MILLING CHARACTERISTICS OF BROWN RICE USING A CONTINUOUS TYPE CONDITIONER

D. B. Song[1], K. Y. Han[1], S. T. Kim[1] and B. J. Choi[2]

[1]Division of Agricultural Engineering, Gyeongsang National University, Chinju, Gyeongsangnam-Do, 660-701, Korea
E-mail:dbsong@nongae.gsnu.ac.kr
[2] Ideal system Co., Ltd. Taegu, 711-810, Korea

ABSTRACT

The water conditioning experiments of brown rice were performed to verify the effect of brown rice conditioner and to decide the optimum operating variables for the conditioner. The initial moisture contents of 13-14%(wb) brown rice were used as experimental samples. The flow rate of brown rice passing through the conditioner was 2,940 kg/hr and water was supplied proportionally from 80 cc/min to 240 cc/min. The differences between expected and measured moisture contents were neglected except 0.25%(wb) of the maximum differences at 0.2920((cc/min)-water/(kg/min) · %-brown rice) of water supply rate. For the initial moisture contents of 13-14%(wb) brown rice, it was found that a proper water supply rate was 0.2415((cc/min)-water/(kg/min) · %-brown rice) and the increments of whole rice was 2.3% compared to non conditioned ones. It was considered that the conditioning process did not influence the whiteness of milled rice because the whiteness differences between conditioned and non-conditioned milled rice were negligible,.

Key Word : Milling, Conditioner, Milled Rice Recovery, Brown Rice, Quality

INTRODUCTION

In Korea, the moisture contents of rough rice at milling process, which varies depends on the vatiety of rough rice, cultivation areas, milling utilities and marketing structures, are around 14-16%(wb). In the case of the moisture content of rough rice at milling is higher than that of the normal moisture content, the humid bran flour causes to trouble the rice milling machines and in the case of lower moisture content, the milled rice recovery is decreased due to the increase of broken rice which is caused by impact forces when they are passing through hullers and rice milling machines (Song et al., 2000).

As the moisture content of rough rice at milling is closely related to a milled rice recovery, a power consumption of rice milling machine and the quality of milled rice, the water conditioning process is highly recommended on a milling process when the moisture content of rough rice is below normal moisture content ranges.

The water conditioning means to uniform the internal water distribution and to soften the internal texture of brown rice by adding water to the surface of brown rice which is over dried by a long-term storage. Therefore, the water conditioning is very effective method to increase the milled rice recovery and quality to reduce the broken rice occurrence. Because brown rice is broken also during the moisture absorption process by the over supplied water, the amount of water added to brown rice should be limited during the water conditioning (Kim et al., 1998). The proper amount of water for brown rice conditioning is varied as initial moisture content and a variety of brown rice. It is important to decide the amount of water supplied from the experimental results(Han et al., 2000).

The objectives of this study are to verify the effect of brown rice conditioning and to determine optimum operating variables to keep the milled rice recovery using a continuous type brown rice conditioner.

MATERIALS AND METHODS

1. Materials

Short grain rice that was stored in a rice bin during 10 months after harvested on Oct. in 1999 in Koheung, Chunnam was selected for the experiment. Initial moisture contents of samples were ranged 13-14%(wb) and 10 tons of rough rice were used for this experiment. The flow rate of brown rice passing through the experimental apparatus was 2,940 kg/hr.

2. Experimental apparatus

A continuous-type brown rice conditioner consisted of a brown rice tank, a gate for flow rate control, an unfolding unit of brown rice, a water injection unit, an outlet unit and an electric control unit. Water was supplied proportionally from 80 cc/min to 240 cc/min. Specifications and a diagram of experimental apparatus are shown in table 1 and fig. 1.

3. Milling process

The conditioner was installed between a brown rice tank and an abrasive type rice milling machine followed by two friction type rice milling machines serially. The milling process is shown in fig. 2.

4. Method

1) Moisture content

Ten grams of samples were used to measure moisture content after drying by an oven method(135℃-24hrs). The moisture contents of three samples were measured at each experiment and the mean value of three samples was selected as the moisture content.

2) Rice quality

The quality of milled rice was measured using a optical rice inspector(RN-500, Kett, Japan). One sample which has 1,000 grains was classified and counted as whole, broken and cracked rice. Three samples were measured at each experiment and the mean value of the three samples was selected as the milled rice quality.

3) Whiteness

The reflective index measured with a photo-diode(C-300-3, Kett, Japan) was used to determine the whiteness of milled rice. Three samples were measured at each experiment and the mean value of the three samples was selected as the whiteness of milled rice.

RESULTS AND DISCUSSION

1. Moisture content of brown rice

The most important point of a conditioner is to let water be absorbed on brown rice uniformly. If water is supplied unevenly, over supplied water causes to increase the amount of broken rice at the absorption process. To validate the uniform water supply performance, the expected moisture content of brown rice was compared to the conditioned moisture content. The expected moisture content could be calculated using initial moisture content, a flow rate of brown rice and a water supply rate.

The moisture contents of non-conditioned, conditioned and expected are shown in fig. 3. The water supply rate, which indicated one of important indexes to operate a conditioner, was derived from the amounts of inlet water(cc/min), a flow rate of brown rice(kg/min) and an initial moisture content of brown rice(%, wb). In fig. 3., we know that the difference between expected and measured moisture contents is negligible except 0.25%(wb) of the maximum difference at 0.2920((cc/min)-water/(kg/min) · %-brown rice) of water supply rate. This means that supplied water was absorbed evenly to the whole brown rice.

2. Quality of milled rice

To increase milled rice recovery by reducing broken and cracked rice occurrences, it is improtant to find out a proper water supply rate to maximize the milled rice recovery in addition to the uniform water supply performance of a conditioner. To achieve this, 1,000 grains of milled rice were inspected and classified as whole, broken and cracked rice at each experimental condition. The differences of whole, broken and cracked rice between conditioned and non-conditioned ones are shown in fig. 4. In fig. 4, the amount of whole rice increases up to 0.2415((cc/min)-water/(kg/min) · %-brown rice) of water supply rate but decreases rapidly over that water supply rate. However the amounts of broken and cracked rice shows an opposite tendency. This means that water absorbed on the surface of brown rice reduces broken and cracked rice occurrences effectively by decreasing abrasive and frictional impacts during milling process under a proper water supply condition. However broken and cracked rice increase rapidly because brown rice are cracked by a reabsorption process under an over water supply condition.

Under 13-14%(wb) of initial moisture contents, it was found that the proper water supply rate was 0.2415((cc/min)-water/(kg/min) · %-brown rice) and the increment of whole rice was 2.3% compared to non conditioned ones.

3. Whiteness of milled rice

The whiteness of milled rice is an index indicating the degree of milling. The whiteness of milled rice is a very important factor related to a milled rice recovery and the values of goods. The prices and demands of milled rice are affected susceptibly by the whiteness of milled rice. Therefore, it is necessary to compare the whiteness of milled rice between conditioned and non-conditioned ones.

The whiteness differences of conditioned and non-conditioned milled rice are shown in fig. 5. In table 5, it was considered that the conditioning process did not influence the whiteness of milled rice.

CONCLUSIONS

Experimental results showed the water conditioning process of brown rice was an effective method to increase the milled rice recovery without any affection of the milled rice whiteness causing to trouble the values of goods.

The difference between expected and measured moisture contents were negligible except 0.25%(wb) of the maximum difference at 0.2920((cc/min) -water/(kg/min) · %-brown rice) of water supply rate. This implied that the supplied water was absorbed to the whole brown rice evenly.

Under 13-14%(wb) of initial moisture contents, it was found that the proper water supply rate was 0.2415((cc/min)-water/(kg/min) · %-brown rice) and the increment of whole rice was 2.3% compared to non conditioned ones.

It was considered that a conditioning process did not influence the whiteness of milled rice because the whiteness differences of conditioned and non-conditioned milled rice were negligible.

REFERENCES

1. Han, C. S., H. K. Koh, D. B. Song, J. D. So and H. Y. Jeon. 2000. Development of predicted model and properties variation of brown rice after conditioning. J. Agr. Sci., Chungbuk Nat'l Univ. vol.17:75-80.
2. Kim, J. S., H. K. Koh and D. B. Song. 1998. Adsorption characteristics of short grain rough rice. J. of the Korean Society for Agricultural Machinery 23(5):465-472.
3. Song, D. B. and H. K. Koh. 2000. Development of continuous brown rice conditioning equipment. Proceedings of the KSAM 2000 Winter Conference 5(1):325-330.

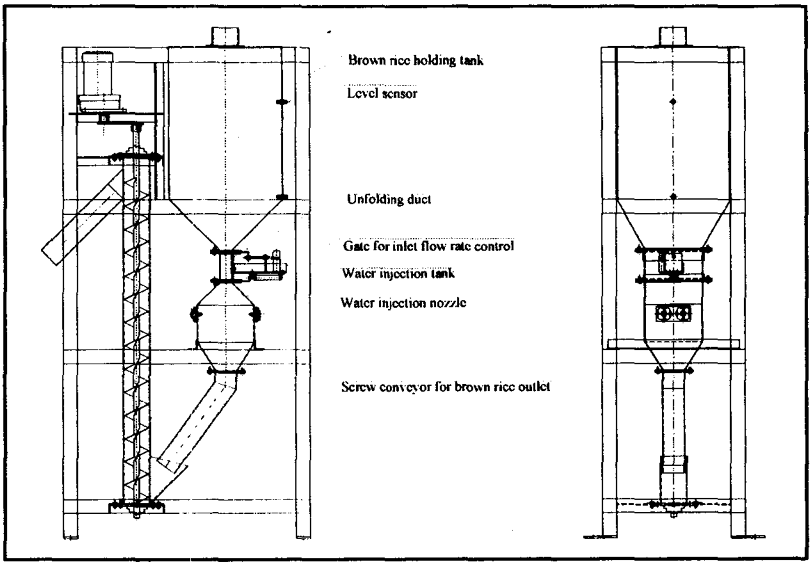

Fig. 1. Schematic diagram of the experimental apparatus.

Table 1. Specifications of the experimental apparatus.

Description	Specification
Capacity(kg/hr)	4,000
Amount of water supply(cc/min)	50 – 400
Water injection pressure(kgf/cm2)	0.5 – 10.0
Power consumption(kW)	0.75
Dimensions(mm)	1,500(L)X1,000(W)X3,300(H)

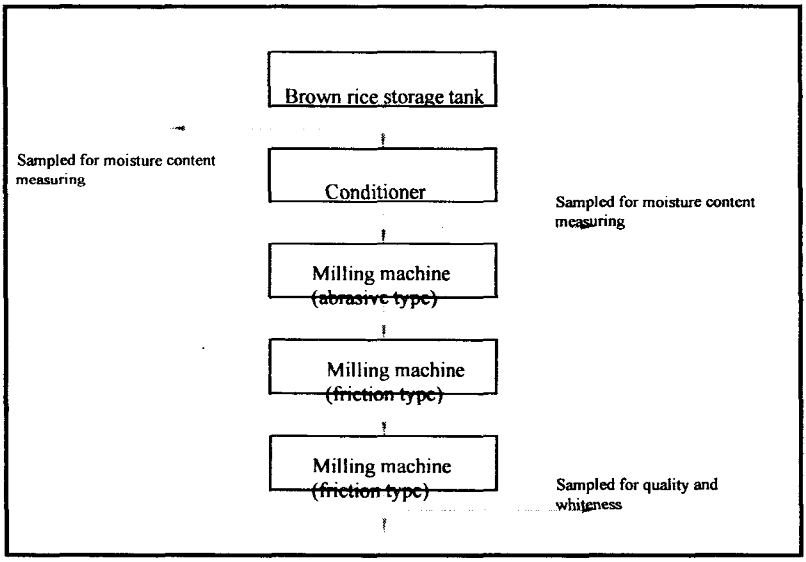

Fig. 2. Milling process at Koheung rice processing complex.

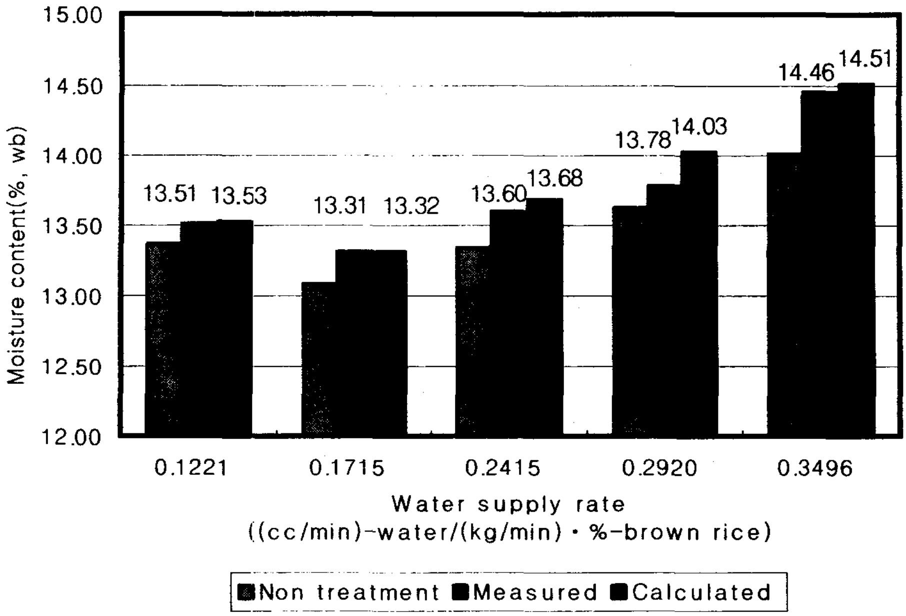

Fig. 3. Moisture contents of conditioned and non-conditioned brown rice.

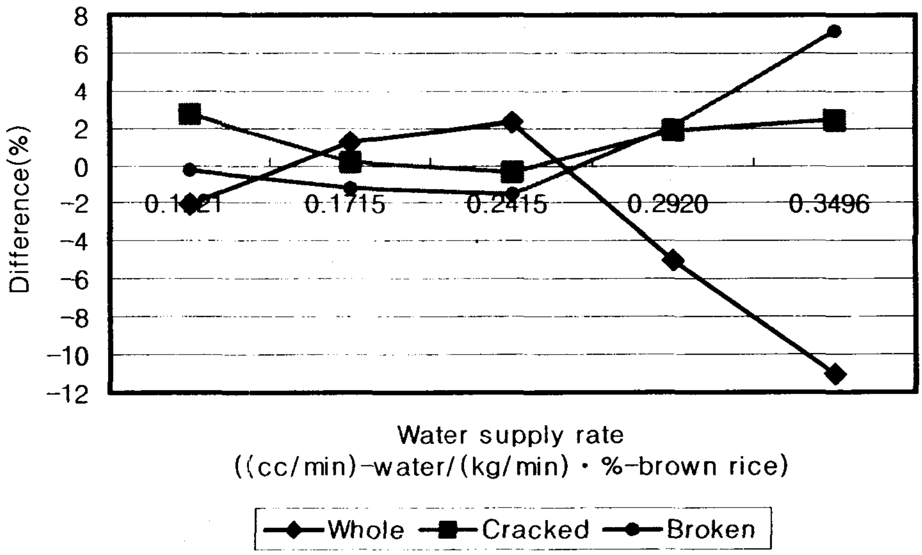

Fig. 4. Quality differences of conditioned and non-conditioned milled rice.

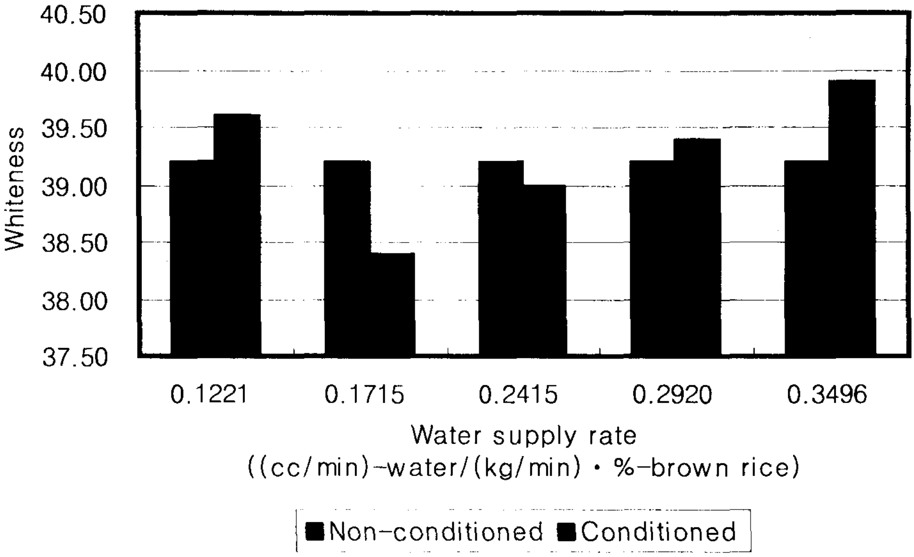

Fig. 5. Whiteness of conditioned and non-conditioned milled rice.