PRESERVATION OF QUALITY AFTER BROWN RICE DRYING

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ABSTRACT

The brown rice drying is effective for energy saving and cost reduction. However, deterioration after drying is one problem, because the skin damage occurs during the drying. So, the measures to preserve the quality has been investigated.

One of major quality deteriorations is the oxidation of fat which is contained in the bran layer. So, milling should be carried out to remove the fat as soon as possible after brown rice drying. And the low temperature storage is also worth to be examined for prevention of oxidation.

The effect of skin damage on the increase of fat oxidation was clarified. For the grain of skin damage, the increase of fatty acid value was remarkable after 70 days elapsed from occurrence of skin damage even in 15 ℃ condition. Therefore it is impossible to keep grain as brown rice form after brown rice drying. For the clean rice and excessively milled rice, the quality can be preserved even in high temperature of 30 ℃. Therefore the brown rice drying can be applied practically using the clean rice technique.

Key Word: Brown rice drying, Skin damage, Storage, Quality, Clean rice

INTRODUCTION

In order to reduce the rice production cost in the postharvest stage, the probability of brown rice drying was discussed. Brown rice drying is considered to be more reasonable than that of rough rice from the viewpoint of effective use of heat energy and high volume efficiency. We authors has decided the proper temperature and relative humidity and ratio of tempering to drying time etc. for brown rice drying.

However, there is a problem for the storage after brown rice drying; because skin damage is much made during circulation, fat in the bran is oxidized easily. Fat oxidation leads to the dererioration of quality and taste. So, to realize the brown rice drying practically, the method of quality preservation has to be established. For this purpose we used the tequnique of clean rice, in which bran can be removed perfectly.

EXPERIMENTAL METHOD

1. Drying apparatus

Brown rice drying was carried out by the ordinary type of circulating dryer for rough rice. The air generator of constant temperature and relative humidity was combined to this dryer for supplying the constant drying air. The total holding capacity of this dryer is 260 kg and the drying part is 16 kg for brown rice. Circulating period can be controlled by regulating the circulating device. Air flow rate can be controlled by the inverter of the blower.

The measuring equipments of air temperature and humidity of the inlet and outlet of the drying part, air velocity meter and wattmeter were set in the drying system. The measurement of moisture content was carried out by oven method and single kernel moisture meter.

2. Material

The varieties used for the experiments were 'Hatsushimo' and 'Nihonbare' which were harvested in Gifu pref. Immediately before drying, the rough rice was dehusked by the impeller type dehusker (FC4, Otake Co. Ltd). 80 kg of rough rice was used per experiment; 64 kg of brown rice was made, 16 kg in the drying part and 48 kg in the tempering tank.

3. Drying condition

The ratio of tempering to drying time was 3, that is, 10 minutes for drying and 30 minutes for tempering. Considering the results of the previous experiment, the temperature of drying air was 30℃ or less, and the relative humidity was 50 – 70 %. The air flow to grain was 0.4 – 0.55 m^3/s.100kg(grain).

4. Storage condition

After the brown rice drying, the rice quality has to be kept in the storage. Then, the dried brown rice was stored in the constant temperature chamber of 4 ,15 and 30℃, being put in the air tight plastic bag.

As the indices of the rice quality, the surface color and fatty acid were used. The rice form during storage were brown rice, ordinary milled rice and clean rice. Clean rice is made using the wet type polishing machine (Satake Co. Ltd) in the final stage of rice milling.

RESULTS AND DISCUSSION

1. Energy consumption

The drying processes of rough rice and brown rice which are similar each other are shown in Fig.1. In order to obtain the similar process, air temperature for rough rice has to be higher than that for brown rice by about 10℃. It is clarified that the energy saving can be obtained by the brown rice drying method; Consumed electric energy of heating for water evaporation was 0.20 kWh/1kg(water) in the brown rice drying, on the other hand that in the rough rice drying was 1.26 kWh/1kg(water). However this degree of energy saving varies according to the ambient air state.

2. Skin damage

Because the circulating dryer was used for brown rice drying, fairly much skin damage was made by the friction with screw conveyor, bucket elevator and the mutual friction between rice particle. Skin damage should be avoided as little as possible because it leads to the oxidation of fat in the bran layer. The relation between initial moisture content of brown rice and the degree of skin damage is shown in Fig.2. The higher the initial moisture content is, the higher the index of skin damage is. Although it is important to improve the dehusking and conveying mechanism, but the initial moisture content also should be lowered by controlling the harvesting period or applying the preliminary drying.

The relation between degree of skin damage and the increase of fatty acid value after 3 months from drying is shown in Fig 3.

3. Change of surface color during storage

The fact that the surface color changes when the brown rice deteriorates is known empirically. Therefore, the surface color was measured with the time elapsed by the color meter (Nihon Denshoku Co. Ltd., ND-300A) in 3 stages of storage temperature to survey the effect of temperature on the deterioration. The surface color was expressed by the values of 'L', 'a' and 'b'. 'L' value shows the brightness, 'a' value shows degree of red or green, and 'b' value expresses degree of yellow and blue.

The changes of surface color of the brown rice which were dried in rough rice form and brown rice form are shown using 'L' and 'b' values and color difference (ΔE)in Fig.4 to Fig 9. The temperatures used for the storage was 4, 15 and 25℃. It is clarified that surface color of brown rice of brown rice drying changes much in comparison with that of rough rice drying. Moreover, the higher the storage temperature is, the more the change of 'L' value, 'b' value and ΔE value are; it is clarified that the low temperature storage is effective to preserve the rice quality after the brown rice drying.

4. Change of fatty acid value

The changes of fatty acid value of brown rice dried by both rough rice drying and brown rice drying are shown in Fig.10. The storage temperature was 4℃ and 30℃. In the case of brown rice drying, fatty acid value increased much especially in high temperature storage. Even for rough rice drying, when the rice is stored in brown rice form, fatty acid value increased to some extent. From these results, storage with brown rice form is improper for quality preservation especially in brown rice drying.

5. Method of quality preservation

In the case of brown rice drying, much skin damage is generated; then fat is oxidized easily and deterioration occurs. It is then thinkable that the bran layer is removed immediately after drying. Fat in the bran also is removed by milling, then fatty acid can not be generated.

As the milled rice, ordinary milled rice and clean rice which is milled by the wet type polishing machine at the final milling stage are used for the experiment. Among the ordinary milled rice, milling rate of 91 % and 89 % were applied. Storage temperatures were 4℃ and 30℃. The changes of fatty acid value for various kinds of milled rice are shown in Fig.11. The lower the milling rate is, the less the increase of fat acidity value is. Therefore, in order to preserve the rice quality, the milling rate should be low. However, this idea is not good from the economical point. The clean rice shows the very good result. That is, even in the high temperature storage, fatty acid value does not increase. From the viewpoint of cost for storage after the brown rice drying, the method of clean rice is thought to be the most applicable.

CONCLUSION

For the brown rice drying, the heat efficiency is fairly high, however there is a problem of quality preservation during the storage after drying. The experiments about the quality preservation was carried out.

(1)Brown rice drying was done with the ordinary type of circulating dryer (capacity: 260 t for brown rice).

(2)In the case of brown rice drying, skin damage is much generated during circulation. The higher the initial moisture content is, the higher the degree of skin damage is. Skin damage leads to the quality deterioration.

(3)When the deterioration occurs, the surface color of brown rice changes. Therefore the values of 'L', 'b' and ΔE are indices of quality.

(4)Even for the rough rice drying, fatty acid value increases in the storage with brown rice form in a short time.

(5)In order to preserve the rice quality, rice milling should be done immediately after brown rice drying. Especially the clean rice is proper because the quality can be preserved even in ambient temperature storage.

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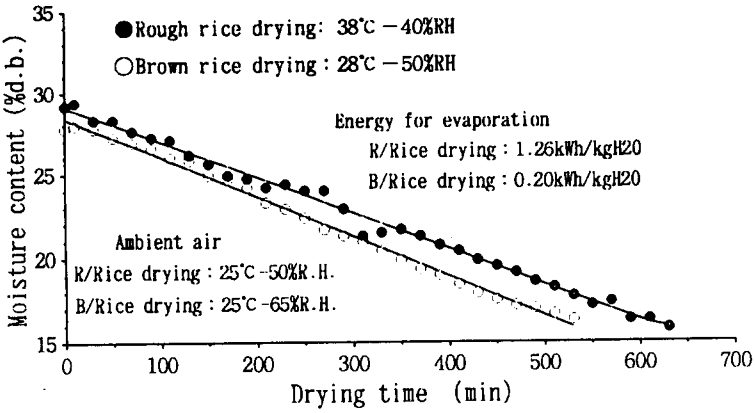

Fig.1 Comparison of R/Rice drying and B/Rice drying

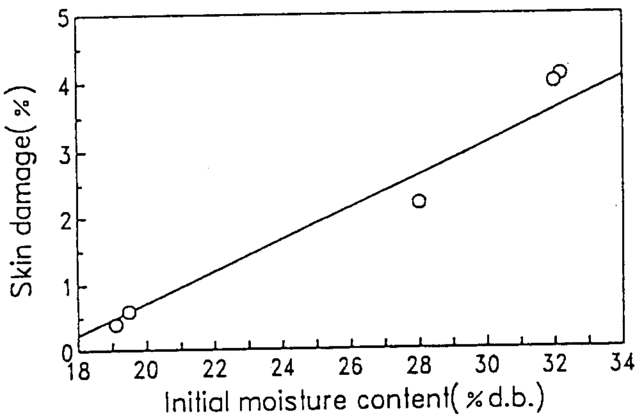

Fig.2 Relation of initial M.C. and degree of skin damage

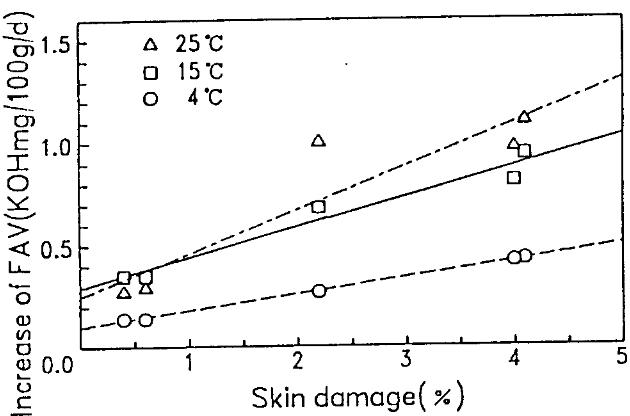

Fig.3 Relation of skin damage and generation of fatty acid

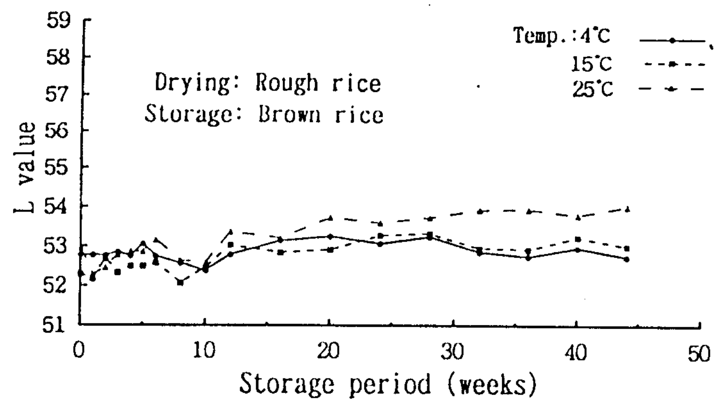

Fig.4 Change of L value during storage (R/Rice drying)

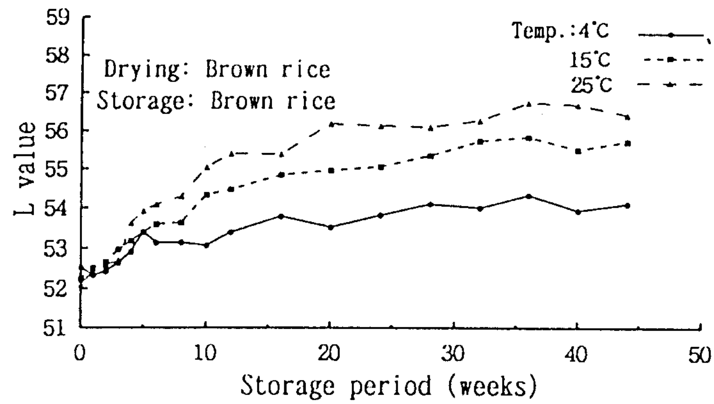

Fig.5 Change of L value during storage (B/Rice drying)

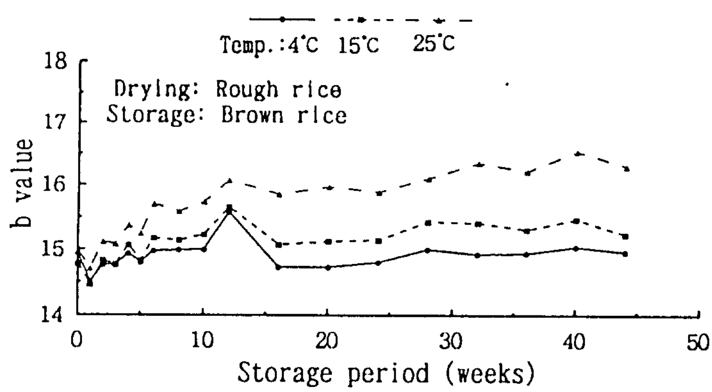

Fig.6 Change of b value during storage (R/Rice drying)

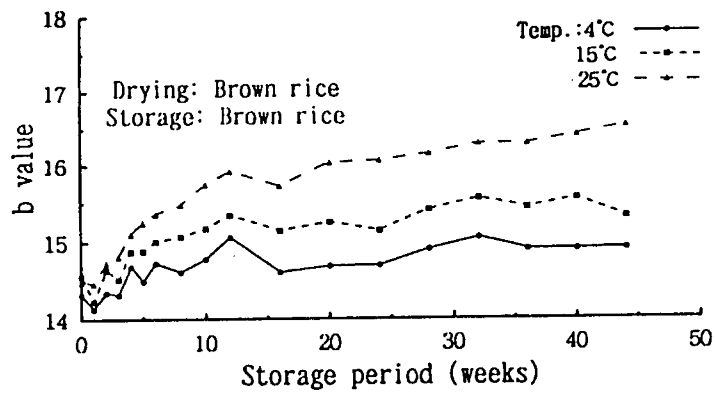

Fig.7 Change of b value during storage (B/Rice drying)

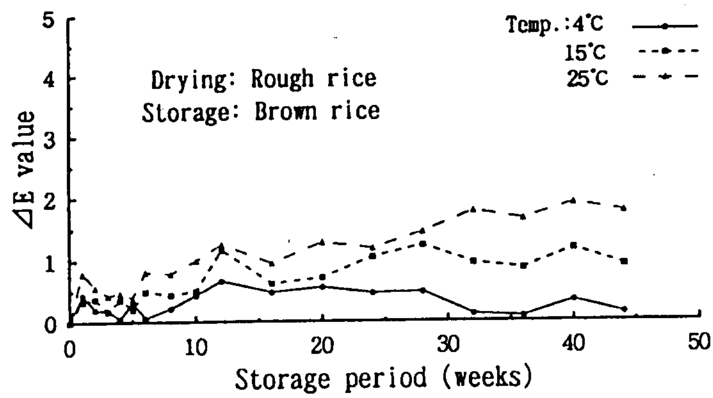

Fig.8 Change of ΔE value during storage (R/Rice drying)

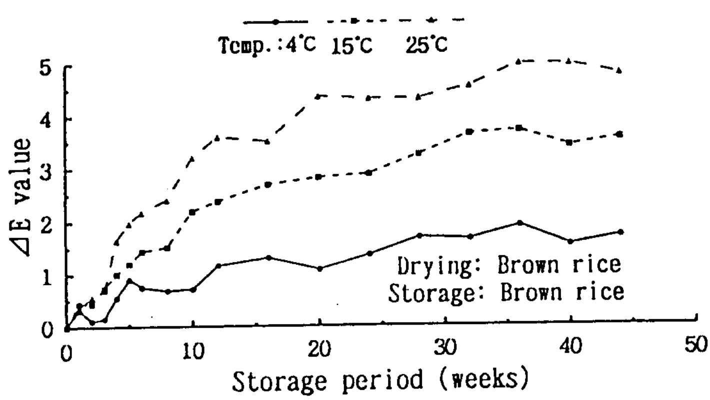

Fig.9 Change of ΔE value during storage (B/Rice drying)

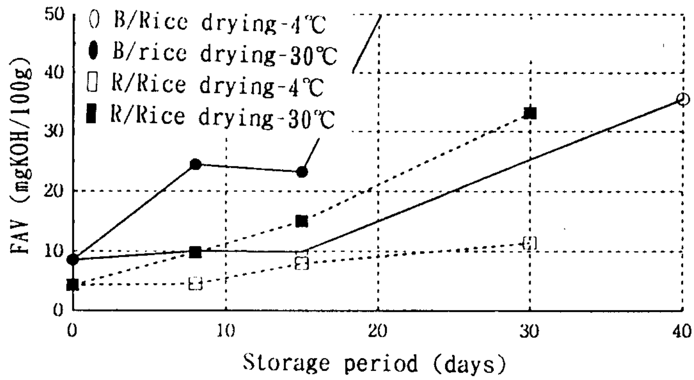

Fig.10 Change of fatty acid value in B/Rice storage

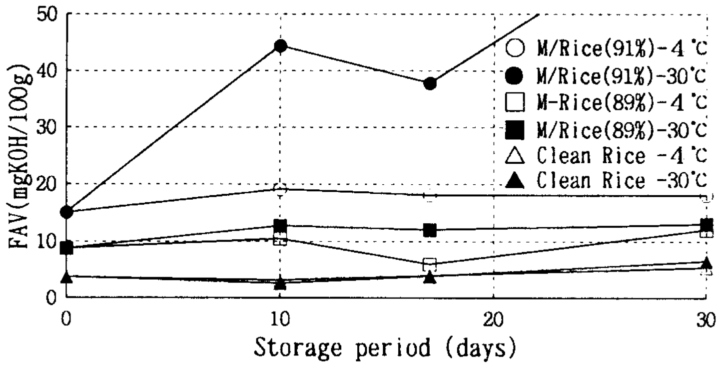

Fig.11 Quality preservation by milled rice and clean rice