

5.2 Effect of storage times on rice quality of ‘Suphan Buri 1’

‘Suphan Buri 1’ paddy and milled rice kept in PE (Polyethylene) bags were stored at ambient temperature ($30\pm 2^{\circ}\text{C}$) for 6 months. Their quality changes were measured and compared with the initial value.

5.2.1. Moisture content of paddy (%)

The moisture content of paddy did not change during storage and it was 8.30–8.80%. The storage time did not affect to the MC of paddy because the paddy was kept in sealed PE bags (Table 4.2.1). The PE bag potentially protects transmission of water between the inner and outer.

5.2.2. Colour of paddy and brown rice

Generally, the stored paddy will presents more dark, low L^* and high b^* values. ‘Suphan Buri 1’ paddy colour presented brown yellow, and it became brown, indicated by L^* , a^* , b^* and h° values, after storage for 6 months (Table 4.2.1). The colour change was obviously found after storage for 4 months, but it only slightly changed after 6 months suggesting that the 4th month would be the critical point of the changing. Even though, this appearance is a minor impact to milled rice quality (Table 4.2.1); it could affect to the market price, especially the brown rice. In this study, the colour of brown rice significantly changed after 4 months and the change period was similar to the paddy (Table 4.2.2). The browning reaction, inducing yellow colour in the husk and brown rice, would gradually occurred during storage. The Maillard reaction is one of the most important modifications in foods that with the contain proteins and reducing carbohydrates (Antonio et al., 2003). It is induced by heating and long storage conditions and can produce a loss in nutritive value. Loss of available lysine, the worst.

5.2.3. Colour of milled rice from stored paddy and from stored milled rice

The colour of milled rice from either stored paddy or stored milled rice slightly changed but the milled rice from the stored paddy presented lower b^* value. This indicated that the changing rate was greater in the stored milled rice (Table 4.2.4 and 4.2.6). The oxidative and/or browning reactions would be induced more in the stored milled rice, which was exposed directly to oxygen. But, the hull could prevent the endosperm and embryo in the paddy. Rice has a long self-life and can usually be consumed for up to 2 years after their manufacture. The storage life conditions of storage and the specific composition of the rice can all influence the progress of the Maillard reaction that occurs during their processing and storage (Antonio et al., 2003).

This suggested that storage paddy would be more effective in delaying milled rice quality. IRRI (2009) reported that rice for food purposes be stored in paddy form (unhulled rice) rather than milled rice as the husk provides some protection against insects and help prevent quality deterioration. In addition, the steeply change of the milled rice colour for both types of storage was observed after 6 months, which was later than that of the paddy and brown rice colour (Table 4.2.1 and 4.2.2).

5.2.4 Determination to detect grains of brown and milled rice grains (head rice of whole grains and imperfect grains) from stored paddy

1) Head yield of brown and milled rice (%)

High head yield is one of the most important criteria for measuring milled rice quality. The actual head rice yield percentage in a sample of milled rice will depend on both varietal characteristics and production factors, harvesting, drying and milling process. Storage for 2 months significantly increased head yield of brown rice compared to the initial value, there after it did not change (Table 4.2.3). The newly harvested rice (after

harvesting) has a loose structure, unpacked starch granules in the endosperm structure. Additionally, the linkage and net work among starch granules, protein, lipids and / other compounds has not been formed completely. The compact and tough endosperm was developed after storage leading to greater head yield after a certain period of storage (IRRI, 2009).

However, the yield of milled rice was slightly declined during storage the paddy for 2-4 months, but it presented the same value as the initial after 6 months (Table 4.2.5). This suggested that the structure of the 'Supah Buri 1' kernel was significantly packed resulting to its resistance to the milling force after 6 months. The result was also correlated with the increase in head rice yield of the stored milled rice (Table 4.2.7). The increase of head yield of stored milled rice generally should not be improved. This might be due to sampling error and the classification of rice kernels was done by un-trained persons.

2) Chalky grains (%)

Chalky rice is downgraded in quality assessment ratings – reducing its value and returns for farmers. Chalky areas occur because of malformed starch granules with air spaces between them. The starch has not been developed properly and is a point of weakness resulting to lower milling quality (Siebenmorgen et al., 2011). Grain endosperm chalkiness is a varietal characteristic that negatively affect not only the appearance and milling properties but also the cooking texture. However, longer period beyond 2 months reduce chalky in the rice kernel, suggesting the improvement of starch and endosperm structures (Liu et al., 2009). The chalkiness of brown and milled rice significantly declined (about 50%) after storage for 6 months for both types of storage (Table 4.2.5 and 4.2.7). The increase in head yield of brown rice would be partial to the lower chalky

grains after storage, but this incidence did not be significantly correlated with the milled rice from stored paddy (Table 4.2.5).

3) Cracked grains (%)

The cracking appearance can reduce payments received by the grower and the miller. The cracking of brown and milled rice increased after 4 months compared to the values at the initial and after 2 month-storage (Table 4.2.5 and 4.2.7). Cracking may result from high humidity on dry grains and storage of the grains with variable moisture levels (IRRI, 2013). In agreement with this research, the increase of cracking in the brown and milled rice might cause by the ambient condition, fluctuation of temperature, during storage (http://www.knowledgebank.irri.org/ricebreedingcourse/grain_quality.htm). However, the cracking of brown rice was lower than 1.0%, therefore, it did not affect to the head yield of brown rice after storage (Table 4.2.3). The cracked milled rice from stored paddy was significantly increased and impact to the low head yield (Table 4.2.5). Storage of the paddy for longer period of 6 months enhanced development of starch granules in the endosperm. But, the cracking of milled rice from stored paddy slightly increased after 6 months of storage which probably involved with fluctuation of temperature during storage, milling and polishing processes (Table 4.2.5). In case of the stored milled rice, the increase of cracking would be caused by fluctuation of temperature during storage. Interestingly, it increased more than the milled rice from stored paddy (Table 4.2.5 and 4.2.7).

4) Defect grains (%)

The defect grains of brown rice were very low (less than 1%) and gradually decreased (Table 4.2.3). This meant the storage time for 6 months reduced defect grain leading to the increase in the yield of brown rice. In general, defect grains would cause by insect invasion during storage, however, the paddy was kept in plastic bags and the insects were not observed.

5.2.5 Amylose content (%) of milled rice from stored paddy and stored milled rice

The amylose content increased approximately 4% after 6 months (Table 4.2.8). This means storage either in paddy or milled rice enhanced degradation of amylopectin after 6 months. Total starch content does not change significantly during storage. However, some small changes in starch properties have been noticed which include the change in molecular weight of starch and its components (amylose and amylopectin) although the small portion maybe significant. Our results were irrespective to Kanlayakrit and Maweang (2013) and Hamaker (1993) whose reported that the amylose content in the rice kernels was not increased. The possibility is the amylase, initiated degradation processes of the starch in the rice grain during storage.

5.2.6 Elongation ratio (mm) of milled rice from stored paddy and stored milled rice during storage

The elongation of cooked rice was increased during storage (Table 4.2.9). This result caused by changes of physical and chemical properties (Singh, et al., 2000) leading to thigh structure of starch granules and more water absorption. This suggests that the cooking quality of rice became more preference because the cooking quality was mainly

determined by water uptake, volume expansion and kernel elongation (Sarathe et al., 1986).

The type of storage (paddy or milled rice) presented almost the same elongation ratio suggesting that the hull of rice (stored paddy as it was) did not reduced the changing rate compared to hulled rice (milled rice in this study).

5.2.7 Water absorption (%) of milled rice from stored paddy and stored milled rice

Water absorption and volume expansion of the grains during cooking are directly affected by amylose content. The water absorption values of the hydrated grains agreed with the cohesive properties and cooking characteristics of the grains. Higher water absorption obtained under these conditions indicated poor stickiness. the high amylose rice generally absorbs more water and expands more during cooking at 95°C in excess water than low amylose rice (Jocelyn et al., 1991). The higher water absorption increased after storage for some months is well documented (Jocelyn et al., 1991). Water absorption of cooked rice generally has strong relation with volume expansion and elongation ratio. The volume expansion of milled rice significantly increased when the paddy was stored after 2 months (Table 4.2.10). This incidence might caused by tight structure of starch granules and interaction of chemical compounds in the endosperm (Juliano, 1993). Kanlayakrit and Maweang (2013) described that the cooking properties of rice improved after three months of storage. The swelling capacity increased and the amylose content of rice remains constant. Storage decreased the amylose dispersion, which is responsible for greater absorption and retention of water and thus expansion of rice grain.

5.2.8 Texture of cooked rice of milled rice from stored paddy and stored milled rice

The newly harvested rice is softer and stickier thereafter a certain period it became harder and less sticky. It is also found in our study that cooked rice of 'Suphan Buri 1' stored milled rice after keeping for 4 months but it took 6 months for the milled rice from the stored paddy (Table 4.2.11). The changing processes involved of physicochemical properties with chemical property, *e.g.* the protein-starch interaction. The protein interacts with starch diminishes there by altering the texture of the rice during storage was observed (Juliano, 1993). The protein influence texture is also hypothesized to involve the regulation of water diffusion into the starch granule and time requirements for cooking. Secondly, protein may impede starch gelatinization. It has been suggested that starch granule associated protein confer strength to the gelatinized granule reducing the leaching of amylose molecules or by physically holding the starch granule together. Thus during storage the interaction of protein with starch diminished thereby altering texture due to change in water diffusion properties and gelatinization process during cooking, the brewing is reluctant to use rice storage for long periods because it requires high temperatures for gelatinization and convert slowly fermentable sugars (Juliano (1993)).

Rice textural properties change significantly in the months following harvesting. Many of the functional changes that occur during storage and influence cooking properties, such as cooking time, water uptake and stickiness are caused by protein-starch interactions. Therefore, when the rice was preserved as milled rice these characteristics were gradually changed with the time and the changing rate of stored milled rice was faster compared to the milled rice from the stored paddy (Table 4.2.11).