CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The effects of operating parameters including the inlet fluidizing air temperature, spray rate of coating solution, superficial air velocity, atomization air pressure and percentage of recycled exhaust air on the quality of turmeric extract coated rice (TECR) and the performance of top-spray fluidized bed coating (TSFBC) were studied. Based on the experimental results of this study, it can be concluded that:

1. The inlet fluidizing air temperature, spray rate of coating solution and the percentage of recycled exhaust air strongly affected the final moisture content of TECR. The superficial air velocity and atomization air pressure had small effect on the final moisture content of TECR. Operation of TSFBC at the conditions that provided the final moisture content of TECR lower than 11.80% wet basis (w.b.), the fissure of all TECR kernels occurred. On the other hand, coating at the conditions that provided the moisture content of TECR higher than 12.50% (w.b.) during coating the risk of collapsing and agglomeration of fluidized rice kernels due to the liquid bridge increased.

2. Production of TECR using the TSFBC under studied conditions slightly affected the head coated rice yield of TECR. It revealed that the collision of rice kernels during coating with TSFBC did not influence the broken kernels of TECR although the fissure of TECR kernels occurred during coating if the moisture content of TECR was lower than 11.80% (w.b.). However, coating should avoid the conditions that provide the fissured kernels of TECR since the fissure of TECR kernels led to poor cooking quality.

This is because the fissured kernels broke to small pieces after cooking which was not preferred by the consumers.

3. The inlet fluidizing air temperature and spray rate of coating solution affected the color of TECR. The color of TECR was darker and redder as indicated by lower lightness value and higher redness value at higher spray rate of coating solution. An increase in inlet fluidizing air temperature resulted in the higher lightness value and lower redness value. For the effects of superficial air velocity, atomization air pressure and percentage of recycled exhaust air on the color and number of uncoated white rice kernels of TECR, it was found that operation of the TSFBC at superficial air velocity of 2 m/s not only provided a low redness value but also led to high number of uncoated white rice kernels of TECR. At this velocity an increase in atomization air pressure resulted in higher redness value of TECR but the number of uncoated white rice kernels of TECR was still high. An increase in superficial air velocity from 2 m/s to 2.5 m/s resulted in higher redness value of TECR and the number of uncoated white rice kernels of TECR decreased significantly. When the fluidizing air velocity was increased from 2.5 m/s to 3 m/s, it did not affect the redness value and the number of uncoated white rice kernels of TECR and at such velocities the atomization air pressure did not affect the color and the number of uncoated white rice kernels of TECR. The percentage of recycled exhaust air had small effect on the redness value of TECR but it strongly affected the number of uncoated white rice kernels of TECR.

4. The superficial air velocity, atomization air pressure and percentage of recycled exhaust air affected the coating efficiency of TSFBC. Most coating efficiency of TSFBC at superficial air velocity of 2 m/s was lower than 80%, depending on the

atomization air pressure and percentage of recycled exhaust air. At this velocity, an increase in atomization air pressure helped to improve the coating efficiency but the number of uncoated white rice kernels was still high. When the superficial air velocity was increased from 2 m/s to 2.5 or 3 m/s, the coating efficiency of TSFBC was higher than 80% and the number of uncoated white rice kernels decreased significantly. At superficial air velocities of 2.5 or 3 m/s, the atomization air pressure and the percentage of recycled exhaust air insignificantly affected the coating efficiency of TSFBC.

5. The effect of superficial air velocity, atomization air pressure and percentage of recycled exhaust air on the specific energy consumption of coating system was found that the specific energy consumption of fluidizing air was increased with increase in superficial air velocity but an increase in superficial air velocity did not affect the specific energy consumption of the blower. Spraying the coating solution at higher atomization air pressure did not affect the specific energy consumption of spraying system. Operation of the TSFBC with 80% recycled exhaust air could save the energy consumption electric heater (SEC_{heater}) by about 41.7-46.5% relative to that without recycled exhaust air, depending on the superficial air velocity.

6. The total phenolics content (TPC) and the total antioxidant capacity (TAC) of TECR clearly increased as compared to TPC and TAC of white rice before coating. The amount of TPC and TAC of TECR depended on the spray rate of coating solution. After cooking TECR, the hardness and stickiness of cooked TECR insignificantly changed from cooked white rice kernels. The retention of curcuminoids, TPC and TAC of cooked TECR remained higher than 90%, indicating the potential of turmeric for food applications.

In practice, all kernels of coated rice product should be uniformly coated with the coating solution. The final moisture content, percentage of fissured kernels, head rice yield and the quality after cooking of coated rice product should be similar to white rice before coating. Thus, based on the experimental results of this study, it is suggested that coating of turmeric extract solution at the concentration of 4% (w/v) onto 5 kg Jasmine white rice kernels using TSFBC should be operated at the superficial air velocity of 2.5 m/s, inlet fluidizing air temperature of 50 °C, spray rate of coating solution of 40 mL/min, spraying time for 12 min, atomization air pressure of 1 bar and 80% recycled exhaust air. After spraying the coating solution, the turmeric extract coated rice kernels are dried for 5 seconds before finishing coating process.

5.2 Recommendations

1. The coating coverage of coating substance on the surface of each coated rice kernel should be considered via the image analysis to evaluate the coating uniformity.

2. The variation of moisture content of coated rice kernels during coating strongly influenced the fissuring and the fluidization quality. Hence, the mathematical modeling of mass transfer to predict the moisture content of coated rice kernels during coating should be developed.

3. The friability of coating substance on the surface of coated rice kernels might occur during packaging and transportation. Thus, the effects of binders on the coating adhesion of coating substance on the surface of coated rice kernels should be studied.