CHAPTER 3 MATERIALS AND METHODS

3.1 Experiment I: Effects of drying methods on rice quality

Paddy preparation: The newly paddy of 'Suphan Buri 1' harvested in March, 2012 were purchased through a local company in Nakhon Pathom Province, Thailand. The empty and defect grains were removed before storage at 10°C until used. The experiment was carried out during August to December 2012.

Two kg of re–wetted paddy at the moisture content MC of 26% (wet basic;w.b)

(639 ml of water) and MC of 28%

(664 ml of water) was added and placed in plastic trays held in a cool room at 10°C for 15 h. Thereafter, it was dried until the MC reached a 12–13% using two methods: sun drying at 38–40°C for 6 or 8 h for the 26 and 28% MC, respectively. In case of a hot air oven dryer Universal oven, model: UNB 100–500, memmert GmbH co., Germany), 1.33 kg re-wetted paddy was placed in an aluminum tray. The drying was done by putting 6 trays of re–wetted paddy in the oven dryer at 60°C. The 26% MC of paddy was dried around 7 h and 28% MC for about 8 h. The MC of paddy achieved 12–13%. The dried paddy was tempering for 1 week, and then it was dehulled to brown rice (Rice Dehuller, Tian Hong Ltd., Thailand) and polished to milled rice or white rice by a laboratory rice mill (Ngek Seng Huat Ltd., Thailand). The non–treated paddy (9.46% MC) was used as a control or reference sample. Each sample was 2 kg. The experiment was carried out during August to December, 2012.

Experimental design: The experiment was arranged as a Completely Random Design (CRD) with four replications and 5 treatments.

T1= Control sample

T2 = 26% MC + sun drying at 38–40°C for 6 h

T3 = 28% MC + sun drying at 38–40°C for 8 h

T4 = 26% MC + hot air oven dryer at 60°C for 6–8 h

T5 = 28% MC + hot air oven dryer at 60°C for 7–8 h

Data collection: Data were collected as the following (see detail in 3.4. Analytical methods):

1. Moisture content of paddy (%)

2. Colour of paddy, brown, and milled rice (L*, a*, b* and h° values)

3. Determination to detect grains of brown and milled rice grains

3.1. Head yield of whole grain of brown and milled rice (%)

3.2. Imperfect grains of brown and milled rice (%)

3.2.1. Chalkiness grains

3.2.2. Crack grains

3.2.3. Defect/damage grains

4. Amylose content (%)

5. Elongation ratio (mm)

6. Water absorption (%)

7. Texture of cooked rice

7.1. Hardness (N)

7.2. Stickiness (N)

Statistical analysis: Data were subjected to analysis of variance (ANOVA) and significant differences among means were determined by Duncan's Multiply Range Test (DMRT) at $P \leq 0.05$ using SAS statistical software (SAS, 1986).

3.2 Experiment II: Effect of storage times on rice quality of 'Suphan Buri 1'

Paddy preparation: The 'Suphan Buri 1' paddy was the same lot as the experiment I.

Two kinds of samples as paddy or milled rice–dehulled and polished similarly as the Experiment I – approximately 2 and 1 kg were put in sealed PE (Polyethylene) bags. They were stored in ambient temperature (30±2°C) for 6 months. The samples were monitored every 2 months. In case of the stored paddy samples, they were dehulled to brown rice and polished to milled rice as same as the Experiment I every 2 months.

Experimental design: The CRD was carried out in experiment. Four replications and 4 treatments (0, 2, 4, and 6 months) were used. The experiment was conducted from April to October, 2012.

Data collection: The data were collected as the same as the Experiment I.

Statistical analysis: Data were subjected to analysis of variance (ANOVA) and significant differences among means were determined by Duncan's Multiply Range Test (DMRT) at $P \leq 0.05$ using SAS statistical software (SAS, 1986).

3.3 Experiment III: Quality of 'KDML 105' and 'Suphan Buri 1' as affected by high temperature treatment

Paddy preparation: The 'KDML105' paddy was the same lot as the Experiment II and 'Suphanburi 1' was as the Experiment I.

The paddy was packed in sealed aluminum foil bags (1.5 kg per bag). They were placed in incubator at 45°C for 1 month during April to May, 2012.

Experimental design: The CRD was employed in this experiment. There were four replications and 2 treatments (T1 = the paddy before storage and T2 = the paddy after incubation).

Data collection: Data were collected as the same as the Experiment I. Other parameters including grains dimensions (length, width and thickness of paddy, brown and milled rice), un-dehulled paddy, immature of paddy, big broken grains, small broken grains, bran and inner matter were also monitored.

Statistical analysis: T–test analysis was subjected for a comparison of initial values and after 1 month storage. Percentage of different changes between 2 cultivars was also compared.

Experiment place: All experiments and data collection were conducted at Programme of Postharvest Technology, King Mongkut's University of Technology Thonburi, Thailand.

3.4 Analytical methods

3.4.1 Moisture content

The paddy was weighted in aluminum cans and then placed in a hot air oven at 130°C for 1 h before moving the cans to a desiccator until the temperature down to ambient temperature.

The weight of the dried samples was recorded and the moisture content (MC)(percentage) calculated as a unit expressed as fresh weight basis (Association of Official Analytical Chemists; AOAC, 2005). The percentage of the (MC) from the following formula:

$$MC\ (w.b.)\% = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

3.4.2 Colour of paddy, brown and milled rice (L*, a*, b*, h° and values)

The paddy and milled rice grains were fully placed in a petri dish. The colour of grains was measured for three places around the equator with a colour meter (Chroma Meter, Model CR–400, Konica Minolta, Osaka, Japan). The colour was expressed as L*, a*, b* and hue angle according to the CIE colour system. The average of colour was analyzed.

3.4.3 Determination to detect grains

Fifty grams of brown or milled rice were taken from working sample and then classified into whole and imperfect grains and other inert matters, including: big broken (5 mm) immature, chalkiness, cracks, small broken (3 mm) and defect/damage grains. Each portion was calculated as percentage compared to working sample (Jocelyn et al., 1994).

1) Head yield of whole grains: Brown or milled rice kernels were separated and measured for calculation from the following formula

$$\% \text{ Head yield of whole grains} = \frac{\text{Wt of head rice of whole grains}}{\text{Wt of working samples}} \times 100$$

2) Chalky grains (%)

A visual rating of the chalky proportion of the grain was used to measure chalkiness and then weighed The chalky grains determined as the % chalky grain using the equation:

$$\% \text{ Chalky grains} = \frac{\text{Wt of chalkiness grains}}{\text{Wt of working samples}} \times 100$$

3) Cracked grains

The number of cracked grains in a 100–grain was counted. The cracked kernel with the aid of light/sunlight was observed and counted. The sample was computed to % cracked grains using the equation (Jocelyn et al., 1991).

$$\% \text{ Cracks grains} = \frac{\text{Wt of cracked grains}}{\text{Wt of working samples}} \times 100$$

4) Defect/damage grains

$$\% \text{ Damage grains (\%)} = \frac{\text{Wt of damage grains}}{\text{Wt of working samples}} \times 100$$

5) Imperfect grains and other inert matters (%)

This portion composes of big /small broken grains, un-dehulled paddy, empty of paddy and immature of brown rice grains, small species of rice.

$$\% \text{ Imperfect grains (\%)} = \frac{\text{Wt of imperfect grains and others}}{\text{Wt of working samples}} \times 100$$

$$6) \text{ Husk (\%)} = \frac{\text{Wt of paddy} - \text{Wt of brown rice}}{\text{Wt of paddy}} \times 100$$

$$7) \text{ Bran (\%)} = \frac{\text{Wt of brown rice} - \text{Wt of milled rice}}{\text{Wt of paddy}} \times 100$$

3.4.4 Length, width and thickness of milled rice (Juliano, 1993)

Milled rice, 100 kernels, was determined for length, width and thickness. The length of the kernel was measured at the longest, the width at the widest kernels and thickness at a middle using a digital Caliper (model Mituoyo Digmatic Caliper, Company Mittutoyo Corporation).

3.4.5 Amylose content (%)

One hundred mg of rice powder was put in a test tube added 1 ml 95% ethanol and 9 ml of 1 N NaOH. The tube was then heated in a water bath at 80–90 °C to gelatinize the starch for 10 min. The starch solution moved to 100 ml volumetric flask. The volumes were adjusted to be 100 ml by distilled water and mixed by hand. Five ml of sample solution was taken into a new 100 ml volumetric flask and then added 1 ml of 1 N acetic acid and 2 ml of 0.2% iodine. Distilled water was used to adjust the volume to be 100 ml, thereafter the solution was mixed by hand and then placed in room temperature (28–32^{o}C) around 10 min. The solution was stirred and then measured the absorbance at 610 nm with the spectrophotometer (AA–6650, Shimadzu Co Japan).

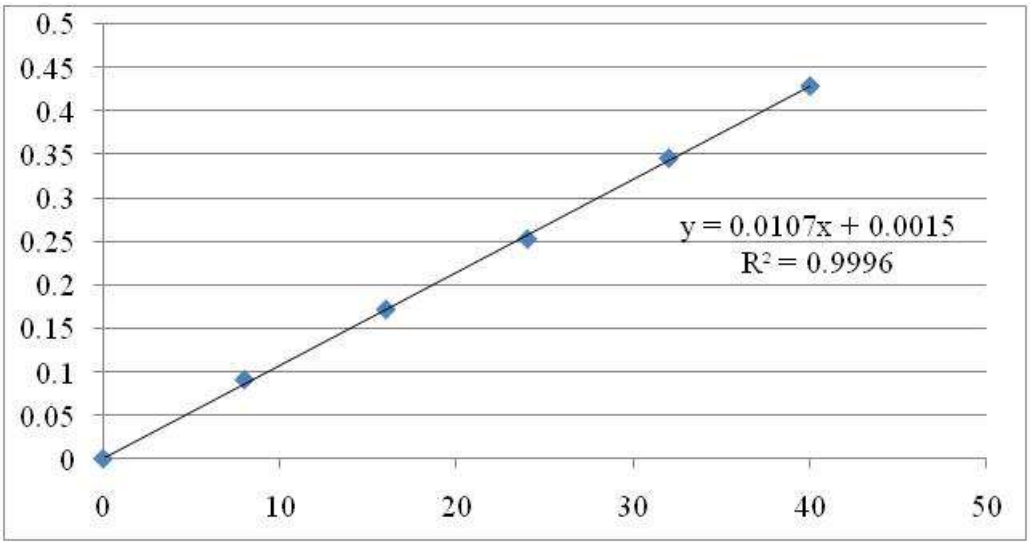

Figure 3.1 Standard curve of amylose content from rice cultivar Formula:

% amylose x = (y/2.5) – (0.001)/0.01

3.4.6 Elongation ratio (Juliano, and Perez, 1984)

Twenty rice kernels were sampled from 3 g, their length was measured by a digital caliper. Thereafter, they were put together in a test tube (1.9 mm ϕ) containing 3.6 ml distilled water for 'KDML 105' (ratio of rice to water (1:1.2), 5.1 ml for 'Suphan Buri 1' (a ratio of rice to water was 1:1.7) The rice was soaked for 30 min.

The test tubes were put in a hot water bath at 95°C for 15 'and 25 min for KDML 105' 'Suphan Buri 1', respectively.

The cooked rice was transferred onto a piece of white cloth for around 10 min. The length of 20 cooked whole grains was measured. The proportionate elongation was the ratio of the average length of cooked rice grains to the average length of raw rice grains.

$$\text{Elongation ratio (mm)} = \frac{\text{Total length of sample cooked rice}}{\text{Total length of sample milled rice}}$$

3.4.7 Water absorption (Daniels, 1998)

Three grams of milled rice were put in a test tube (1.5 mm ϕ). The water was with the same volume before being immersed in a hot water bath at 95°C similar to elongation ratio measurement (Item no. 3.4.6). The cooked rice was removed onto a piece of cloth. The sample was weighed. The water absorption was calculated using the following equation:

$$\% \text{ Water absorption} = \frac{\text{Wt of cooked rice} - \text{wt of milled rice}}{\text{Wt of milled rice}} \times 100$$

3.4.8 Texture of cooked rice

Cooked rice hardness and stickiness were analyzed with a texture analyzer (TX-XT2 Plus, Scardale, NY, USA) by the aniaxial single compression method. Sufficient cooked rice kernels were placed on a flat aluminum plate (100 mm diameter) and compressed to 90% of their original height using a 50 kg loaded cell. The pre-test speeds 0.50 mm/sec, test speed 1.00 mm/sec, post-test speeds 10.00 mm/sec, target mean; distance and distance 4.000 mm respectively. The texture data was obtained and processed with texture exponent software (Stable Micro systems 50 kg load cell). The maximum compression force (N) was used as an indicator of cooked rice hardness, while the adhesion energy measured during the upward travel of the compression plate (area under the curve expressed in N) was used as an indicator for cooked rice stickiness (Patindol et al., 2010).