Thai Aromatic Rice (*Oryza sativa* L.)

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ABSTRACT

The review of Thai aromatic rice had been made in terms of characteristics, growing area, scent aroma, factors affect aroma, breeding program, aromatic rice germplasm both glutinous and non-glutinous rices. The characteristics of aromatic rice is to have aroma flavour and texture is rather tall structure and weak to pests and diseases. It can be grown throughout the country with variation of aroma. The paper is specified to Khao Dawk Mali 105 that is not popular only in the country but also neighbour countries as well. The conservation had additionally been established for 904 samples at the centre for the collected aromatic rice in Thailand, that could be used for breeding program in both in and out of the country.

Key words: aromatic rice, Khao Dawk Mali 105, conservation

Introduction

Rice is a major food commodity throughout the world. Different cultures have preference for different type of rice namely glutinous and non-glutinous rice; aromatic and non aromatic rice. In Thailand, aromatic rice or scented rice is so popular among Thai people that the price is higher than other type of rice and has not only grained wider acceptance in Thailand but also in Asia, Europe and the United State of America because of aroma flavour and texture. Aromatic rice emit specific aromatic in fields, at havesting, in storage, during milling, cooking and eating (Efferson,1985; Sithiyos,1986) can

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be detected and evaluated by various techniques (Sithiyos,1986). Aromatic rice generally can be grown throughout the country (Niamsrichand,1977; Sithiyos, 1986) and mostly photosensitive varieties, long duration of growth, tall structure, lodging susceptibility, suffer most from pests and diseases. Soil fertility light intensity day length , storage are believed to affect the aromatic odor.The most well known variety Khao Dawk Mali 105 (KDML 105) although it can be grown once a year and the yield is rather quite low but it is needed by many countries.Then attempts have been made to develope the hybrids that ahould be photoperiod non-sensitive varieties with higher yield and the same quality of aromatic rice. Luckily a few varieties had been released and responded to the need of consumers.This paper has reviewed the area where aromatic rice is growing in both glutinous and non-glutinous rice in Thailand, factors affect the aroma odor in particular to soil fertility as well as biochemical basis of aroma and hybrids of aromatic rice.

Characteristics of aromatic rice

Aroma rice has aroma flavour and texture but is generally weak and tall structure, long duration of growth which causes lodging susceptibility and suffered from pests, and diseases. Among the diseases: neck blast, bacterial blight, sheath blight, brown spot are disastrous while stem borer, leaf folder, brown plant hopper and gallmidge are the most common insect pests.

So far, attempts on discovering genes influencing rice aroma have been reported. As the earliest step in map-based cloning, the primary work on locating grain aroma was reported on chromosome 8 at 4.5 cM from RFLP marker RG28 based on F2 from near-isogenic line cross (NILs) (Ahn *et al.* 1992). In Thai Hawm Mali Rice, using bulk segregant analysis (BSA), grain aroma was linked to a PCR fragment generate from random amplified polymorphic DNA (RAPD) in an F_2 population developed from Thai Hawm Mali Rice and CT 9993 (Tragoonrung *et al.*, 1996). Because of the qualitative scoring used in those studies, it was not possible to determine quantitative nature of the grain aroma. The quantitative trait loci (QTL) analysis was firstly reported for grain aroma in a doubled haploid population (DH)

developed from Azucena, the upland fragrance rice from the Philippines, and IR 64. Both sensory test and the accumulation of 2AP were perfectly mapped on the same chromosomal region flanked by RFLP markers RG 28 and RG 1 (Wanchana, 2005).

Recently, the DNA sequence polymorphism of RG 28 has been assessed in aromatic and non-aromatic rice strains and a PCR-based marker for aroma was subsequently generated (Garland *et al.*, 2000). Moreover, by data mining the rice genomic sequence, a closely-linked microsatellite marker (SSR) (Cordeiro *et al.*, 2002) and a single-nucleotide polymorphism (SNP) marker (Jin *et al.*, 2003) were linked to grain aroma by the genetic distances of 4 and 2 cM, respectively. Although several markers closely-linked to grain aroma, has been reported, their precision in marker-assisted selection program (MAS) has not been realized practically. Therefore, tightly-linked markers at the vicinity of 1 cM are required for effective MAS and positional cloning.

Wanchana (2005) reported that the most important characteristic of Os2AP gene, 8-bp deletion, was uniquely found in all aromatic rice varieties and that can be determined as aromatic or non-aromatic based on this single most important characteristic. According to the sequence variation on the exon 7 of Os2AP, Aromaker was designed for chanracterizing rice depening on their aroma properties. Forty Thai rice varieties different in aroma characteristics as well as well-known foreign aromatic rice strains were tested with that aromarker. The result showed two successfully amplified alleles that were 400 an 392 bp-long corresponding to Nipponbare an THM sequence-reference strains, respectively. All aromatic varieties have THM's allele, while all non-aromatic strains contain Nipponbare's alleles.

Area growing

Aromatic rice both glutinous and non-glutinous are growing throughout Thailand and normally begun with Hawm that mean scent or aroma. Niamsrichand (1977) made a survay and found that, there were totally 17 species of glutinous rice in the Northeast (Table 1) and 28 species of non-glutinous rices in the North, Northeast, the Central plain and the West (Table 2). Each species was

mostly dominantly in specific habitat in each province (Tables 1,2). Hawm Mali or Khao Dawk Mali 105 was broadly populated and popular in quite a few provinces (Table 2) could adapt well to a wide range of environmental conditions, however wide variation in aroma content is observed in rice grain obtained from different areas. Milled rices from the North East region have strong and stable aroma while samples from some areas from the Central Plains and other regions have very weak aroma or non aroma at all. It is believed that the aroma in KDML 105 is depended on the location, soil type and soil fertility, not from the seed sources.

Table 1. Photoperiod sensitive aromatic glutinous rice varieties in Thailand. (Niamsrichand,1977; Anon, 1988)

Type/aromatic rice variety	Province found
1. Kor Hawm	Nakhon Ratchasima,Yasothon
2. Hawm Kaen	Surin
3. Hawm Daengnoi	Nakhon Ratchasima
4. Hawm Dawkpradoo	Sri Sa Ket
5. Hawm Tawng	Ubon Ratchathani
6. Hawm Nangnuan	Surin
7. Hawm Pamah	Ubon Ratchathani
8. Hawm Sawan	Chaiyaphum
9. Hawm Huakao	Surin
10. Hawm Huadaeng	Surin
11. E-Nawn Hawm	Khon Kaen
12. Hawm Naipon	Nakhon Nayok
13. Hawm Nuan	Nan
14. Hawm Udon	Udon Thani
15.Hawm Phaephalo	Kalasin
16. Hawm Daw	Sakon Nakhon
17. Hawm Huan	Sakon Nakhon

Scented aroma

Aromatc rice has likely smell as popcorn or Pandan (Baitoey) (*Pandanus amaryllifolio* Roxb.). (Tsugita,1985-1986). The smell is normally emited in the paddy field during harvesting stage or milling, cooking and eating (Efferson,1985, Sithiyos,1986). Aroma development is influenced by both genetic and environmental factors. It is known that aroma is the best when aromatic rices are grown in area where temperature is cooler during maturity (Efferson,1985). The North and Northeast of Thailand are in that category, then are the best location of aromatic rice production especially KDML 105. Aroma is due to certain chemicals presented in the endosperm. The biochemical basis of aroma is identified as 2-acetyl-1-pyrroline, and the compound is known to be presented in raw grain as well as in plant (Efferson, 1985). There are various techniques to detect and evaluate the aroma in rice namely chewing a few seeds from individual plant and noting aroma

Table 2. Photoperiod sensitive aromatic non glutinous rice in Thailand (Niamsrichand, 1987; Anon, 1988)

Variety	Province found
1. Khao Mon	Nakhon Nayok
2. Khao Hawm or Hawm Dong, Hawm Nangnoi	Ratchaburi
3. Bao Luang or Khao Hawm	Nakhon Ratchasima
4. Khao Ungjerngnoi, Hawm Nak	Petchaburi
5. Kheaw Nokgraling	Nakhon Nayok
6. Naipol no I	Nakhon Nayok
7. Wonglai	Petchaburi
8. Hawm Kaset	Yasothon
9. Hawm Kaenchana	Nakhon Nayok
10. Hawm Dong	Chaiyaphum, Nakhon Ratchasima
11. Hawm Nangmon	Petchaburi, Chachoengsao, Ratchaburi
12. Hawm Mali (KDML 105)	Saraburi, Lopburi, Nakhon Pathom, Nakhon Ratchasima, Chachoengsao
13. Leuang Kaset	Petchaburi
14. Hawm Hang	Phra Nakhon Si Ayutthaya
15. Hawm Sethi	Phra Nakhon Si Ayutthaya
16. Hawm Lai	Bangkok
17. Hawm Puang	Petchaburi
18. Hawm Medlek	Phra Nakhon Si Ayutthaya
19. Hawm	Trat
20. Hawm Kamen	Kanchanaburi
21. Hawn Durian	Chiang Mai
22. Hawm Mala, Hawm Pho, Hawm Bao	Phisanulok
23. Hawm Pai	Chiang Rai
24. Hawm Krua	Sukhothai
25. Hawm Bai	Phichit
26. Hawm Nangnuan	Phayao
27. Hawm Suan	Kamphaeng Phet

(Dhulappanavas, 1976; Sithiyos, 1986) and cooking a sample of seeds from individual plant and noting aroma (Sithiyos,1986; Niamsrichand,1987). The concentration of aroma were tested among the aromatic rice from many countries, Khao Dawk Mali 105 was found to be in the high level (Buttery *et al.*, 1983) (Table 3).

Factor affects aroma

Temperature is believed to be highly effect on aroma especially at the time of flowering grain filling and maturity (Rohilla *et al.*, 2000). Soil factor do affect aroma and other quality traits presenably through plant nutrition and the interaction of volatile nutrients with aroma related to volatile compounds (Rohilla *et al.*, 2000). Application of nitrogen fertilizer adversely affects cooking and eating quality and Suwanarit *et al.* (1996) found that aroma, softness, whiteness, stickiness and glossiness of cooked milled rice of Khao Dawk Mali 105 were adversely related to applied dosage of nitrogen. Soil in low nitrogen generally produced higher quality aromatic rice grain. For potassium fertilizers favorably influence cooking and eating qualities of rice. Suwanarit *et al.* (1997b) found that application of potassium fertilizer at higher dosages

Table 3. Concentration of 2-acetyl-1-pyrroline found in cooked rice varieties in terms of dry weight of rice. (Buttery *et al.*, 1983)

Variety	Country	2-acetyl-1-pyrroline concentration(ppm)	
		Milled rice	Brown rice
Malagkit Sungsong	Korea	0.09	0.2
IR 841-76-1	Philippines	0.07	0.2
Khao Dok Mali 105	Thailand	0.07	0.2
Milagross	-	0.07	-
Basmati	Indonesia,Pakistan	0.06	0.17
Selatus Malum	Philippines	0.06	-
Azucena	Philippines	0.04	0.16
Hieri	-	0.04	0.1
Texac Long Grain	USAUSA	<0.008	-
Calrose		<0.006	-

beyond which produced maximum yields of aromatic rice variety Khao Dawk Mali 105 increased the aroma and made the grain whiter and more glossy but less soft. Phosphorus and zinc application favourably influenced the rice grain qualities parameters. Aroma, softness, whiteness and glossiness in Khao Dawk Mali 105 rice were related to P content in rice grain and not to the P content in the plant (Suwanarit *et al.*, 1997c). Moderate application of sulphur to a deficient soil increased aroma, softness, whiteness, stickiness and glossiness of cooked aromatic rice variety Khao Dawk Mali 105. However, the higher rates than the optimum required adversely influenced these quality characteristics (Suwanarit *et al.*, 1997a). And it has been shown that cultural practices namely harvest and post-harvest affect the amount of 2-acetel-1-pyrroline in a sample of aromatic rice.

Breeding program

One of the objectives of rice breeding in Thailand has been bred both photoperiod non-sensitive and sensitive aroma variaties as well as glutinous and non glutinous varieties. This effort had released 3 varieties namely Hawm Klong Luang 1, Hawm Suphanburi 1 and Pathum Thani 1 for photoperied non-sensitive varieties and 3 varieties of

Table 4. Aromatic improved variety (Sakarung *et al.* 2000)

Type/variety	Photoperiod sensitivity
Glutinous	Photoperiod sensitive
RD 6	
Non-glutinous	Photoperiod sensitive
RD 15	
Pathum Thani 1	Non-photoperiod sensitive
Hawm Klong Luang 1	Non-photoperiod sensitive
Supan Buri 1	Non-photoperiod sensitive
Pitsanuloke 1	photoperiod sensitive

Table 5. New local name of Khao Dawk Mali 105 introduced to other countries

New name	Countries cultivated
Jusmine 85	USA
Songyin 85	Chaina
Bengawonsolo	Indonesia
BR 1	Brunei
IR 841	Argentina
Eampasak 104	Brazil
KDML 105	Vietnam

photosensitive aroma variables namely RD 6, RD 15 and Pitsanulok 1 (Table 4). All new varieties are glutinous rice varieties except RD 6 as non-glutinous variely and seems to have better resistance to pests and diseases than KDLM 105 as their parent.

Aromatic rice germplasm

All aromatic rice seeds has been collected from throughout the country since 1970 and conserved totally 904 samples at the National Rice Seed Storage Laboratory Genetic Resources, Rice Department, for conservation as well as breeding program. And some seeds are conserved at the International Rice Germ Plasm for 100 samples. According to the popularity of Thai rice aroma especially Khao Dawk Mali 105, many neighbour countries have been trying to grow directly in their own country. Khush and Juliana(1991) reported that KDML 105 from Thailand was one such variety with potential as parent. Then, seed of KDML 105 had been introduced to China, Indonesia, Brunei, Argentina, Brazil USA and Vietnam with different local names (Table 5). For Vietnam Khao Dawk Mali 105 was introduced in 1980 and was tested in different sites of Makong Delta. It reached the maximum cultivated area of 5,000 ha in 1992 then the area reduced approximately to 2,000-3,000 ha. Mostly it was grown in the state farm 30-40 (Soc Tang) on more than 1,000 ha every year. It is still maintains the aroma in coastal area under salanity instrusion in dry season, but it shows no aroma the alluvial soil (Bui Chi Buu, 2,000)

Conclusion

1. There are both aromatic glutinous and non glutinous rice which structure is rather tall and weak to pests and diseases.

2. Aromatic rice could be grown througout the country with variation in aroma and 904 samples had been collected and conserved at the National Rice Seed Storage Laboratory Genetic Resources, Rice Department for conservation and breeding program.

3. The smell of aromatic is likely popcorn or Pandan (Baiteoy) which can be detected and evaluated by chewing seeds and nooting aroma as well as cooking. The main chemical is 2-acetyl-1-pyrroline.

4. Many aromatic rice varieties namely RD 6, RD 15, Pathum Thani 1, Hawm Klong Luang 1, Supan Buri 1, and Phitsanulok 1 had been released to farmers.

5. Khao Dawk Mali 105 had been introduced to cultivate abroad at least 7 countries with different local names.

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