CHAPTER V

CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

5.1.1 Chemical compositions of fresh hulled red jasmine rice

Fresh hulled red jasmine rice consisted of 84.14 $\pm$ 0.46% carbohydrate, 6.95 $\pm$ 0.24% crude protein, 3.38 $\pm$ 0.29% crude fat, 4.24 $\pm$ 0.51% dietary fiber, 1.26 $\pm$ 0.05% ash and 15.19 $\pm$ 0.81% amylose.

5.1.2 Effects of drying methods on qualities of fresh hulled red jasmine rice

The sun-dried samples had the lowest moisture content and water activity. DSC data revealed that the samples dried by FB dryer had the significantly highest T_o and T_p but had significantly lower enthalpy of gelatinization (ΔH_g) than that of the control samples ($p \leq 0.05$). In case of RVA experiments, FB-dried samples showed the significantly lowest BD ($p \leq 0.05$). There was no significant difference among the swelling power analyzed from the samples dried by any drying methods ($p > 0.05$). In case of sensory characteristics, cooked hulled rice prepared from shade-dried samples had the significantly lowest a and b values measured in Hunter L, a, b system ($p \leq 0.05$). QDA data reveled that cooked hulled rice prepared from FB-dried samples had the significantly lowest fragrance but had the significantly highest rancidity ($p \leq 0.05$). However, there was no significant difference among hardness of the samples dried by any drying methods ($p > 0.05$).

5.1.3 The effects of storage conditions on qualities of hulled red jasmine rice

For all drying methods, greater change in moisture content and water activity was observed in the samples packed in Nylon/LLDPE pouch and stored at ambient temperature.

In case of thermal properties, for any drying methods and packaging materials, T_o and T_p of all samples tended to increase after storing for 6 or 8 months. ΔT_g of shade-dried and sun-dried samples increased, then slightly decreased after storing for 10 or 12 months whereas time-dependent change of ΔT_g of FB-dried samples was still inconspicuous. For any drying methods, packaging materials and storage temperature, ΔH_g tended to increase within the first 2 or 4 months of the storage, and then dramatically decreased after the samples were stored for 10 months and remained constant or slightly changed afterwards.

As for pasting properties, for any drying methods and packaging materials, PT of the samples stored at ambient temperature tended to increase after 4 or 6 months of the storage whereas PV and BD increased within the first 2 or 4 months, then decreased. SB of the samples stored at ambient temperature gradually increased during storage.

For any drying methods and packaging materials, swelling power at 70°C and 90°C of the samples stored at ambient temperature tended to decrease after being stored for 4 or 6 months. The swelling power at 70°C remained unchanged within the last 6 months while the swelling power at 90°C was constant during the last 2 or 4 months of the storage. In addition, at any given storage time, the samples stored at 15°C had higher swelling power than those which were stored at ambient temperature. This trend was apparent for the swelling power at 90°C.

After rice flour prepared from the samples packed in Nylon/LLDPE pouch and stored at ambient temperature for 12 months were treated with 2-mercaptoethanol, the DSC and RVA results showed that, for any drying methods, the samples treated with 2-mercaptoethanol had lower T_o, T_p, PT and SB but higher ΔT_g, ΔH_g, PV and BD than those of non-treated samples. These could indicate that an increase in disulfide linkages of oryzenin affected the physicochemical changes of hulled red jasmine rice during storage.

Color in Hunter L, a, b system of cooked sun-dried samples which were stored at ambient temperature were evaluated. For the samples packed in OPP/AL/LLDPE and Nylon/LLDPE pouches, L and a value were fluctuated but b value of the samples packed in OPP/AL/LLDPE pouches did not significantly change during storage ($p>0.05$). However, for the samples packed in Nylon/LLDPE pouches, b value was significantly lower than the fresh samples after stored for 4 months ($p\leq0.05$). In case of aroma and texture of the samples evaluated by trained panelists, cooked hulled rice prepared from sun-dried samples packed in Nylon/LLDPE pouches and stored for 6 and 12 months had the significantly lowest fragrance but had the significantly highest rancidity ($p\leq0.05$). The samples packed in any packaging materials and stored at ambient temperature for 12 months had the significantly highest hardness ($p\leq0.05$). However, according to affective test using 5-point hedonic scale and evaluated by 34 consumers, there was no significant difference in color, aroma and overall acceptance among the fresh and stored samples ($p>0.05$). In case of hardness, cooked hulled rice prepared from fresh sun-dried samples had the significantly highest hedonic scores while the cooked rice prepared from the samples stored for 6 months had the significantly lowest hedonic scores ($p\leq0.05$). However, all sensory characteristics received hedonic scores higher than 2.5. This could point out that all samples still be accepted by consumers.

5.2 Suggestions

5.2.1 Raw materials management

In this study, freshly harvested paddy was not promptly delivered to the lab and immediately used in the experiment. The paddy was sun-dried to prevent microbial deterioration which could occur during the paddy was transferred to the lab. Moreover, the pre-dried paddy was stored in a cold room at 4-5°C for approximately 1 month before being subjected to the experiment. According to those circumstances, some changes of physicochemical properties of rice grains may irreversibly occur. To reduce those changes, preliminary drying should be avoided and the experiment should be started in the shortest time after the paddy was harvested.

5.2.2 Proper postharvest handling of hulled red jasmine rice

The most suitable paddy drying methods greatly depends on the desirable characteristics of final products. As for products sold as hulled rice, the proper drying methods may depend on desirable texture and aroma of the cooked rice. If the hulled rice is sold as fresh hulled rice, FB drying may not be suitable due to the loss of fragrance and the formation of rancidity. Generally, FB drying of paddy helps increase head rice yield of milled rice. As red jasmine rice is usually sold as hulled rice, this advantage of FB dryer can be neglect. However, FB drying may provide an advantage regarding postharvest handling of organic paddy. Since no chemical agents, including herbicides and pesticides, are allowed in organic cultivation, high drying temperature of FB drying can help demolish insect pests and their eggs which contaminated with the paddy.

In case of storage conditions, greater effects of storage temperature and storage duration, rather than packaging materials and drying methods, on thermal properties, pasting properties and textural properties of hulled red jasmine rice were observed. Thus, to postpone undesirable quality changes such as an increase in rancidity and hardness of cooked rice, low storage temperature should be applied. However, for the exported products, ambient temperature in European countries is lower than that in Thailand. Therefore, changes of physicochemical properties and qualities of hulled red jasmine rice may be delayed.

Packaging materials obviously affect aroma of cooked hulled red jasmine rice as OPP/AL/LLDPE pouch can prevent the loss of fragrance and retard the formation of rancidity of the hulled rice. However, consumers may not differentiate those changes as indicated from this study. Moreover, price per unit of OPP/AL/LLDPE bag is generally higher than that of Nylon/LLDPE bag. Hence, to reduce the cost of rice manufacturing, Nylon/LLDPE film may be selected as packaging material for vacuum-storage of the hulled rice products.

As for DSC parameters, although these parameters may not be direct indices for rice quality, they can provide essential explanation for changes of physicochemical properties of rice due to different methods of postharvest handling. In case of RVA parameters, these parameters can be applied in many cases. For instance, rice with high SB may not be suitable for some food products, including frozen, ready-to-eat meal because SB, related to ability of starch to retrogradation, has negative correlation with freeze-thaw stability (Zobel, 1984). Upon microwave heating, cooked rice with higher SB may become dry and hard due to greater extent of syneresis. As for rice porridge, viscosity of product may be predicted by PV and BD. If PV is high, the product will have high viscosity during cooking. However, if BD is high, viscosity of the product will decrease when the product is heated for longer time. The product may have watery consistency which may be undesirable.