Nonsom fermented fish rice biology essay

ASSIGN BUSTER

Fish is classified according to origin such as seawater fish, shellfish, oily and white fish and freshwater fish. Fish is a rich source of protein and it contains other nutrients such as essential fatty acids, fat soluble vitamins and calcium (Barnett, 1998). In fish, it contains fat soluble vitamin such as vitamin A , D and a number of water soluble vitamin B group. Vitamin A and D are mostly found in the visceral fat, though there are amounts in the flesh for a few species such as lamprey and some species of tuna (Pirie and Swaninathan, 1975). Fish is also low in saturated fatty acids and oily fish in particular is an excellent source of long-chain omega-3 fatty acids with Î±- linolenic acid(ALA), Eicosapentaenoic acid (EPA) and cocosahexaenoic acid (DHA) to aid in preventing cardiovascular disease(Brunner, 2008). Fish can be rich source of iodine and some magnesium, calcium and iron are also present. However, fish are more perishable due to the surface slime by a mass of bacteria covering the fish body and the bacteria resides in the digestive tract. In Malaysia, fish is an important food in the Malaysian diet and besides consuming it as a dish itself it can be used as a condiment in various traditional form such as dried, salted and fermented.

1. 2 Fermentation

Fermentation is the most conventional method in food processing. It is a desirable process of

biochemical modification by microorganisms that bring changes to food and enhance properties such as taste, aroma, shelflife and nutritive value. Through fermentation, the safety of food can be enhanced by removing their natural toxin components or by inhibiting the growth of disease-causing microbes (Adams et. al., 2001). Food fermentation can be classified in

several groups which is beverages, cereal products, dairy products, fish products, fruit and vegetable products, legumes and meat products. Fermented foods were developed by many cultures for two main reasons, that is to preserve harvested or slaughtered products which were abundant during those times and are scarce and the other reason is to improve the sensory properties of products that are unappealing.

In Southeast Asia, fermentation of fish the most common as fish is a major component in the human diet. Freshwater shellfish , marine fish and crustaceans are processed with salt to produce various type of fermented fish products. Fish fermentation produces a type of savory flavor from marine products by using both endogenous enzymes in fish and salt tolerant microorganisms in the environment. Fish fermentation is also a method of preserving perishable fish and marine products in a high salt concentration (Lee et al., 1993). Lactic acid fermentation plays a major role in preserving perishable vegetables and fishes, ensuring its safety. The organic acids, mainly lactic acid and acetic acid, produced by lactic acid bacteria are effective antimicrobial agents, and they reduce the pH in the foods to prevent the growth of most hazardous food microorganisms (Lee et al., 1994).

1. 3 Nonsom

Nonsom or bosou is a traditional fermented fish-rice product made among the among the KadazanDusun-Murut community in Sabah. It is served during festival occasions such as Pesta Keamatan. The ingredients used to make this dish includes fish rice, salt and grinded kernel seed of the Pangium edule. The process of producing nonsom is simple. First the fishes are

cleaned thoroughly and salted. Rice is added into the conoction and mixed thoroughly. Dried seed of Pangium edule also known as pangi , with the content that is scraped out are pounded into a powder form and is then sprinkled onto the conoction to be mixed. The mixture is then transferred into a tightly close jar and kept for one month period before consumption. Nonsom can also be cooked by steaming, fry with onions and chili or be eaten just as it is (Vivienne, 2007).

One of the ingredients in nonsom is the seeds of Pangium Edule that are said to be poisonous due to presence of hydrocyanic acid which is toxic Pangi seed can only be consumed after treatments such as boiling and soaking in running water(Davidson and Jaine, 2006). These seeds are specialty in Indonesia and have been used as spices. It is claimed that the addition of these seeds into the fermented foods helps in controlling the fermentation process and provide unique flavor to the products. The KadazanDusun community eliminates the poison of pangi by soaking and boiling them in water. They use the powdered seed of pangi as food ingredients in the fermented fish product. This gives a nutty aroma on the fermented fish. The flavor source for spices is due to the dominant amino acids that is present in the fermented seed, which is Glutamic acid (Andarwulan et. al., 1999).

2. 0 SIMILAR PRODUCTS WORLDWIDE

2. 1 Burong dalag.

In the Philippines a fermented rice-fish product which involves lactic acid bacteria is served as appetizer, sauce or main dish (Melchor, 2007). Burong isda is a traditional fermented fish product in the phillipines that is similar to narezushi in Japan. Burong isda is produced in white and red form. The red is

by addition of angkak which is a culture grown in rice. Burong isda is prepared using freshwater fish that is cleaned thoroughly and mixed with salt overnight before mixing with cooled cooked rice. The mixture is left to ferment for 7 to 10 days in room temperature. There are other kinds of burong isda based on the type of fish used. An example is Burong dalag, a fermented rice-fish mixture using mudfish, Phicephalus striatus (Sanchez, 2008).

2. 2 Narezushi

Narezushi is a fermented fish product by fermented salted mackerel with boiled rice. It was suggested that narezushi was developed as a mean of fish preservation. In the past half century, marine fishes has been substituted with freshwater fishes due to the drastic decrease of harvest. Aji-no-sushi is another form of Narezushi that is made from horse mackerel (Trachurus japonicas). The mackerel is gutted and put in a barrel that has been salted. It is then drained off and placed in a vat filled with vinegar rice. The salting takes 3 days to 2 months and the desalting phase varied. The fish are stuffed and covered with cooked rice, scattered with a small amount of Japanese pepper leaves or red pepper and pickled in a barrel with the lid that is held closed by stone weights. The fermentation period last from 6 weeks to 1 year, depending on the manufacturer (Kuda et. al., 2009).

2. 3 Sikhae

Sikhae in Korea is the lactic acid fermentation of seawater fish with cooked millet. The process of producing is similar to other fermented fish-rice products but millet is used instead of rice as it is the common carbohydrate source in the northeastern country. Other ingredients added include minced

garlic and red pepper powder. Garlic shows antimicrobial effect on most microorganisms in raw material and the product. It also functions as a selective agent which explains that why lactic acid bacteria is dominant in sikhae fermentation (Lee, 1997). Garlic plays dual role in fermented fish products by inhibiting Gram-negative bacteria and yeasts and providing LAB less sensitive to garlic with a carbohydrate source for growth (Puladan-Muller et. al., 1999) .

The fermentation last for 2 to 3 weeks at 20°C. The pH of Sikhae drops quickly due to the organic acids formed from the millet that provide fermentable sugar for lactobacillus. The product can be stored up to one month at 5°C after fermentation. The foul fish odor disappears and an acceptable flavor is formed during the fermentation process (Lee et. al, 1993). Leuconostoc mesenteroides and Lactobacillus plantarum are the lactic acids involved in the fermentation of Sikhae. The role of these acid forming bacteria for the preservation of fish is apparent, but a more important factor is their ability to produce acceptable flavor during the fermentation process.

2. 4 Plaa-som.

Plaa-som is a Thai fermented fish produced according to family or local geographic preferences, especially in the central, northeastern and northern parts of Thailand. The fermented fish product is composed of freshwater salt, boiled rice or cooked rice and garlic. In Southern Thailand, another local variety of plaa-som is produced. Palm syrup are used to replace garlic and boiled rice, and from time to time by roasted rice resulting in the resembles of another type of fermented Thai fish known as plaa-uan (Paludan Muller et.

al., 2002). In processing of plaa-som, all ingredients are mixed and left to ferment at ambient temperature (25-30 °C) for 3-5 days in a covered-lid cooking pot. The fermentation spontaneously occur due to the presence of microflora , mainly lactic acid bacteria that is found in raw materials. Appropriate conditions are important in order for the complete fermentation by lactic acid bacteria. For example the presence of carbohydrate and antimicrobial substances containing ingredients like salt and garlic (Kopermsub and Yunchalard, 2008). Garlic is believed to act as an antimicrobial agent against certain gram negative bacteria and stimulating the growth of lactic acid bacteria(Paludan-Muller et. al, 1999).

2. 5 Pekasam

Another similar product to nomsom is pekasam that is localized in the state of Kedah, Perak and Kelantan of Peninsular Malaysia. Pekasam is made from fermented freshwater fish that is mixed with ingredients such as roasted rice, tamarind and salt. It is prepard by thorough cleaning of the fish and salted overnight with 20-50 per cent of salt. Then the fish are drained before mixing 50 per cent of roasted rice powder and some tamarind. The mixture is packed into an earthenware container in layers and allowed to ferment for 2 to 4 weeks. After fermentation, the fish is consumed deep fried or made into a side dish(Lee et. al., 1993). The table below shows the composition of pekasam and the composition may vary slightly depending on the type of fish use and method practiced.

Table 1. Composition of pekasam.

Composition

Approximate range

pH

4. 5 – 6. 1

Lactic acid (%)

0. 1-0. 4

Salt (%)

10. 0-16. 0

Moisture (%)

57. 0-73. 0

Protein(%)

15. 0- 25. 0

Fat (%)

3. 0-8. 0

Ash (%)

6. 0-14. 0

Souce Zaiton (1980)

During fermentation process, lactic acid bacteria lowers the pH and preserves the product. The presence of the organic acid also contribute to the flavor of the product. The formation of acid combined with the addition of

salt eliminate proteolytic and putrefying microorganisms. The carbohydrate source that supports the growth of lactobacilli comes from the roasted rice powder which also aid in masking the fishy odor and colour development of the final product. There is also some breakdown of the fish protein by autolysis to peptides and amines. These compounds together with acids and products formed by microbial fermentation give rise to typical flavor and odor of the pekasam (Lee et. al., 1993; Kuda et. al., 2009).

3. 0 WHAT WERE DONE IN THE PAST.

Currently there are hardly any studies on the local indigenous fermented fish-rice products of Malaysia such as nonsom. The only studies made so far are the effect of Pangium edule seed in the production of fermented fish by Ajik (1999) and the nutritional content and physiochemical analysis of fermented fish of different species from different areas in Sabah by Joanis (2002). The study done by Joanis (2002) found that nonsom from Tamparuli using Tilapia mossambica contained the highest nutrient and mineral content. Most of the studies were carried out on the seed extract of Pangium edule whereby antioxidant activity were associated with mobilization of lipids and phenolic compound during fermentation (Andarwulan et. al., 1999). According to (Chye and Sim, 2009) report, there is a strong relationship between the phenolic compound of the seed extracts with the antioxidative and antibacterial activities. It was concluded that the phenolic extracts possess good antioxidant and antimicrobial activities which could be a promising source of natural preservative and be used in pharmaceutical industry. On the other hand, pekasam which is a similar product of nonsom has already been studied on the fermentation process and fast fermentation

method has been introduced whereby the product can be ready in 2 to 3 weeks (Che Rohani Bt. Awang, 2001).

In other previous work, there were studies done on the microflora and chemical changes in fermented fish products during fermentation. It is found that lactic acid bacteria are the dominant microorganisms involved in the fermentation of fish-rice products such as Plaa-rom, Narezushi, Burong isda, sikhae and in our local indigenous fermented food of Pekasam and Nonsom. The lactic acid bacteria involved for each type of fermented products are listed in the table below. The role of lactic acid bacteria is to ferment available carbohydrates which lead to a decrease in pH that inhibits pathogenic and spoilage bacteria. The combination of low pH and organic acids present is the main factors that preserve fermented fish products (Paludan-Muller et. al., 2002).

Table 2 : Type of lactic acid bacteria found in fermented fish-rice product.

Country

Name of fermented product

Findings

Journal resource

Thailand

Plaa-som

Parallel growth of yeast and LAB was found. Pediococcus pentosaceus and Zygosaccharomyces rouxii are the predominant lactic acid bacteria and yeast species respectively.

Lactic acid bacteria initiates fermentation followed by alcoholic fermentation by Zygosaccharomyces rouxii.

Paludan-Muller et. al., 2002

Japan

Aji-no-susu

It is reported to be a typical traditional lactic acid fermented fish product and the lactic acid concentration was very high as compared to other narezushi products. The predominant bacterial groups were lactobacilli and lactococci.

Kuda et. al., 2009

Korea

Sikhae

Leuconostoc mesenteroides and Lactobacillus plantarum are the lactic acids involved in the fermentation of Sikhae

Lee et. al., 1997

Phillippines

Burong dalag

The fermentation is initiated by Leuconostoc mesenteroids and Streptococcus faecalis then followed by Pediococcus cerevisiae and finally Lactobacillus plantarum.

Orillo and Pederson, 1968

Besides that, reports on different salt concentrations, presence of amino acids and organic acids and also source of carbohydrates influenced the fermentation process of fermented fish-rice products. In fermentation with salt, the high salt content retards microbial growth, hydrolysis of the fish protein is thought to occur by natural tissue enzymes, cathepsins. For low salt products, halotolerant populations consisting of gram-positive organisms will prevail. “ I- sushi” which is fermented by various strains of lactobacillus has been associated with food poisoning outbreaks from toxin production by C. botulinum type E. (Downes and Ito, 2001). However, different fermented fish products have different salt concentration requirement. The sufficient amount of salt in fermentation is important as it influence the microbial growth and the rate of fermentation which also affects the sensory quality and safety of the product. Padulan-Muller et. al.(2002) studied on the growth of microflora with different concentration of salt in Plaa-som, a Thai fermented fish product. It is found that in high salt concentration of plaa-som, the growth of lactic acid bacteria was inhibited and this delayed the fermentation process. This increase the risk of growth for salt-tolerant potentially pathogenic bacteria, example Staphylococcus aureus (Paludan-Muller, 1999). Thus, 6-7% of salt concentration is recommended for Plaa-som to facilitate the growth of LAB and rapid decrease of pH to below 4. 5.

However, different fermented fish products have different salt concentration requirement.

Aside from salt, the taste of fermented fish-rice product is enhanced during fermentation due to the presence of organic acids and amino acids. According to (Itou et. al., 2006) research, it is reported that the marked increase of the extractive components and organic acids is thought to contribute to the umami taste and the sour taste of narezushi. The extractive components such as free amino acids and peptides increased remarkably because of the decomposition of proteins in fish. As for the organic acid, it increased rapidly due to the fermentation of rice and permeation into the fish meat. Same goes the taste of Aji-no-susu where the predominant amino acids of alanine, lysine, leucine, glutamic acid and theronince were found and are important in providing the taste of fermented fish products (Kuda et. al., 2009).

Fish contains little carbohydrate and thus rice or millet that is used mainly functions as a carbohydrate source for fermentation by LAB for the reduction of pH in products without indigeneous starter culture. Rice is an important source of carbohydrate to provide fermentable sugar for lactic acid bacteria in the reduction of pH. High buffering capacity of the fish is also reduced by the rice in order to obtain a rapid decrease of pH. The decrease of pH inhibits pathogenic and spoilage bacteria thus preserve the fermented fish. The starch from rice are hydrolyzed by the amylolytic activity found in lactic acid bacteria by which is reported (Olympia et. al., 1995.) that lactic acid bacteria strains isolated from burong isda hydrolyzes soluble starch, amylopectin, glycogen and pullulan. Addition of salt and spices such as garlic or pepper

may add to the safety of the product. In another study (Paludan-Muller, 1999) describes the role of garlic that serves as carbohydrate source for lactic acid bacteria in fermented fish product. In garlic, a garlic fermenting Lb. Plantarum strain was found . This indicated that garlic may be more important than rice starch as a carbohydrate source for fermentation. Moreover, garlic play dual role in fermented fish by inhibiting gram negative bacteria and yeasts and acts as a carbohydrate source for growth of lactic acid bacteria.

The traditional method of fermented fish product was based on spontaneous fermentation or by the use of indigenous starter culture. The starter culture serves as a source of a variety of enzyme including amylolytic enzymes. Based on a study (Olympia et. al., 1995) it was found that in strains of L. plantarum contains the L137-amylase enzyme that hydrolyzes both Î±-1, 4 and Î± -1, 6-glucosidic linkages in polysaccharides. The enzyme degrades the starch to fermentable carbohydrates for the growth of lactic acid bacteria in the fermentation process.

Recently there has been studies that mentioned the fermentation process could be improved by using a mixed starter culture. In the fish sauce fermentation a report from Yongsawatdigul et al. (2007) found that strain of Staphylococcus sp. SK1-1-5 from proteinases and bacterial starter culture has the potential to be utilized as it can accelerate the fermentation without having great effect on the sensory qualities of the fish sauce. Another research by Saithong et. al (2010) examined the use of lactic acid bacteria as potential started cultures of plaa-som. The scientists discovered that plaa-som inoculated with the mixed starter culture were found to contain higher

amounts of lactic acid after 24 h than plaa-som inoculated with single starter culture. This indicated the possible advantage of increased product safety and quality in addition to reduction in fermentation time. Moreover, the combination L. plantarum IFRPD P15 and L. reuteri IFRPD P17 starter cultures could also inhibit the growth of clostridia during plaa-som. As a conclusion, L. plantarum and L. reuteri have great potential to be used as starter cultures in plaa-som and may possibly reduce fermentation time.

4. 0 CHALLENGES

The indigenous fermented fish-rice products are mostly produced in household or small factory scale with limited processes to control and ensure the safety and quality of the product. Like other fermented products, it is easily contaminated due to the presence of other harmful microorganisms. Contamination can occur due to exposure to microorganisms from the environment during harvesting, processing, storage and distribution. Besides that, improper food handling and lack of good hygiene practices increases the risk of microbial contamination. For example, fish that is not eviscerated prior to fermentation process are prone to spoilage since the raw materials are not cooked.

Nearly all fish bourne botulism outbreaks are associated with the consumption of salted-dried or fermented fish that is consumed without further cooking. Clostridium sp has been reported to contaminate izushi, a fermented preserved fish with rice in Japan (Downes and Ito, 2001). Likewise in the Philippines, Staphylococcus aureus and Clostridium sp. which has been isolated from bakasang indicated that practice of hygiene during production was poor (Salampessy et. al., 2010). The resultant from pathogenic

microflora present in the food include negative effects such as spoilage, where the food is unfit for human consumption or risk of health by infectious or toxigenic microorganisms being present. Proteolytic bacteria such as Staphylococcus aureus and Clostridium botulinum cause microbiological hazards in fermented fish as both of these microorganisms are associated with salt and raw fish used in the processing. Insufficient level of salt concentration also leads to growth of pathogenic microorganisms in fermented fish products. At higher salt concentration there is a risk for growth of Staphylococcus aureus and Clostridium botulinum type A and B.

Besides that, the producers of the fermented fish-rice products are not well educated on importance of proper handling and maintaining good hygiene practice to avoid cross-contamination during fermentation process of the product. They are also not well aware of the undesirable changes on the fermented food may occur during processing and repackaging of the product. Knowledge on the microflora which are involved in the fermentation process of the fermented fish-rice products are limited.

5. 0 THE EMERGING NEED OF RESEARCH

Currently there are no studies done on the nutritional composition of certain indigenous fermented fish-rice products such as nonsom. Moreover, there is no standardization in the addition of salt concentration since nonsom made from different areas of Sabah are based on personal preferences. Thus, the final product of this fermented fish-rice based product may contain excessive addition of salt. In addition, higher percentage of salt concentration was found to have a slow or no decrease in pH, whereas a rapid decrease of pH was found in low salt concentration (Paludan-Muller et al., 2002). However,

Pekasam which is a similar product to nonsoom has already been standardized in Malaysian Food Act 1985 whereby it must not contain less than 10% salt. Because of this, more research on this indigenous fermented product needs to be carried out for the standardization and safety of the product produced.

Next is the need of improving knowledge base. Other fermented food such as cheese, bread , beer and wine are well known and well developed. However for indigenous fermented fish-rice products, the knowledge is poor. Therefore, to have a broader spectrum of understanding these indigenous fermented products, microbiological, nutritional and technical investigation should be carried out on each process. The isolation and characterization of each organism should be determined and should not narrowed to only the dominant organisms as other organisms in small numbers may contain important function in the process. Understanding the roles of the microorganisms in these fermented products is important as they largely control the qualities of the fermented products.

Also, more research needs to be done on various fermented fish-rice products to accelerate the fermentation time by using mixed starter culture instead of depending on traditional spontaneous fermentation to produce the fermented products. Researches on starter cultures by lactic acid bacteria or commercial proteinase with bacterial starter culture showed that there are great potential for the use of these starter cultures in accelerating fermentation of fish products (Yongsawatdigul et. al., 2007; Saithong et. al., 2010). Thus, more research has to be made on the use of these starter

cultures to other fermented fish-rice products to accelerate the fermentation time and without adversely affecting the sensory quality.

6. 0 STRATEGIC FOR CONTINOUS IMPROVEMENT.

The production indigenous fermented fish-rice product of nonsom has the potential to expand and commercialized as more people are consuming the fermented food and the taste is acceptable. However, the process of fermented fish-rice products are done using traditional method so a more organized and specific method is required to upgrade the way of processing the fermented product.

For small scale industries that produce fermented fish-rice products, implementation of quality control of the processing and distribution is required based on Hazard Analysis Critical Control Point principles. New practices can be added for improvement in Good Manufacturing Practices. Good practices in certain steps and identifying the possible critical control points for example lactic acid bacteria counts, pH and the length of maturation stage, for better production and higher safety standards. Food handlers should also be educated in line with on (HACCP) for controlling safety of the product.

Besides that, to combat issues on safety of fermented fish-rice products reseraches on the microbial and chemical changes in these indigenous fermented fish-rice products are necessary in order to ensure the safety and improve the quality of the fermented product produced. Findings from research can be used as an indicator for the producers to understand different stages of fermentation process and precautions to be taken to

minimize the risk of contamination and maintain quality consistency of the product.

Furthermore, a more safe production can be resulted if starter culture are used. The use of starter culture in the fermentation of fermented fish-rice product could increase product safety and quality as there is a rapid growth of lactic acid bacteria and lower pH to a safe level. In addition, fermentation time is also shorten.