Agri. & Biosys. Eng. Vol. 5(2):60-63(2004)

Development of the Processing System for Pre-washed Rice

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Abstract: Demand for development of processing systems for pre-washed rice and propagation of the systems has recently been on the rise, because rice-cooking requires watering 15 times the rice quantity to cook, as in case of the regular rice currently being circulated in Korean market, in addition to paying the trouble of washing it for cooking, and besides the milky turbid water coming from the rice-washing contributes to water contamination. In this study, therefore, a processing system for pre-washed rice was designed and built with rice surface polishing devices that adopted abrading and airing methods, an electrostatic method and a method using a fine watering, to conduct its performance test. The result showed that turbidity of the wash water, which is the base to determine the pre-washed rice standard, turned out 47.33 ppm and 48.00 ppm respectively for 800 kg/hr and 1,000 kg/hr supplies, which meets the standard for the processing system free from rice-washing for cooking. The quantity of watering at this experiment was only 0.43 times the rice, thus resulting in curtailment of process-watering by approximately 69% compared with the existing wet-type pre-washed rice processing system popular in Korean market.

Keywords: Pre-washed Rice, Milling Machine, Rice Cleaning, Rice Processing, High Quality Rice, Polishing

Introduction

With improvement of the level of income, preference in food for convenient cooking is growing as much as the propensity to consume grows diverse. In line with such a trend, the demand for convenient high-quality rice is also growing which enables cooking free of pre-washing.

The domestic demand is also expected to tilt toward such an increase for pre-washed rice. However, since the present situation of the pre-washed rice processing industry in Korea is still remaining at its rudimentary stage, development of a stable and sanitary pre-washed rice processing system built with diverse techniques is required to prepare for a pre-washed rice mass production system.

This is why the study came down to building a pre-washed rice processing system and conducted a performance test for it which is built with rice-surface polishing devices adopting abrading and airing methods, an electrostatic method and a method using damp-airing and a fine watering.

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Materials and Methods

1. Test Device Manufacturing

The pre-washed rice processing system is built with rice-surface polishing devices adopting abrading and airing methods, an electrostatic method and a method using a fine watering, and the processing passes through each of the devices to complete.

As illustrated on the Fig. 1, the detailed mechanism is to inject raw rice into a feeding inlet to pass through abrading and airing polishing devices that consist of a wire mesh and a brush where the coarse rice bran is removed, and during the course, static electricity breaks out to impede removal of the minute rice bran.

Therefore, the next stage is designed to weaken the adhesiveness of the rice bran and remove it by neutralizing the static electricity when it passes through a blast pipe installed with an electrostatic eliminator, and the last stage to complete polishing by a device using a fine watering.

2. Authorized Materials and Test Method

- Authorized Materials: The authorized materials were the class A grains of rice produced from the roofed paddy field of the National Institute of Agricultural Engineering during 2001~2002 period, which were used throughout the courses of up to rice-polishing at some farm-product experimental laboratories and RPC of the National Agricultural Cooperative Federation.
- Whiteness Measurement: The mean value out of 10 measurement for each sample was taken by using an

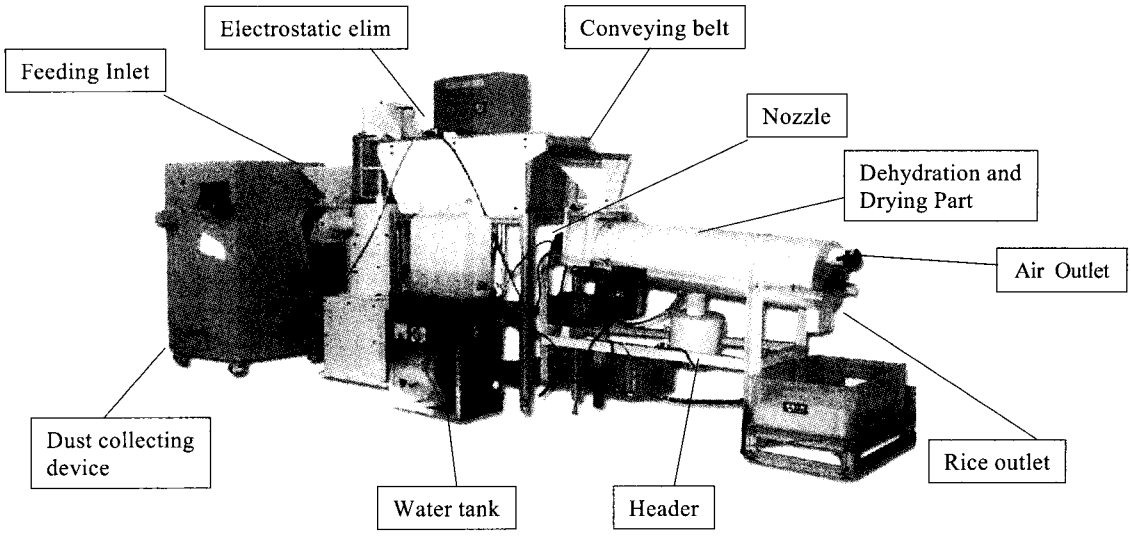


Fig. 1 Pre-washed rice processing system equipped with devices using a fine watering.

optic-electronics whiteness gauge (Kett-300, Japan), and the measurement was made only for flawless grains while excluding colored or pulverized grains.

- Turbidity Measurement: In order to produce effluents, an exact amount of 20 g flawless grains and 200 ml distilled water was put into a beaker, which was stirred for 10 minutes by using a shaker, to collect the effluent. It was then diluted by 10 times to provide measurement by a turbidity gauge (TR-705, Japan).
- Weight Measurement of 1,000 Grain Unit: Flawless grains only were singled out for the measurement on a precision scale.
- Rice Grade: Repeated 3 measurements by using a grain measurement gauge (Kett RN-500, Japan).
- Static Electricity: Measurement was made by using an electrostatic potential measurement gauge (SSD-M2).

Results and Discussions

1. Turbidity Variation by Amount of Watering

As shown on Table 1 below, the turbidity was found significantly being reduced in response to increase in watering, and was driven down to the target of 50 ppm or even lower when watering rose up to 423 mℓ/kg or over.

Another finding was that the turbidity did not respond to variation of cylindrical screen revolution but a revolution of 302 rpm or faster brings about an impediment to rice transfer to the next chamber in spite of a transfer screw running since its centrifugal force affects it sticking to the inner wall of the screen.

Consequently, watering of 423 mℓ/kg or over and a cylindrical revolution of 205 rpm were determined to be the optimum dehydrating settings, on which the performance test was built.

2. Variation by Rice Feeding rates

As shown on Table 2 below, turbidity varied to 47.33 ppm, 48.00 ppm and 48.67 ppm respectively for watering of 800 kg/hr, 1,000 kg/hr and 1,200 kg/hr, which means a successful rice processing free from pre-washing.

Looking into the rice grade based on its supply of 1,000

Table 1 Turbidity (ppm) according to the amount of watering and rotor speed

Rotor speed (rpm)	Raw material	Amount of watering (mℓ/kg) LSD				LSD (5%)
		215	336	423	521	
108	66.33	58.33	52.33	48.67	47.33	3.01
205	66.00	58	52.67	47.33	47.67	3.55
302	65.67	57	53.33	48.33	48	3.15

1) Raw material was polished and cleaned by air cleaning device and passed through the electrostatic elimination process

Table 2 Turbidity of wash water and quality factors of rice varied to rice feeding rates into the pre-washed rice processing system with watering

Input rice quantity (kg/hr)	Turbidity (ppm)	Whiteness	Broken rice ratio (%)	Moisture content (%, w.b.)
Raw material	97.33	36.8	5.30	15.60
800	47.33	42.77	7.43	15.83
1,000	48.00	42.80	7.37	15.80
1,200	48.67	42.70	6.97	15.87
1,400	50.33	42.77	6.87	16.10
LSD (5%)	2.74	0.11	0.76	0.42

kg/hr, post-processing turbidity dropped down to 48.00 ppm as opposed to pre-processing turbidity of 97.33 ppm, while the whiteness improved to 42.80 post processing from 36.80 prior to processing. The grain pulverization ratio showed a marginal increase to 7.37% from 5.30% prior to processing while water ratio rose by approximately 0.2% (w.b.) after the processing, which was also concluded presenting little significance when compared with the existing wet pre-washed rice processing system.

3. Rice Grade by Processing Course

Looking into the rice grade by processing course setting rice and watering at 1,000 kg/hr and 430 mℓ/kg respectively, the course of rice-surface polishing by abrading and airing was found effective of reducing the turbidity by 22.67 ppm, the course of electrostatic rice-surface polishing by 8.33 ppm and the course using a fine watering by 17.34 ppm respectively.

In particular, it is noteworthy that turbidity curtailment effect made possible by the electrostatic polishing is significant, although it was comparatively smaller than the other two courses of processing, in the respect that the improvement was attributed to removing the minute rice bran and alien particles that are hard to get rid of.

The final turbidity of the rice after all the courses of processing were completed was 48.33 ppm, an outstanding improvement compared with the turbidity prior to processing. Consequently it is proven that this newly developed pre-washed rice processing system is good for rice processing free from pre-washing that only takes watering 0.43 times the rice quantity, and that it could contribute to reducing wash-watering by 69% compared with the existing wet type pre-washed rice processing systems popular in the Korean market (Table 3).

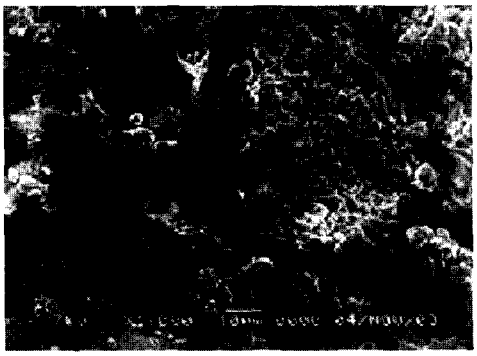
In addition, scanning electro-microscopic photographs of surface of the rice grains sampled from each course of the processing (JSM 5410, Joel Co., Japan) are shown in Fig. 2 below.

In case of raw (milled) rice, the surface structure of the grain is large and coarse, while the surface structure of the processed grains by abrading and airing looked rather smaller, if not for a major difference. Lastly, the rice grains that passedthrough the polishing device using a fine watering showed their surfaces clean and polished with a least amount of residual particles and their cell membranes in an obvious beehive shape, which is reported the typical shape of the

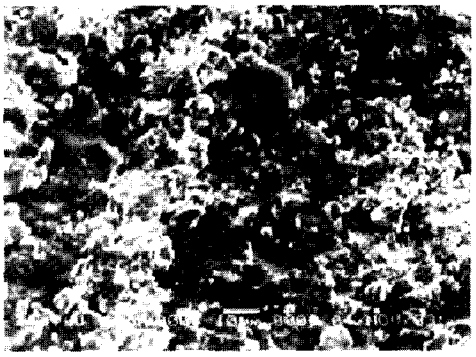
Table 3 Turbidity of wash water and some quality factors of rice after each cleaning process in the pre-washed rice processing system

Items	Raw materials	Polishing & air cleaning	Electrostatic eliminator cleaning	Watering process	LSD (5%)
Turbidity (ppm)	96.67	74	65.67	48.33	3.65
Whiteness	36.73	38.07	37.97	42.47	0.11
Broken Rice ratio (%)	5.25	5.9	5.83	7.1	0.36

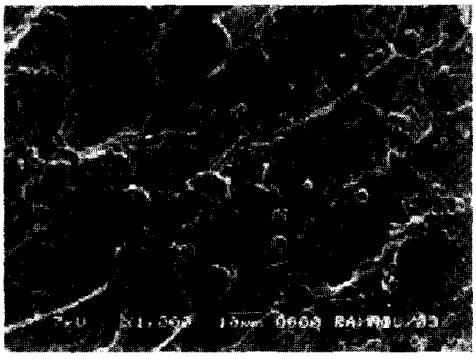
1) Maximum pressure in the polishing chamber: 0.68 kg/cm^2
2) Watering quantity : 430 mℓ/kg
3) Input rice quantity : 1,000 kg/hr



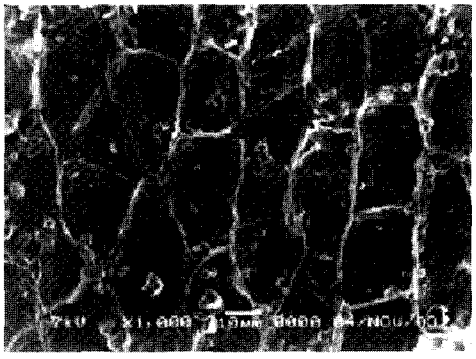
(a) Raw material



(b) 1st process
(After polishing & air cleaning)



(c) 2nd process
(Post-electrostatic eliminator cleaning)



(d) 3rd process
(Post-watering process)

Fig. 2 Surface structure of rice after each cleaning process by scanning electron microscope (JSM5410).

surface of pre-washed rice.

Therefore, it is found that the surface of the newly developed pre-washed rice had a very similar look to that of the existing pre-washed rice, although the amount of process-watering was just minimal.

Conclusions

The rice currently in circulation entails the trouble of washing before cooking and also gives rise to water contamination because of the turbid wash water. Therefore, it is expected that use of the processed rice from this newly developed system will provide convenience for the consumers in rice cooking and contribute to propagation of clean and high-grade rice with added value.

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