CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Rice (*Oryza sativa* L.) is the world's single most important crop and a primary food source for half of the world's population. A total of 49% calories consumed by the human population come from rice, wheat, and maize, where 23% are provided by rice, 17% by wheat and 9% by maize. Thus almost one fourth of the calories consumed by the entire world population come from rice (Subudhi et al., 2006). Besides that, rice also plays an important role both economically and in terms of food security (Timmer, 2010).

Rice, like wheat, corn, rye, oats and barley belongs to the grass family (Gramineae) and is a member of the genus *Oryza*. *Oryza* consists of 22 species, of which only two are cultivated: The common rice, *O. sativa* and the African rice, *O. glaberrima* (Khush, 1997). *Oryza sativa* was domesticated in South Asia at least 10,000 years ago (Zhang & Jiarong, 1998) and *O. glaberrima* was domesticated in West Africa between 1500 and 800 BC (Murrey, 2004).

In recent years, aromatic rice has been introduced to the global market. Aromatic rice is also named as fine rice, scented rice or fragrance rice. It is very popular in Asia as well as Southeast Asia and has recently gained wider acceptance in the United States, Europe (Weber et al., 2000), the Middle East (Shobha et al., 2006) and Australia (Blakeney, 1992). Because of its' natural chemical compounds which give it a distinctive scent or aroma when cooked, aromatic rice commands a higher price than non-aromatic rice. Thus, aromatic or scented rice plays a vital role in global rice trading.

Aromatic rice varieties constitute a small but special group of rice. Numerous varieties of rice are aromatic, ranging from the famous Basmati to the lesser known Randhunipagal (Singh et al., 2000). Aroma in cultivated rice is being appreciated more and more by many people and they are willing to pay at a premium price for aromatic or fragrant rice (Sarhadi et al., 2008; Myint et al., 2009; Sakthivel et al., 2009). It represents a high-value-added trait recently. Dela Cruz and Khush (2000) found that high milling returns and good cooking quality are often associated with aromatic rice. Besides, in a report by Sekhar and Reddy (1982), it was found that not only is aroma one of the most important characteristics for determining good quality rice but aromatic rice varieties have comparable or superior nutritional values and better amino acid profiles. One example is Basmati-370 rice which has a higher lysine, phenylalanine, leucine and methionine content than non-aromatic varieties.

The major concern in rice grain quality for aromatic rice is their unique aroma or flavors. Several chemical constituents are related to the aroma or fragrance of cooked rice (Cordeiro et al., 2002). Yajima et al. (1979) have detected a total of 114 different volatile compounds in rice fragrance. Whereas, Nijssen et al. (1996) reported more than 200 volatile compounds in cooked rice. Among them, a "popcorn" like flavor compound, 2-acetyl-1-pyrroline (2AP) stands out as the main aroma compound in both jasmine- and basmati-style rice varieties (Buttery & Ling, 1982; Buttery et al., 1983b; Lorieux et al., 1996; Widjaja et al., 1996; Yoshihashi et al., 2002). In addition, 2-acetyl-1-pyrroline was reported to be found in all parts (stems, leaves, grains) of the rice plant except for the root (Sood & Siddiq, 1978).

There have been many studies on analysis of aroma in rice. Methods like chewing the grains, smelling leaf tissues and grains after heating in water, and reacting with solution of 1.7% KOH are firstly developed by Sood & Siddiq (1978). Although these methods are subjective, they have been widely practiced by researchers

(Bounphanousay et al., 2008; Myint et al., 2009) and become standard protocols for sensory tests in the Grain Quality Laboratory lab at the International Rice Research Institute (IRRI), Philippines.

More recently, gas chromatography mass spectrometry (GC-MS) was introduced to identify 2-acetyl-1-pyrroline (Yoshihashi et al., 2002). Molecular markers also been developed to help identify the genetic control of aroma trait in rice. Molecular markers such as RFLPs, RAPDs, STSs, and isoenzymes were used (Lorieux et al., 1996). Meanwhile, single nucleotide polymorphism (SNP) and simple sequence repeat (SSR) that are genetically linked to aroma have been developed for the selection of aromatic rice (Cordeiro et al., 2002; Jin et al., 2003; Chen et al., 2006; Kibria et al., 2008).

Recently, with the availability of rice genome sequence (Goff et al., 2002), Bradbury et al. (2005b) have developed a perfect marker for aroma genotyping in rice. They declared that it is a recessive trait. They used allele specific amplification (ASA), which is a low cost and time-saving technique to discriminate between aromatic and non-aromatic rice. This is possible because of an eight base-pair deletion and three SNPs in a gene on chromosome 8 of rice that encodes a putative betaine aldehyde dehydrogenase 2 (BADH2) enables the accumulation of 2-acetyl-1-pyrolline. Hence, it has been used to aid the selection of aromatic and non-aromatic rice in rice breeding programs (Sarhadi et al., 2008). During a review of aroma related research of rice, Sakthivel et al. (2009) mentioned that some researchers concluded that the aroma trait undergoes monogenic inheritance, while others favoured the idea that two or three recessive or dominant genes participate in the construction of this trait. But, many research works are still carried on to understand the genetic and molecular basis of aroma in rice.

In aromatic rice breeding program, besides the evaluation of the presence or absence of aroma, the total yield of aromatic rice is the second important selection criteria. A hybridization technique has been developed to assist in producing a high yielding aromatic rice variety (HYV) with better grain quality (Singh et al., 2000b). This is because aromatic or scented cultivars have often been associated with undesirable agronomic characters, such as low yield, susceptibility to pests and diseases, and strong shedding. So, breeders wish to develop aromatic varieties with high yield and good resistance to pests (Bemer & Hoff, 1986).

In this regard, the first high yielding aromatic rice variety was developed in the Indian Subcontinent in 1925 (Azeez & Shafi, 1966) and was followed by others. Most of these were from direct crosses and subsequent generations were handled by pedigree method of selection. Kusuma (crossing TN1 and Basmati 370) is one of the first dwarf aromatic rice varieties released in Kamataka in 1969 (Mahadevappa et al., 1977).

Malaysian aromatic rice varieties are inferior compared to jasmine and basmati type. Malaysia imported almost 100% of aromatic rice from other countries because aromatic rice is now becoming more and more popular in the dealing market (MARDI, 2007). So, in Malaysia there is a wide scope for research on aroma improvement of rice. Malaysian rice breeders should develop a few good quality fine rice varieties to meet the market demand and decrease Malaysia’s expenses in import of fine rice.

Some constraints are slowing down the crop improvement of aromatic rice in Malaysia such as high temperature during their grain filling and ripening stage. However, it is possible to overcome these constraints by selecting proper parental materials and an appropriate breeding strategy (Faruq et al., 2010; 2011). In these observations, genotypes such as E13, E7, E11, Khau Dau Mali, Rambir Basmati and Rato Basmati produced moderate aroma in the tropical environment. These genotypes can be used as potential breeding materials for aroma improvement in rice.

Therefore, the objectives or aims of this research are as follows:

1) To investigate the efficiency of molecular markers in aromatic rice breeding.
2) To detect aroma in F_1 hybrids through phenotypic (sensory test) and genotypic (allele specific amplification) assessments.
3) To carry out genetic analysis in F_1 hybrids.
4) To screen and select F_1 individuals having aroma with fine grain and good yield.