The pre dominant staple foods biology essay

Science, Biology

CHAPTER 1

INTRODUCTION

1. 1BackgroundRice (Oryza sativa L.) is one of the pre-dominant staple foods for more than half of the world’s population, and is consumed as a whole grain after cooking (Singh et al., 2005; Cai et al., 2011). In the normal Asian diet, rice contributes over 40 to 80% of the calorie intake (Bhattacharjee et al., 2002). Rice is normally grown in continents like Asia, Africa and America. Depending on the geographical location, consumer preference varies based on different varieties (Azabagaoglum et al., 2009; Musa et al., 2011). Evaluating the nutritional qualities of rice grain has been given high priority, as it is the major cereal consumed in most of the developing countries, where it is grown (Tan et al., 1999; FAO, 2004; Jiang et al., 2005). It has been opined that variations in composition and cooking quality of rice to mainly depend on the genetic as well as surrounding environmental factors where they are grown (Giri and Vijaya Laxmi, 2000; Singh et al., 2005). Rice grain quality is reported to be influenced by the physicochemical characteristics that determine the cooking behaviour as well as the cooked rice texture (Bocevska et al., 2009; Moongngarm et al., 2010). Additionally, amylose content can highly influence cooking and eating qualities of rice, which can vary based on the variety (Juliano, 1972; Bhattacharjee et al., 2002). Providing adequate information’s on the quality of rice consumed by local population is important for health conscious consumer as well is expected to be useful for minimizing fuel consumption while cooking. Apart from that, as the demands for rice continuously grow due to the increase in population,

the safety aspect of rice needs to be determined (Wogu et al., 2011). Grain quality need to be preserved when it comes to long term storage, hence bacteria and yeast and mould count should be considered. Standards have been established by various bodies regarding the safe limits of microbial population in rice grains. Functional properties such as emulsifying activity and stability, foaming capacity, water and oil absorption capacity of rice are important as it helps to decide whether the grains have promising usage in the food ingredient industry (Theerakulkait, 2006; Marerat et al., 2011). The processing capability and characteristic of the final product is strongly influenced by the functional properties of rice (Perdon et al., 2001). Rice starch is made out of two main polymers which are amylose and amylopectin which is most abundant in the endosperm. The ability of starch to gelatinize and form a viscous substance consisting of leached amylose and broken up starch granules is known as pasting (Manois et al.., 2009). The pasting properties is essential as it helps decide the cooking stability, water binding capacity and baking quality of starch (PBIP, 1995). As functional and pasting properties can play a major role in determining the quality of a rice product, it’s very important to provide details on these parameters, especially for the locally grown rice varieties. Hence, based on these facts, the present study was undertaken to evaluate the functional and pasting properties of different locally grown rice varieties and were compared with those of popular, imported rice varieties in order to provide baseline information’s which are investigated to be useful while developing new rice based food products or food formulations. There has been an escalating interest in research of natural antioxidants present in cereals, fruits and vegetables as consumer

preference and awareness of the health benefits of antioxidants has been made known. Since a long time ago, the health benefits and nutritional quality of pigmented rice have been acknowledged and is beneficial in lowering the development of diet associated chronic diseases (Gunaratnea et al., 2013). The beneficial effects have been related to the phenolic phytochemicals which possessed antioxidant activity. Flavonoids and phenolic acids are the frequently found phenolic compounds in whole grains (Al-Farsi and Lee, 2008). Therefore eating adequate proportions of rice is advised as it not only gives nutritional but health benefits too. With consumer expectations and demands rising for healthy food, food manufactures are having a tough time formulating popular food products which still maintains its appeal in terms of taste, texture and appearance but with different ingredients used. Rice noodles are conventional and a very common dish which is broadly consumed in many Southeast Asian Countries (Panlasigui et al., 1990). The main ingredients for rice noodles are rice and water. Hence the starch found in rice is has to possessed adequate functional and physiochemical properties to produce a high quality starch based noodle (Chen et al., 2003). Partial starch gelatinization is needed to form an amylose network which helps improve the texture of the batter. Rice noodles have a very smooth texture, mouth feel and are white in colour. Apart from that, noodles made from starch is required to have high tensile strength and low cooking loss to maintain the integrity of its eating quality (Purwani et al., 2006). The quality of cooked or uncooked noodles is usually assessed by its visible characteristics. 1. 2ObjectivesThe general objectives of this research were to evaluate the quality and safety parameters of locally

grown and imported rice varieties in Malaysia. These parameters could provide vital information's in identifying ‘ superior quality of rice’ based on its nutritional, microbial, physical, chemical, cooking, functional and antioxidant properties. The specific objectives in this study were: To determine the nutritional and microbial qualities of locally grown and imported rice varieties in Malaysia. To evaluate the physical, chemical and cooking properties. To determine the functional properties. To isolate antioxidant compounds and determine their activities. To produce ‘ local popular rice based food product’ from selected/best rice variety.

CHAPTER 2

LITERATURE REVIEW

Rice is an important cereal crop in Asia where 90% of its production and consumption originates (Hossain and Narciao 2004). Rice is rich in nutrients and contains a number of vitamins and minerals. It is an excellent source of complex carbohydrates which are the best source of energy. There are more than 120000 varieties of rice available worldwide, some of which are consumed only where they are grown and others are well known around the world (USA rice federation, 2007). Oryza sativa, is the more commonly cultivated species around the world and Oryza glaberrima, is more popularly grown in different parts of West Africa (IRRI, 2012).

2. 1Rice Varieties

2. 1. 1White Rice

Milled rice that has had its outer layers removed which consists of the husk, bran, and germ is called white rice. White rice is one of the most popular

types of rice and is the staple foods in countries like Japan, Malaysia and China because it has a fine flavour which balances well with intense and subtle sauces. White rice undergoes a polishing process which eventually leads to a white, shiny and vivid grain. Polishing is also done to avoid oil found on the outer layers of the grain from going bad, thus preventing spoilage (Montilla et al., 2006). White rice has a long storage life which can be extended even further if grains are stored in air-tight containers. Consumers generally favour polish rice over unpolished rice. Most varieties of rice are processed into white rice at the mill, where the grains are scoured to remove the husk, bran, and part of the germ. Many vital nutrients are removed during the polishing process. Rice which has undergone polishing losses about 90 % of vitamin B6, 80 % of vitamin B1, 79% of fat, 67% of iron, vitamin B3 and 29% of its protein content (Abbas et al., 2011; Babu et al., 2009). Hence it is usually recommended that milled and polished white rice be enriched with vitamins B1, B3 and iron to avoid nutrient deficiencies.

2. 1. 2Brown Rice

Brown rice (un-milled rice) has the whole kernel still complete as its bran layer has not been removed. The distinct characteristic which differentiates brown from white rice is not only the colour but also in the milling process. The hull is removed for brown rice, where else the bran and the germ is retained when compared to milled white rice. Brown rice is richer in fibre, nutritious has a mild nutty flavour and is chewier than white rice. It has a shorter shelf life because of the oil present in the germ which causes it to get rancid and develop a bitter taste quicker. Brown rice is not as appealing as

white rice because of its poor cooking and eating attributes (Das et al., 2008). Therefore, the consumption of brown rice is still relatively low, despite being highly nutritious (Chunga et al., 2012). Brown rice is generally not an allergenic food as it does not contain any oxalates and purines.

2. 1. 3Bario Rice

Bario rice is grown at high altitude above 1000 m sea level and has a unique taste. It is considered to be an organic product and demands a high market value, as there is no usage of fertilizers or pesticides during cultivation (NST, 2012). Planting bario rice is a very labour intensive process as it planted and harvested without any usage of equipment’s and machines. Traditional methods are used for harvesting. It has a soft texture, faint aroma, delicate and elongated grain. The yield for bario rice has been declining over the past decade as farmers prefer to venture into other businesses which are more lucrative. The yield for bario rice is only once a year and it takes 6 months to grow hence making it less profitable (Naeg, 2012).

2. 1. 4Black Rice

Black rice (Forbidden Rice) is a type of un-milled rice and is considered to be the heirloom variety of rice cultivated in Asia. The fibre-rich black husks of the rice are not removed, thus increasing its nutritional value which is a rich in iron, vitamins and minerals. Its uncommon colour makes black rice very popular for exotic desserts, noodles and sushi. The name was given back in the olden days as only emperors were allowed to consume it, hence making it more valuable. Black rice is slowly gaining popularity and is rich in antioxidants. The colour of black rice is actually a deep purple to burgundy

and this is due to its high anthocyanin content (Xia et al., 2006). The colour becomes more apparent after rice has undergone the cooking and soaking process. It has a very unique taste, slightly sweet with a nut like flavour, highly nutritious and is claimed to be the new super-food in the market (Daily Mail, 2010). The cooking time of black rice is relatively high; however it can be shorten if it is soaked first. Like brown rice, black rice undergoes spoilage easily, hence having a short storage life. Consuming black rice can lead to the prevention of atherosclerosis, cancer, heart problems, and infectious diseases (Barron, 2010).

2. 1. 5Glutinous Rice

Glutinous rice which is also known as sweet rice isn't sweet and does not contain gluten. It is a rice variety which is particularly cultivated due to its sticky and dense texture once cooked. Thailand and Laos are the primary producers and consumers of glutinous rice worldwide as it is used mainly for in house utilization (Wanchanaa et al., 2003). Glutinous rice is commonly used in stabilizing sauces and gravies due to its low amylose content which makes it more versatile especially when it comes to frozen food (Juliano and Hicks, 1996). It is also used by Asians, to make sushi, desserts and rice crackers. There are two kinds of glutinous rice which are the white type and the black type. Milled glutinous rice is white, and it may be polished to remove the germ whereas un-milled glutinous rice can range in colour from light brown to a mix between purple and black. There was a decline in the cultivation of glutinous rice for a brief period of time due to changes in rice

cultivation technique. However in the twentieth century its popularity increased again.

2. 1. 6 Basmati Rice

Basmati rice is grown mainly in Pakistan and India and is characterized by its long and slender grain. It has an exquisite aroma and a nutty flavour which is associated with the aging process subjected to rice grains to reduce its moisture content (Wass, 2011). Basmati rice has good cooking properties which separate into soft grains combined with a fantastic aroma. It is considered worldwide to be the best variety due to its soft texture, distinct scent, long grain and good cooked elongation ratio once cooked (Bligh, 2000; Arora et al., 2007). Basmati rice has been recommended as an alternative to other rice varieties for people suffering from diabetes as it has a lower glycaemic index thus helping to maintain blood glucose levels (British dietitc association, 2011). The slow releasing carbohydrates, helps limit the appetite.

2. 2Rice Quality

Rice quality is a compound of physical and chemical attributes which is used by a particular user for a distinct application (IRRI, 1980). Being the major grain consumed and grown around the world, rice quality plays an important role to both consumers and rice breeders. There are many factors which determine the quality of rice such as its visible presentation, taste, composition and nutrition (Das et al., 2008). In order to improve grain quality, variety, crop management and post production has to be taken into consideration. Based on milled rice standards in the Philippines, premium

rice should contain 95% head rice, 4. 9% brokens and 0. 1% brewers. Head rice is rice kernels which remains as a whole rice (75% or more) after milling (IRRI, 1985).

2. 2. 1Nutritional Quality

Rice a type of nutrient dense, wholesome grain which provides most of the recommended dietary needs. Rice grain consists of carbohydrate, moisture, fibre, protein, ash and fat. Carbohydrate makes up 75-85% of rice grain and provides most of the calories associated with rice with an extremely small percentage from fat. However, certain vitamins like vitamin A, D ascorbic acid and B12 is not present in rice grain (Houston et al., 1970). Suggestive amounts of dietary fibre can be found in rice grains (Norman et al., 1987). Protein is an essential constituent in a healthy diet as it helps repair and maintain cells, tissues and muscles in the body. Protein is the second highest constituent found in rice and it is considered to be of good quality as it has eight of the essential amino acids. Rice protein is easier to digest when compared to other proteins obtained from vegan sources. Rice does not increase cholesterol levels at all and has a very small percentage of fat. The American Heart Association (1988) states that rice bran oil have a higher percentage of unsaturated fat which does not increase blood cholesterol levels. Rice bran oil has been said to prevent cholesterol synthesis and reduce serum cholesterol levels in different animal models (Wilson et al., 2002).

2. 2. 2Total Dietary Fibre

Dietary fibreis the food fraction which cannot ne enzymatically degraded within the human alimentary digestive tract. The main components are cellulose and lignin, but it can also contain hemicelluloses, pectins, gums and other carbohydrates, which are not hydrolysed by human digestive enzymes (Spiller, 2001). Total dietary fibre (TDF) is the portion which still remains after elimination of plant cell walls using either an acid or alkali solution (Wilians and Olmstead, 1935). TDF is important in the calculation for caloric reduction if foods formulated with fibre. Dietary fibre can be separated into two groups which are insoluble dietary fibre (IDF) and soluble dietary fibre (SDF) based on their dispersibility in water. Both fractions, IDF and SDF have nutritional significance (Ronsivalli et al., 1992). Soluble fibre is known for its hypocholesterolemic effects whereas insoluble fibre is known for reduction in the risk of colon cancer (Sudha et al., 2007). In terms of the effects on dietary and functional needs, the ratio of soluble to insoluble dietary fibre plays a crucial role (Jaime et al., 2002). The food industry has primarily agreed that the SDF/IDF ratio used in the manufacturing of food ingredients should be approximately 1: 2 (Jaime et al., 2002). Dietary guidelines advise a minimum daily intake of 25 g of dietary fibre and this corresponds to 12. 5 g dietary fibre per 100 calories consumed (Marlett et al., 2002). Dietary fibre is normally found in food such as vegetables and fruits or introduced in the food such as bread products to improve their nutritional properties. Fibre incorporation, in frequently consumed food, could help to overcome the fibre deficit (Fernandez-Gines et al., 2003). I cup of brown rice provides 4 g of fibre (University of Nevada, 2009). Rice bran is

one of the richest in dietary fibre. It is commonly used in various health foods and can be a substitute in bakery products and breakfast cereals (Garcia et al., 2012, Dakhara et al., 2012). Food rich in fibre may reduce the levels of total cholesterol and low density lipoproteins found in plasma, which is associated to a greater decrease and excretion of bile acids (Gallaher et al., 1992). Regarding food carbohydrates, dietary fibre plays an important role as defensive agent against cardiovascular diseases, constipation, irritable colon, colon cancer and diabetes (Pietinen, 2001). Additionally, some food high in dietary fibre may result in low glycaemic indexes (GI). Low GI foods are differentiated from other foods by the reduced rate at which they are digested and the slow release of glucose to the blood (Trinidad et al., 2006).

2. 2. 3Amino Acid content

As the world’s population continue to grow, the need for a decent source of protein is essential to provide the essential amino acids required, thus meeting the growing needs (Friedman and Brandon, 2001). Hence, in order to improve the quality of rice, more research needs to be done to study its protein and amino acid composition. Amino acids are organic compounds which are the building blocks for protein and acts as intermediates in various metabolism reactions. Amino acids can be classified into three groups which are essential amino acid, non-essential amino acid and conditional amino acids. Non -essential amino acids can be made from the body, hence not required from the diet. Conditional amino acids are only required when one is sick or ill. Some examples of the essential amino acids required are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, valine,

thereonine and tryptophan. Lysine is required in the development of healthy bones and tendons and can be obtained from half cup of brown rice which provides about 99mg lysine per serving (USDA, 2011). The high concentration of lysine helps boosts up digestibility, hence making rice possess an exceptional biological value and protein efficiency ratio (FAO/WHO 1998). The rice bran which is rich in histidine is required in the maintenance of tissues in the body and for the synthesis of red and white blood cells (Juliano and Bechtel, 1985). Kamara et al., (2010) reported that the concentration of amino acids found in rice influences the sensory properties of cooked rice hence affecting the overall acceptability of rice. Glutamic acid which can also be found in rice has been proposed to be incorporated as a bioactive constituent in the food processing industry due to its various health benefits associated with it (Roohinejad et al., 2009).

2. 2. 4 Mineral Content

The availability of minerals in rice grains has generated an increased interest over the past decade where nutritional benefits are concerned (Abbas et al., 2011). The human body requires various minerals to maintain its healthy state. There are two types of minerals which can be grouped into macro and trace (micro) minerals. Macro minerals are required in larger amounts and some examples include calcium, sulphur, potassium, magnesium, sodium and chloride. Trace minerals are also required and some examples include manganese and iron (Yousaf et al., 1992). Consumption of calcium is essential as it assist in the development and maintenance of strong bones and teeth. Magnesium is required for over 300 biochemical reactions in the

human body and it assists in reducing the risk of cardiovascular disease and high blood pressure. A higher content of magnesium can be found in un-milled rice such as brown and black rice (USDA, 2011). Potassium is required to regulate the behaviour of cells, nerves and muscles in the body. A higher concentration of potassium can be found in rice bran and its contents can also be lost when rice is boiled. Iron on the other hand, is an integral component in blood cells as it assists in carrying oxygen to various parts of the body for various reactions. When cooked, one cup of white rice provides 0. 6 mg of iron, whereas the same amount of brown rice provides 1. 1 mg (Trinidad et al., 2009). The daily recommended intake for iron is 18mg/day (Commission on Life Sciences, 1989). Manganese which regulates the synthesis of fatty acid can be obtained from brown rice as it provides 88% of the daily recommended intake (Lotus food, 2003). Factor such as rice variety, agricultural methods, post-harvest conditions and handling carries weight in the manipulation of nutrient content in rice (Kennedy et al., 2002). Generally brown rice has a higher amount of iron, vitamins and minerals such as potassium as the bran layer is not removed during milling when compared to white rice (American Rice Inc, 2004).

2. 2. 5Heavy metals

Activities done by human for basic survival and wealth such as cultivation, mining, construction and production processes is the main cause of heavy metal abuse (Chiras D. D, 2001). Common heavy metals consist of elements such as arsenic, cadmium, chromium, copper, mercury, zinc, nickel and many others. Heavy metals can intrude into the surroundings from both

human impact on the environment or naturally and hence be a second hand menace to human health (Chen et al., 2001, Imura 1981). In the recent years, community interest has increase as these heavy metals can enter the food chain and get aggregated in the human digestive system to some degree. Plants easily absorb cadmium and other heavy metals from tainted soil (Sukreeyapongse et al., 2010). Since rice is the staple food for most people, grains grown on contaminated soil might be concentrated with toxic elements, hence posing problems to those consuming it (Ashifa et al., 2001). Since the early 1950's, Japan was the first country to disclose findings on cadmium toxicity to humans caused by rice plants grown in contaminated cadmium soil (Kaneta et al., 1983). The source of contamination was from a zinc-mining operation near the paddy fields, which was irrigated with water from a polluted river. The aggregation of cadmium in the body is detrimental when it reaches levels above 200 µg/gm wet weight in the kidney cortex as it will harm the kidney, cause skeletal irregularity and may other illness (Kjellstrom and Nordberg, 1978). The risk of developing cancer in various body parts like the lung, endometrium and breast has been magnified and statistically linked with cadmium toxicity (EFSA, 2009). Arsenic is another heavy metal element which is malignant to human and is regularly found in fungicide, pesticides and also a common element found in the environment. Arsenic has been associated with causing cancer of the skin, kidney, lungs, liver bladder and many more diseases. Initial data shows that arsenic can be found in many rice and rice goods found in the United States (US FDA, 2012). Soil and water are the main cause of arsenic in rice as rice easily imbibes elements compared to other crops. Consumer Union found that brown rice

has a higher level of arsenic as the outer layer of the grains are able to store up more as compared to white rice (Consumer Reports, 2012). Lead is another common heavy metal found in the environment and can cause detrimental effects to human health when present in significant amounts either through aggregation in the food chain or found consistency in the environment. Many body systems like the reproductive and central nervous system can be hindered when intense levels of lead are found and can occasionally lead to death (Ahmed et al., 2001). Lead has been found in japonica rice grains grown in Southeast China at varying concentrations.

2. 2. 6. Fatty Acid Composition

Essential dietary lipids can be found in rice, however not much research has been done, and thus the possibility of its usage has been undermined (Oko et al., 2012). Rice lipids can be divided into two groups which are either free lipids or bound lipids. Most of the oil content can be found in the bran which is removed during the milling of white rice. However the lipid content found in rice still plays a crucial role in the processing, cooking and eating quality of rice (Zhou et al., 2002). This is because, rice lipids can associate and form complexes with amylose, thus interfering with starch gelatinization and water absorption of starch (Tester and Morrison, 1990). Auto-oxidation of lipid can happen when rice is stored for long periods of time thus affecting the quality and odour of cooked rice (Yasumatsu and Moritaka, 1964). Rice lipids are highly nutritious and exist as liquid in room temperature. The fatty acid profile can provide substantial information on the physical and chemical properties of fats and oil in rice. When compared to other cereal grains, the

fatty acid profile for rice is far more superior than other cereal grains as the ratio of saturated, monounsaturated and polyunsaturated fatty acids are roughly 1: 2. 2: 1. 5 (Krishna, 2002). Polyunsaturated fat provides a lot of health benefits due to its hypocholesterolemic effects which regulates cholesterol levels. A good balance of polyunsaturated fatty acids in the diet can prevent and reduce atherosclerosis, coronary heart and inflammatory disease (Connor et al., 2000).

2. 2. 7Microbiological Quality

Microorganisms can be found in boiled and raw rice (Frazier and Westhoff, 1996; Food and Environmental Hygiene Department, 2008). Other potential sources of contamination could come during stages of cultivation, harvesting and other agricultural procedures which are processing and handling (Haque and Russel, 2005). The main types of microbes which are found to contaminate rice grains are yeasts and moulds, mesophilic aerobic bacteria, coliforms and bacillus cereus. To prevent stored rice from getting spoiled or contaminated by microbes, good storage conditions and practices need to be observed and employed. Monitoring and making sure the moisture, oxygen and temperature are at the right levels are necessary to prevent and stop microbial growth. Rice quality will not deteriorate if it’s stored at 65% equilibrium relative humidity (IRRI, 1985). Microbial growth seen in cooked rice will germinate into distinct vegetative forms which will then yield low molecular weight toxins (Jenson and Moir, 2003). Climate is said to influence the formation of mycotoxin and it varies according to geographical location (Reddy, et al., 2004). Grain discolouration, disappearance of vivacity and

toxic contamination are some of the adverse effects of fungal attack. Millions of dollars are lost per annum globally in human and animal health as a result of these toxins (Vasanthi and Bhat, 1998). Food free from physical, chemical, foreign matter and pathogens has an expanding requirement globally as more people desire high quality and secure food (Weinberg et al., 2008).

2. 3 Physical properties

There are many factors which help contribute to the physical quality of rice such as the milling degree, foreign material, head rice, chalkiness and a few others (IRRI, 1985). Foreign material such as stones, weed, soil, gravel, mud lumps are some of the common material found in rough rice. All these contribute to the market price of packaged milled rice. Brown rice kernel with the bran eliminated is a known dimension for milling degree. Milling degree has a strong influence on a few feature qualities of rice such as nutritional, chemical, cooking, eating and physiochemical properties (Payakapol et al., 2011). The market cost and consumer acceptance of milled rice is strongly dependable on its usual manifestation (Rickman, 2002). The corresponding ease during the milling process to remove the bran from rice kernels is controlled by various factors such as moisture content, temperature, kernel exterior profile (Cooper and Siebenmorgan, 2005). After rough rice undergoes milling, rice kernels which maintains 75-80% of its length is known as head rice and the remainder 20-25% is known as broken rice. The combination of head rice and broken rice makes out total milled rice. Chalkiness is described when the milled rice kernel is murky rather than being translucid. It diminishes the visible manifestation and cooking

character of milled rice and is considered as a defective characteristic (Bautista et al., 2009). Chalky grains are more fragile and tend to break easily during milling as it has a lower density when compared to whole translucent kernels (Del Rosario et al., 1968). Rice grains can be classified according to the length and width and is used as an international standard to characterize the rice appearance, configuration and origin based on species (Rice Quality, 2012). Rice grains are generally characterized by its length into three categories which are short, medium and long. In terms of length and width, all samples must be consistent. The facts about dimensions and density of the grain can be evaluated from grain weight. Based on the codex standards (1995b) for rice, long grain rice has a length/width ratio of 3. 0 or more with a kernel length of 6. 0 mm or more and is also classified as slender. Medium grain rice has a length/width ratio of 2. 0-2. 9 with a kernel length of 5. 2 mm or more but less than 6. 0 mm and short grain has a length/width ratio of 2. 0 or less with a kernel length of less than 5. 2mm. Short grain rice is usually classified as bold based on its length to width ratio. Long grain rice are usually fluffy and slender, an example being basmati rice while short grain rice are plump and round and is generally cooks sticky due to the higher starch content present. Medium grain rice is in between long grain and short grain rice. Grain quality appraisal is based on kernel shape and length to breadth ratio (Bisne and Sarawgi, 2008). Consumer acceptance varies from region to region. Long grain rice is preferred by Southeast Asians and South Asians where else short grain rice is much preferred by Japanese and Koreans (Suwannaporn and Linnemann, 2008).

2. 4Chemical properties

The chemical properties of rice such as gelatinization temperature and amylose content play an essential role in influencing the cooking and eating quality of rice (Pandey et al., 2012). Gelatinization temperature is the time required to cook rice and is determine using the alkali spreading value. It is also the temperature where the starch granules began to swell irreversibly in hot water. Intermediate gelatinization temperature is preferred which is within the range of (70-74oC) as compared to low gelatinization temperature (55 to 69. 5°C) and high gelatinization temperature (74. 5 to 80°C). The cooking quality of rice is affected by gelatinization temperature due to the time it takes to cook from its core to the surface (Juliano, 1993). The temperature at which 90% of starch granules has lost its Maltese cross and has coagulated is known as the final gelatinization temperature.

2. 4. 1Amylose Content

Rice is made out of amylose and amylopectin starch. The cooking and eating quality of rice is single-handedly controlled by its amylose content which is directly associated with water absorption, volume augmentation and compactness of cooked rice (Juliano et al., 1965). High amylose content rice (25-30%) tends to cook fluffier, absorbs more water and hardens upon cooling compared to other amylose content groups (Frei et al., 2003). On the other hand, low amylose content rice tends to cook moist and sticky. It breaks apart and divides upon cooling. Hence rice with intermediate amylose content (20 -25%) rice which corresponds to high cooking quality is much

more sought after as it remains soft after cooling. (Suwansri et al., 2004; Ong et al., 2012).

2. 5Cooking Quality

Cooking and eating quality of rice which has an impact on the overall grain quality has many implications on rice cultivating countries (Tian et al., 2005). Rice grain can be classified into two main categories which are Indica (long grain) and Japonica rice (short grain). Japonica rice varieties generally have low amylose content. However, indica rice has a higher percentage of high amylose content with a few varieties falling under the low amylose content group. Cooked Japonica rice tends to cook stickier as it has higher amylopectin content, hence more starchy. Even though rice breeders have been developing many different rice varieties with an increase in yield and resistance to various environmental factors, their eating quality still remains the same and needs to be enhanced (Sun et al., 2011). Variations in terms of cooking properties can be observed in the wide range of cultivars grown worldwide due to the difference in genetic and environmental factors.

2. 6 Functional Properties

As production and consumption of rice is high in Asia, various popular dishes are prepared by utilizing rice in different percentages. Generally, the ingredient in processed foods also utilizes a small percentage of rice (Zhou et al., 2002). Starch is one of the principal components of rice grains and encompasses nearly 90% of dry weight of a rice grain. It also has a significant influence on the texture of cooked grains (Iturriagaa et al., 2010; Mutters and Thompson, 2009). Rice products with varying degree of amylose

content are commonly used in preparation of cakes, baby foods, desserts, or canned soups (Juliano and Hicks, 1996, Mohamed and Hamid, 1998). Consumers' acceptance is very important in choosing the right variety of rice when quality criteria's are set. Furthermore, the structure, physicochemical qualities, texture and gelatinization properties of starch can be an influential parameter in distinguishing particular industrial application and utilization (Juliano, 1985; González et al., 2004). Apart from that, functional properties which includes pasting properties such as gelatinization and retrogradation has an effect on cooking traits (Atwell et al., 1988). Low pasting temperature and setback viscosity is usually correlated with rice which possessed high eating quality (Patindol et al., 2007, Juliano, 1985). In terms of industrial application, pasting properties will help in the prediction of the behaviour of starch during processing.

2. 6. 1Rice Starch

The primary constituent of milled rice is starch and it can be found in the endosperm of rice grains. Apart from starch, carbohydrate and protein are some of the main components found in grains. With the many different varieties found worldwide, isolation of starch from each variety results in different structures, hence possessing different functional behaviours and can be used in various processing applications (Vandeput et al., 2004). Starch granules found in rice were small (2-7 µm). Compared to other starches, rice has one of the smallest particles making it very permeable. Rice starch is well known for being used in various ingredients in food processing due to its versatility, smooth and stand-alone taste as it does not

interfere with other tastes found in other components. The food industry for babies utilizes starch as it’s hypoallergenic, easily digestible and is a good thickening agent. It is also used in the production of low fat food as it has a smooth, milky and rich mouth feel which imitates the dairy industry. Based on its amylose content, rice starch could be divided into non-waxy rice starch (1. 64% of amylose) and waxy rice starch (above 21-30%) (Jiranuntakul et al., 2011). The variation in starch content in rice was mainly due to environment and genetic factors. Rice starch has a polyhedral shape and tends to combine together to form clusters when heated. It is whiter compared to other starches and is easily digestible. Rice starch is generally more stable in cold conditions, therefore can be incorporated in food which uses the freeze/thaw cycle.

2. 6. 2Gelatinization

Starch gelatinization is a crucial factor in determining the rheological properties of various foods as it affects the structure and texture (Ubwa et al., 2012). Changes caused by gelatinization are irreversible as starch granules undergo swelling, loss of birefringence and solubility. Hydration is a common term used to explained gelatinization as the starch granules viscosity starts to increase. Larger granules tend to expand in size first as compared to smaller granules. The presence of lipid, protein, sugar and other foreign material found in the aqueous medium influences the time, temperature and energy required for gelatinization (Delcour et al., 2000). When starch is heated in the presence of water till it reaches its gelatinization temperature, starch will absorb water, thus causing the

granules to swell. The molecules will start to vibrate thus causing the disruption of hydrogen bonds between granules. New bonds will then be formed between water and the hydroxyl group of starch (Murphy, 2009). There is a strong attraction amongst starch molecules and water. Maaruf et al., (2001) states that gelatinization is a process which causes disorder in the molecular arrangement of starch granules. This process can only happen when water, heat and starch are present. The crystalline region of starch which does not allow the access of water, will slowly lose its nature and start dissociating to form an amorphous phase. Once this happens, crystallite melting, solubility and birefringence is lost (BeMiller et al., 2009). Starch is believed to have form paste (gel) when a large amount of starch granules has lost its structure. Birefringence can be observed when starch granules are viewed using a microscope in the presence of polarized light. The crystalline region of starch will exhibit the Maltese cross when refracted with polarized light. When 98% of the maltese cross is lost, the gelatinization temperature of starch is known (Goering et al., 1974). The gelatinization temperature for starch granules varies accordingly as size of granules has an impact on temperature. Smaller granules will take a longer time to gelatinize as it absorbs water slower when compared to larger granules. Factors such as starch concentration and granular type based on the different rice varieties has an effect on the starting point and gelatinization temperature of starch (Singh and Medina, 1988). Apart from that, chemical components which possess strong water affinity may prevent gelatinization by forming hydrogen bonds with water thus, preventing any interaction with starch. Retrogradation plays an important role in establishing consumers' utility of

food products. It is usually described as recrystallization of starch molecules during storage. When retrogradation happens, the intermolecular distance between starch molecules decreases (Sobolewska-Zielińska and Fortuna 2010). The degree of starch retrogradation is influence by storage time, temperature and also starch concentration (Liu et al., 1998).