bhd. is the culmination of a joint venture between UKM, Malaysian Technology Development Corporation (MTDC) and two other associated companies of Ample Effect Sdn Bhd. ChitoChem Sdn. Bhd exclusive supply of chitosan to be made available to Ample Effect for its production of the skincare as well as maintain the health products.

Today the application of chitosan no longer for functional food merely in fat remover, blood clotting as well as cholesterol lowering but also for creation of many product items from wonder drugs to artificial skin, to surgery thread, to biodegradable plastics, to crop enhancer, animal feed and water treatment. In this regards Malaysia has step forward for further in-depth research and development are being undertaken in close collaboration with the Malaysian Institute for Nuclear Technology Research (MINT) and local company (Ample Health Products Sdn. Bhd) in the application of chitin-chitosan in Wound Healing Dressing.

Research and product development have been conducted since 1984, and established the sole and pioneer of chitin and chitosan producer was started on the year of 1993. Although raw materials are sufficient for the chitin and chitosan production but the main problem are raw materials scattered in small quantities from small and medium processing plants all over the country. This situation, retarded the development of functional foods industry if compared with Thailand and Indonesia. Products available in market are imported from the neighbouring country.

Based on annual production crustacean- molluscan in Malaysia which involved about 30 marine food processing plants throughout the country are produced 40% of waste materials from this shellfish potentially can be converted about 2.5% into chitin which can provides 80% yield of chitosan (Zakaria, 1994).

The latest development as reported by Jess (2009) chitosan was used with omega-3 to boost the fillet life and improved the nutritional value of lingcod fillet. The lingcod frozen fillet was coated with a mix of chitosan and fish oil can boost shelf life and improve the nutritional load. And another development also reported chitosan marine compound claimed to remedy obesity (Mike, 2009). Its disrupted the uptake of lipid into the cell membrane and block the body’s hunger response.

Fish Oil and Omega-3

Fish oils is a long chain polyunsaturated fatty acids (PUFAs) especially those of the n-3 series mainly cis 5,8,11,14,17-eicosapentaenoic acid (EPA; C20:5) and cis -4,7,10,13,16,19-
docosahexaenoic acid (DHA; C20:6). Fish oil is the main source omega-3 fatty acids are increasingly demanded as pharmaceutical products, food additives, functional food and dietary health supplements. They have pharmaceutical value in prevention of atherosclerosis, heart attack, hypertension and cancer (FAO, 1998). Since then, many studies have been published on the role of omega-3 fatty acids in human health and diseases (Weaver & Holub, 1998; Pamela, 2001).

A number of research on composition of fatty acids of marine fish and fresh water have been conducted in Malaysia (Osman and others, 2007; Suriah and others, 2007; Khoddami and others, 2009). The fatty acids of fish flesh are most beneficial for human health due to its high proportion of unsaturated fatty acids. Osman et al., 2007 has reported on their study of the marine fish in Malaysia water show that fish lipid rich in long-chain n-3 PUFA, especially EPA and DHA. The composition of PUFAs was abundant in head, middle and tail where range for C22:6 (DHA) was from 8.18% to 23.95%, while EPA was present in significant proportion from 7.13% to 19.61% respectively. Another studies by Suriah and others (1995) the composition of fatty acid slightly different with fresh water fish. The fresh water fish contain higher concentration of MUFAs than the saturated and PUFAs. The differences can be due to the fact that fresh water fishes feed mainly on vegetation and plant material while the marine fishes feed on zooplanktons, which are rich in PUFAs. Osman and others (2001) in their studied shown that fatty acid composition on the selected marine fish in Malaysia water, was the PUFAs contents were much higher (56% to 92%) that the saturated fatty acids (3.63% to 11.4%), and MUFAs were much lower (1 to 10%) in marine fish.

The recent study conducted by Khoddami and others (2009) on fatty acid profile of the oil extraction from the fish waste (head, intestine and liver) of Sardinella lemuru and found that all the extracted oils were less than 6% of which the highest was in the liver (5.80%). The predominant fatty acids in sardine waste were palmitic (C16:0; 27.80-35.56%), stearic (C18:0; 5.90-9.30%), oleic (C18:1c; 15.47-21.79%) and docosahexaenoic acid (DHA; C22:6; 11.87-15.95%). The n3/n6 ratio of the respective head, liver and intestine lipid samples showed the value higher than 1. Due to n3 fatty acid compound and n3/n6 ratio, lipid from sardine waste may be a valuable source for human consumption. The studied can be concluded that the waste from sardine could be used as decent substitute source to extract the fish lipid and the advantages is the lipid from the fish waste much cheaper compared with the lipid extracted from flesh. This lipid considered as a highly attention source for human consumption as well as industrial use. In this regard the financial benefits can be obtained and environmental pollution is may be reduced. The potentiality to obtain health benefit of PUFAs especially for the family of omega-3 fatty acid whether in laboratory or at industrial scale have been successfully identified (Sahe and others, 2009) for the purpose of producing functional and supplements food. Now, emphasize must be given on the recent advances technology developments, in particular the supercritical fluid extraction (SFE) from marine fish as well as from the by-product of processing plant.

Even though there are a lot of work and researches on product development has been carried out, yet not many industries involve in the production of fish oil from the marine and aquaculture fish in Malaysia. This is may be due to the Malaysian is known as a fish eating nation; with a good reason. At present, fish constitutes about 60% of the animal protein intake with per capita consumption is 60 kg per annum compare to 10 years ago 46 kg per annum.

At present, only one factory produce fish oil in Malaysia. Most of the fish oils available in market are imported. This is because not enough of raw material to extract the fish oil from fish. All fish landed are being used by fish processing plants. Therefore the potential alternative source to produce a good quality fish oils for human consumption are from large amount of offal generated from the processing plants particularly from fatty fish by products. Marine fish in Malaysia and its by products contain high value of fish oils (Khoddami and others 2009; Osman 2001). At this moment Malaysia not yet utilized by-products from the processing plants for any products of functional foods.
Gelatin

Gelatin is denatured protein derived from collagen by thermo-hydrolysis. It is a unique protein due to both its ability to form thermo-reversible gel with melting temperature close to body temperature and its solubility in water. Gelatin is one of the most important biopolymer; with wide spread application in the food, pharmaceutical, cosmetic and photographic industries. In food industry, gelatine is used extensively to enhance the elasticity, consistency, and stability of food products. Recently its use is expanding to new applications such as functional food.

Collagen is the most abundant protein in vertebrate and constitutes about 30% of the total protein. It has a wide range application in the leather and film industries, in cosmetic and biomedical materials and as food. In addition, collagen has been used to produce edible casings for the meat processing industries such as sausages, salami and snacks. Due to many constrains with regards to religious and cultures the production of the collagen now focus on the alternatives sources of collagen is from the aquatic including freshwater, marine and mollusc.

In Malaysia, many people’s have reported the potential of product development on gelatine from marine fish (Irwandi, and others, 2009) and fresh water fish (See, and others, 2010; Jamilah & Harvinder, 2002). Research still is going on the use of by-product and discards fish from the processing plant. See and other (2010) reported freshwater fish skin comprising about 5% of the whole fish has become an interesting raw material for gelatine production. From the study they conducted on the four types of fresh water fish namely; snakehead (Channa striatus), catfish (Clarias batrachus), pangasius catfish (Pangasius sutchi) and red tilapia (Oreochromis niloticus) found that the skin of these fish gave high yield of gelatine and gel strength. The extraction yields of the gelatine were higher ranging from 10.78%(w/w) for pangsius catfish gelatine to 27.79%(w/w) for catfish gelatine. Different yield values for gelatine reported by Jamilah and Harvinder (2002) on the black tilapia (5.4%) and red tilapia (7.8%) respectively.

Another study on the extraction and characterization of between the Pangsius sutchi and Salmo salar have been carried out by See and other (2007) showed that extract gelatine from pangsius catfish skin possessed physiochemical and rheological properties were quite similar to those of commercial bovine gelatine, however extracted gelatine from salmon skin had significantly poor physicochemical and rheological properties. Therefore, pangsius catfish skin can be a potential material for gelatine industry in Malaysia as the replacement of bovine skin. Irwandi and others (2009) found the gelatine from for local marine fish namely ‘kerapu’(Epinephelus sexfasciatus), jenahak (Lutjianus argentimaculatus), ‘kembong’ (Rastrelliger kanagurta) and ‘kerisi’(Pristipomodes typus) were comparable to the fish gelatine from other fish species previously reported. Gelatine extracted from Epinephelus sexfasciatus had the highest percentage of yield (68.47%) followed by (Rastrelliger kanagurta (67.8%) and Lutjianus argentimaculatus (55.21%) while Pristipomodes typus give low percentage of yields (43.57%). Amino acids composition of the gelatines produced in their study was comparable to the gelatine from other Malaysia fish species as been reported in previous literatures.

Even though there are numbers of research have been carried out by the universities on the gelatine and collagen in Malaysia but till now none of the industry applied its in their production. Only one operator in Sarawak produced gelatine from fish. Fish gelatine and collagen products available in the market are imported from China. In Malaysia, gelatine and collagen consider a new industry and operated in a small scale. Recently the government has launched the new site in Pahang state to build the factory for production of halal gelatine in a commercial scale.
Carrageenan and Seaweeds Products

In recent years, there has been a growing interest on seaweeds as functional foods. Seaweeds can provide physiological benefits additional to nutritional and energetic, as, for antihypertensive, antioxidant or anti-inflammatory. Its also rich in vitamins such as vitamins A, B and E. According to the previous report, it has been proved that so many biologically active compounds are presents in seaweeds those can use them as therapeutic agent and dietary supplements. Those products derived from seaweeds as nutraceutical and employed as a food supplements are marketed as tablets and pill can provide important health benefits.

The people living on the sea coasts in these countries commonly use fresh seaweeds as food. For instance in the region of Far East and Australia, seaweeds are used as a main food (Madhusudan and others, 2010) as well as people living the coastal areas in Sabah, East Malaysia such as in Sempurna and Kudat. In Malaysia, and others countries like Singapore, Indonesia, Korea, Japan and Australia used of seaweeds or algae in the form of salads, soups, jellies and in vinegar dishes (Madhusudan and others 2010). This is a direct, fresh and natural of functional foods being consumed. Drum (2008) proposed the seaweeds to be eaten uncooked in most cases; he recommends that for more productive to eat a small amount of seaweed daily rather than larger amount occasionally. The reason was positive therapeutic changes caused by eating seaweeds regularly may take several weeks to several months to become obvious. Those species used as food includes Caulerpa sp., Codium sp., Hydroclathum sp., Sargassum sp., Porphyra sp. and Laurencia sp.

Seaweeds are used as a source of food, for industrial application as well as a fertilizer. In Asia, utilization of these plants as a food, where seaweed cultivation has become a major industry. In Malaysia, seaweeds was strong emphasized in the National 2010 Budget by the Prime Minister as one of the most important commodities to be further developed particularly in Sabah. Sabah is still the major producer of seaweed in the country on a commercial scale, and this is mainly in Semporna, Lahad Datu, Kudat, and Kunak. Two species of seaweeds are currently being cultivated namely *Kappaphycus alvarezii* and *Eucheuma spinosum*, largely produce for export purposes.

In 2008, Malaysia has produced 111,298 tonne wet weight of seaweed mainly from Sabah. The seaweed national production target by 2010 of 250,000 tonne (wet weight), however is yet to be achieved. Currently there are two active seaweed processing mills in semi-refined carrageenan production. Both of these processing plants located in Sabah. Malaysia requires about 200,000 tonnes dried seaweeds for the production of carrageenan. Looking at the national production in 2008 was 111,298 tonne (wet weight) it clear that Malaysia is still playing a small role compared to the world requirements of the commodity (Maritime Institute of Malaysia, 2009). In the world hydrocolloid market the requirement of carrageenan is 41,600 tonnes per annum value to about US$416.4 million.

With the emphasized of government as one of the priority commodity to be developed this will give opportunity on the development of functional foods from seaweeds as a carrageenan. Currently the Department of Fisheries has doing the joint collaborations with five local universities to conduct research and product development from seaweeds. The research program will implement soon merely on the cultivation of seaweeds and their usage include by product from seaweeds to semi-refined carrageenan for other value-added products including the functional food.

Other Functional Food Products

Other products could be considered are having the functional properties are the fish protein concentrate (FPC), fish protein hydrolysate (FPH), fish powder and fish sauce. Fish protein concentrate (FPC) was one the earlier products developed from the low-cost protein for the human consumption. It was effective in treating infant malnutrition. Fish powder from the whole by catch marine fish was used to produce fish crisiest. It contains high protein, high
calcium and good source to develop snack. And was suggested could be an alternative source of protein and calcium for consumers allergic to dairy products.

The development of fish protein hydrolysates (FPH) and peptides as functional food ingredients is a relatively recent technology gaining in popularity due to array of potential bioactive properties associated with them, including antioxidant, antihypertensive, immunomodulatory, nuroactive, antimicrobial, and mineral or hormone regulating properties (Alasalvar and others, 2002). Protein hydrolysates obtained by enzymatic or chemical breakdown of food proteins into peptide fragments have long been used for various applications in the food industry including milk replacers, protein supplements, and stabilizers in beverages and flavour enhancers in confectionery products (Kristinsson and Rasco, 2000). Protein hydrolysates are also used in sport nutrition, weight control diets and nutritional supplements (Mahmoud and Cordle, 2000). In Malaysia development of FPC is the first concerted efforts to increase the use and the value of underutilized fish by converting it into a more-readily accepted form. Yu and Ahmad (1998) reported the hydrolysate from *Liza subviridis* has good water-absorption properties and emulsifying capacity increased with degree of hydrolysis.

**FUNCTIONAL FOOD PRODUCTS FROM FISHERY WASTE (BY-PRODUCT)**

There has been an increasing interest in fish by-products during the past year. Today it is seen as potential resource instead of a waste. Marine capture fisheries contributes over 50% of total fish production and more than 70% of this production has been utilized for processing (FAOSTAT, 2001). As a results, every year a considerable amount of total catch is discarded as processing leftover that includes trimming, fins, frames, heads, skin and viscera. A large quantity of processing by product is accumulated as shells of crustaceans and shellfish from marine bio processing plants. Recent estimates revealed that current discards from the world fisheries exceed 20 million tons equivalent to 25% of the total production of marine capture fisheries. A large proportion of total landed fish remains unused due to inherent problems related to unattractive colour, flavour, texture, small size and high fat content. Abundant of trash fish not utilized properly for other products. Waste of processing is also not fully exploited into products that can give benefit to health. In Malaysia this activities has not being fully utilized for the functional food and nutraceutical production into commercial scale.

In 2008, Malaysia has produced 1.4 metric tonnes from the marine capture fisheries which contributing about 80% to the total fish production. About 70% of the total catch direct to domestics market for table food and 30% used in the processing plants for surimi and surimi-based products. The Pelagic fish make up to 30-35% of the total fish landing. A large fraction of this fish end ups as non-food use, such as fishmeal and direct feed to both livestock and high-value species aquaculture. Only a small fraction is being used for human food use, such as a traditional fish product include fermented fish, fish sauce, salted–dried and smoked fish.

The aquaculture sub-sector has contributed of 354, 428 metric tonnes and about 20% from the total fish production. About 80% of the total aquaculture productions are from the brackishwater. Most of brackishwater production are mainly shrimps and used to process for export market. Another 20% of the aquaculture productions are from the fresh water fish which used for table food.

It was estimated about 30% of the capture fisheries are discarded as a trash fish or as an underutilized species. Most of the underutilized fish are the pelagic and a small quantity from demersal fish. However, in recent year the demand for otohimi or fish minced meat for the fish cracker, fish ball and other value added product are increasingly by fish processing plants. Fish ball production is the second largest processed fish based production in Malaysia after fish cracker production. The contribution of fish ball production to the total fish–based processed food products in Malaysia has reached approximately 15-20%. Other fish based products which processed in Malaysia are fish paste, fish nuggets, fish burgers, fish sausages,
fish cake, fish satay, fish patties, fish sauce and fish fingers. Shrimp paste, pickle prawn are fermented products from shrimp. All this activities is usually carried by small and medium enterprises. The commercial fish processing operator are export-oriented and encompasses the processing of prawns, canning of fish, production of carrageenan from seaweeds and the production of surimi and surimi-based products.

Therefore, these underutilized fish were fully utilized for human consumption. At the same time they have to compete with the fish meal and aquaculture operator for the trash fish. Last five year the fish processing industry in Malaysia has shown rapid development, the industries are facing shortage of raw materials. Price of underutilized fish has gone up due to increase demand on the surimi and otoshimi based products. This trend will continue on the following year, therefore a great demand for a raw material from the fish processing plants is expected. There will be greater utilization of discarded fish species for the optimum utilization of value added products for human consumption.

In Malaysia, there are 120 commercial and 5000 small and medium fish processing plants actively operated over the country. Most of these processing plants are only utilized fish flesh and discarded the skins, bones, head, scales, fins, offal and viscera. Estimated a few thousand tons of fish by-products in high nutrient content are dumped or discarded by these processing plants every year. Depending on the type of fishery, by product or waste generated from fish processing plants usually accounts about 30% of the weight of the landed catch. Some of the by-products are converted to fish meal for the commercial fish feed pellets. These by-products offer a good source essential amino acids and rich in energy, minerals and essential fatty acids, potential to be converted to the functional foods, nutraceutical and pharmaceutical. Unknown exactly quantity of these by-products disposed from the processing plants is quite difficult to estimate the capacity of the functional foods can be produced. No literature report on the total quantity of fish waste or by–product dumped by fish processing plants in Malaysia.

Regulation of Functional Food in Malaysia

In Malaysia, the term functional foods are not used in the regulatory system. Therefore, at this moment Malaysia do not have regulation on functional foods. However, foods with nutrition and health claim are permitted. A lot of products in the market claim are the ‘functional food’. These products have flooded in the Malaysian market since they are distributed under the food supplementary category which not covered by the Food Act 1983 (Fatimah, 2002). A term of functional food in Malaysia still not conclusive and no clearly define have been established. Therefore very difficult for the authority to regulate and monitor the products in the market. Malaysia has officially implemented the dietary guidelines. However, functional food claims are not incorporated in the guideline. The Food Act 1983 and regulation 1985 confined to food additives and nutrient supplement in part V Food Fegulation 1985.

But some of the functional foods, destined solely for special target population groups, it is necessary to ensure safety to health for all groups likely to be potential consumers, particularly sensitive groups such as infants, pregnant women, breast feeding mothers and elderly and chronically sick people.

In the United State, Food and Drug Administration (FDA), functional foods regulate under the same regulatory framework as other conventional foods under the authority of the Federal Food Drug and Cosmetic Acts (FDCA) of 1938 which functional foods or components can be placed into numbers of existing regulatory categories, including conventional foods, food additives, dietary supplements, medical foods, or food for special dietary use. Meanwhile, in Canada, Health Canada regulates the functional food and nutraceutical industry whereas the Canadian Food Inspection Agency enforces these regulations. And, most of the nutraceuticals fall under the Natural Health Products regulations of the food drugs and Act which came into effect on January 1, 2004.

Survey was conducted by ILSI Southeast Asia in 2002, in Asian; Japan, China and Taiwan have regulatory system to regulate foods falling wholly or partially within the scope of the functional foods. The Japanese Ministry of Health, Labour, and Welfare (MHLW) set
up “Foods for Specified Health Use” (FOSHU) in 1991 as a regulatory system to approve the statements made on food labels concerning the effect of the food on the human body. In 2001, the MHLW enacted a new regulatory system, “Foods with health Claim” which consist of the existing FOSHU system and newly established “Food with Nutrient Function Claims (FNFC). The FNFC refers to all food that is labelled with the nutrient function claims specified by the MHLW.

**FUTURE PROSPECTS OF FUNCTIONAL FOOD IN MALAYSIA**

Nowadays, functional foods and nutraceuticals have become a hot topic with increasing research interest and product developments. There are also growing interest from the consumers pertaining to these foods. Food can be regarded as functional if they can be satisfactorily demonstrated to contain bioactive molecules that reduce the risk of diseases or act positively to promote good health.

Over the years, functional foods have been given various definitions in the food industry throughout the world. However, in the Malaysian market and despite its variants, it still carries the basic meaning of being a ‘food that has had one or more components incorporated into it to give a specific health, medical or physiological benefit beyond its normal nutritive values’.

One indisputable fact is that the trend of functional foods is picking up steadily in most countries. Despite being one of the smallest segments in the entire world food industry, it has had steady growth over a decade now. In addition, the global economic boom has caused the industry expand into developing nations such as those in South East Asia. Functional foods are not considered entirely new to the local food industry in Malaysia. In Malaysia, functional foods may be divided into two categories, which are modern functional foods and traditional functional foods.

However, there are many products under the traditional functional food category, which incorporate the basic or generic ingredients such as fish sauce and all fermented fish products also be categorized as functional foods. These fermented products are prepared by small or medium scale industries. The more advanced or modern functional foods, from high technology food manufactures, have become major players in the market. This category may prove more useful and trendy over the traditional category.

Overall, the Malaysia functional foods industry is still in its infancy stage (Malaysia’s Premier Online Functional Food Retailer, 2005). More research and development is required in this field to cater for growing demand of functional foods by an increasingly health savvy nation.

Functional foods continue to attract a great attention among the scientific community as well as the public and the food industry, yet there is no internationally recognised definition on the functional foods. To date, number of national authorities, academic bodies and industries have proposed definition for functional foods. According to the Functional Food Science in Europe Project (FUFOSE) functional food ‘ a food regarded as functional if it is satisfactorily demonstrated to affect beneficially one or more target function in the body, beyond adequate nutritional effects in a way which relevant to either an improved state of health and well being and/or the reduction risk of disease. This definition was generally agreed by International Life Science Institute (ILSI) Southeast Asia after organised consultations among Asian nutrition scientists. The functional food should have these criteria:-  i) be in conventional food form and possess sensory characteristics including appearance, colour, texture, consistencies and flavours; ii) contents nutrients; iii) possess functional benefits that can be scientifically proven; iv) possess functional benefits that can be derived by consuming normal amount of foods; v) contain functional nutrient s and/or other substances that may be naturally present or be added to the food; and 6) have been proven to be safe over long term usage for the intended target population based on the existing science (Tee, 2007).
In Malaysia, there is no definition on functional food, it is still inconclusive. Foods and beverages, which are beneficial to health, are referred to as functional foods. The area of functional foods and nutraceuticals is still active research and justifications (Fatimah, 2002). However, direct selling outlets throughout the nation is flooded with these items since they are distributed under the food supplement category and not covered by the Food and Drug Act 1983.

The functional foods and nutraceutical market in Malaysia may be viewed as an emerging industry. It has primarily targeted to address high profile health concern such as heart diseases, high blood glucose and cholesterol levels, hypertension, cardiovascular ailments and menopause. Although the industry has considerable potential, basic research as well as applied clinical and production engineering and marketing are needed to support current aspirations and to help popularise and commercialize product in domestic and foreign market.

A survey conducted in 2007 (Anon, 2007) on the response of consumer to the functional foods in Malaysia, revealed that only 43% consumers attitude towards functional foods, and thus their purchases, are influenced by knowledge and awareness, self-motivation and belief in nutrition and health and 57% might be caused by other factors. The auditor suggested, future research can further study other factors like price sensitivity, availability of functional food on the market and the growing ageing population that might influence consumer’s attitude and the purchase behaviour of the functional food. Nevertheless the study found health-conscious consumers toward the functional food in Malaysia are increasingly in an effort to control their own health and well-being. Consumers tend to purchase functional foods when they have knowledge and awareness of the functional foods. At this moment people tend to belief that whatever food provides a good health be considering as a functional food. The combined scientific support from independent, university and government laboratory for product claims in this area is needed to develop a high level of confidence among the Malaysia consumer.

Actually Malaysia was lags behind in term of the functional foods development particularly in fisheries sector on the usage of waste and by-products from the fish processing plants. Participation from the industries involve in this sector for also very few. They prefer in the production of value added of fish product which its considered also as a functional food. The situation may be due to constraint face by the industry.

The main obstacles in the development and expansion of functional foods in Malaysia are as follows:

i) Insufficient raw materials;
ii) Raw materials are scattered;
iii) By-products from processing used for their fish meal;
iv) Compete with the aquaculture sector for the same raw material;
v) Lack of appropriate technology;
vi) Legislation and enforcement framework;
vii) Lack of collaborative research and product development between industry and government agency, university on the functional foods;
viii) Lack of fund to carry out research and product development on the functional foods;
ix) Slow market and target for certain group of people;
x) Acceptance by the public’s on the functional foods; and
xi) Consumer awareness .

**CONCLUSION**

In Malaysian perspective, functional foods are considered food that caters for certain group of people and have not been listed under the food security issue of the country. Therefore, consumer’s purchase of functional foods is no longer to fulfil their hunger but is to prevent some diseases and have a better and healthy life style. Functional foods potentially
offer consumer many benefits (Hilliam, 1996). Only a few people go for this food particularly community live in city where the awareness on functional high. Most consumers believe that what they eat influences their health.

The functional foods industry is still in its infancy stage. Therefore, the usage of fish by product from the fish processing plants still not fully exploit by the industry as alternative to substitute the raw materials from fish flesh for functional foods. The government needs to intervene and play its roles to urge and encourage the industry to look into this possibility as raw materials for the development of the functional foods. This is in line with the government policy to implement of zero waste concepts and optimum utilization wastes and by products from the fishery industry as well as promoting value added of fisheries products for healthy food to people. Research and product development also must be strengthened on application of suitable technology for the production of functional foods in Malaysia.

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