Germination Power, Analyses and Vitamin-B of Hulled Rice stored during 4 years either Air-tight or in Carbon dioxide. *

By

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[April 19, 1930.]

Introduction.

In the preceding paper the writers reported on the effect of air-tight and carbon dioxide upon the storage of rice, especially regarding the several kinds of physical properties. Later the writers investigated further the germination power, analyses of nutriments and Vitamin-B, the same materials being used as in the preceding experiments. The results are reported in the present paper.

I. Materials.

The materials of investigation were the hulled rice of "Shinriki" and "Omachi" of 1924. They were dried very thoroughly, i.e. the moisture of "Shinriki" was 11.8% and that of "Omachi" 11.3%. Each kind was divided into three divisions and stored by the three following methods.

A. Carbon dioxide storage. The hulled rice was stored in the large zinc vessels with CO₂.

B. Air-tight storage. In the same zinc vessels as A the hulled rice was stored and the vessels were closed tightly.

C. Straw-bag storage. The hulled rice was stored in the common straw-bags.

These vessels and straw-bags of rice were placed in the same granary of the Ōhara-Institute. The details about storage are written in the preceding paper. These materials were stored during 4 years, from 1924 to 1928. As a control, new rice of 1927 was used.

* This article was already in "The Proceedings of the Imperial Academy" (Tokyo) V, (1929), No. 3, p. 159—160 quite briefly, and also in "Nōgaku-Kwai-Hō" (Journal of the Scientific Agricultural Society) No. 318 (1929), p. 183—204 in Japanese in details reported.
II. Experimental Results.

1. Germination power of rice.

In the preceding paper the results of the germination experiments of stored rice, in October 1927, just three years after harvest, were given. The germinating capacity of "Shinriki" was 97% and that of "Omachi" 96%, and it was just the same as that of the new rice.

In July 1928, the germination power of the same rice was examined again. It was just four years after harvest. The results of the experiments are given in Table 1.

Table 1.
Germinating capacity of rice, in July 1928.

<table>
<thead>
<tr>
<th>Material</th>
<th>Method of storage</th>
<th>Germinating capacity</th>
<th>Material</th>
<th>Method of storage</th>
<th>Germinating capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shinriki</td>
<td>CO₂ storage</td>
<td>99.0</td>
<td></td>
<td>CO₂ storage</td>
<td>95.5</td>
</tr>
<tr>
<td></td>
<td>Air-tight storage</td>
<td>98.0</td>
<td>Omachi</td>
<td>Air-tight storage</td>
<td>93.5</td>
</tr>
<tr>
<td></td>
<td>Straw-bag storage</td>
<td>0</td>
<td></td>
<td>Straw-bag storage</td>
<td>0</td>
</tr>
</tbody>
</table>

The above table shows that the hulled rice stored air-tight or in carbon-dioxide during 4 years retained its germination power perfectly, i.e. the germinating capacity of "Shinriki" 98—99%, that of "Omachi" 93.5—95.5%. It shows that rice was preserved perfectly in its quality during 4 years after harvest. In the writers' opinion, the rice could retain its germination power even longer than 4 years, when stored still longer.

It might not be necessary to test the germination power of rice in the straw-bags, because the germination power of hulled rice in straw-bags is scarcely one year, as Kondo reported already.

2. Analyses of rice.

The rice stored during 4 years by the three different methods, i.e. in carbon dioxide, air-tight and in straw-bags, was analysed, and as the control the new rice harvested in autumn of the preceding year was used. It was carried out in July 1928 by the ordinary process and the analytical data are as follows.
Table 2.
Composition of rice.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Moisture %</th>
<th>In the dry substance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ash %</td>
</tr>
<tr>
<td>New rice of 1927 (Control)</td>
<td>13.18</td>
<td>1.24</td>
</tr>
<tr>
<td>Rice of 1924 stored in CO₂</td>
<td>12.82</td>
<td>1.27</td>
</tr>
<tr>
<td>Shinriki</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• • • • air-tight</td>
<td>12.46</td>
<td>1.31</td>
</tr>
<tr>
<td>• • • • in straw-bags</td>
<td>12.75</td>
<td>1.12</td>
</tr>
<tr>
<td>New rice of 1927 (Control)</td>
<td>12.94</td>
<td>1.25</td>
</tr>
<tr>
<td>Rice of 1924 stored in CO₂</td>
<td>12.55</td>
<td>1.25</td>
</tr>
<tr>
<td>Omachi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• • • • air-tight</td>
<td>12.34</td>
<td>1.24</td>
</tr>
<tr>
<td>• • • • in straw-bags</td>
<td>12.76</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Note:—1) Protein......N x 6.25, after Kjeldahl,  
Fat......after Soxhlet,  
Carbohydrate......after Liebermann and Bertrand,  
Crude fiber......after Henneberg and Stohmann.  
2) This analysis was carried out by S. MATSUSHIMA in the Institute for Labour Science in Kurashiki.

The facts brought out in the above data are as follows:—  
1) In the rice in straw-bags, the percentages of ash and fat of "Shinriki" and "Omachi", and that of protein of "Shinriki" decreased in a great degree, in comparison to the control, because the rice was much damaged by insects and at the same time chemical changes may have occurred in a great degree during the storage of 4 years.

2) On the contrary to the above, in the rice stored air-tight or in CO₂, the percentages of ash, fat and protein of both kinds are much greater than those of the rice in straw-bags and nearly the same as those of the new rice used as the control. It is clear that no remarkable chemical change occurred during 4 years.

3) Between the rice stored air-tight and that stored in CO₂ there is no definite chemical change of composition.

In short, rice in straw-bags lost protein, fat and ash in a great degree during 4 years, but rice stored air-tight or in CO₂, on the contrary, preserved these nutriments in safety during 4 years.

3. Vitamin-B.

The preservation of vitamin-B in rice is a very important problem, because vitamin-B is, as well known, the anti-beri-beri element. This disease is
prevalent in Japan and other rice-eating countries. It is believed generally that vitamin-B is contained particularly in the embryo and also, that it will be decomposed by oxidation gradually, when stored in straw-bags as usual. The content of vitamin-B in one year old unhulled rice is about 60% of the content of it in new rice.

The writers investigated the effect of air-tight and carbon-dioxide upon the preservation of vitamin-B in rice. They used the hulled rice of “Omachi” and “Shinriki” harvested in 1924 and stored air-tight or CO₂ to July 1928. As the control the rice of 1927, just after 8 months from harvest was used. The method of TERUUCHI and OYAMA was adopted. As the experimental animals young White Leghorn fowls were used, whose weight was about 3.400 g.

A few days before the experiment the fowls were fed with hulled rice. During the time of experiment, 25—30 g cleaned polished rice was given in proportion to the weight 300—400 g and 1.1 g embryo added in proportion to the polished rice 30 g and 1.4 g embryo to the polished rice 40 g. The feeding experiment began on July 16th and ended on August 10th, 1928. The feeding experiment with rice “Omachi” was carried out by OKAMURA in the Ohara-Institute and that with “Shinriki” by MATSUSHIMA in the Institute for Labour Science. Both results were quite the same.

The fowls exclusively fed on polished powdered rice, lost their appetite sooner or later in 4—8 days, sickend and died in 8—13 days after the beginning of the experiment. It shows that owing to the deficiency of vitamin-B, the fowls suffered from a kind of neuritis. The writers found that there was no difference in regard to the feeding results between the rice of 1924 (old) and that of 1927 (new) and also no difference between the rice stored air-tight and that stored in CO₂.

When the certain quantity of embryo of rice of 1924, 4 years old rice, was added to the polished rice, the fowls generally had a good appetite, thrived and lived to the end of experiment with a duration of 26 days. In comparison, the results of the feeding experiment with the old and the new rice, were just the same in regard to the content of vitamin-B in its embryo, and also there was no difference between the rice stored air-tight and that in CO₂.

The above facts show that rice, although it is hulled, can retain its vitamin-B perfectly like the new rice during 4 years, when it is stored air-tight or in CO₂. (Plate XXVIII.)

The rice stored in straw-bags, was much damaged by insects, especially at the embryonal portion, and it was not possible to examine the content of vitamin-B. But in the writers’ opinion, is should be safe to assume that vitamin-B very much decreased in its content and scarcely any remained.
III. Conclusion.

In the preceeding paper it was reported that the rice stored air-tight or in CO$_2$ remained quite unaltered in its physical properties for the period of the three years. After 4 years it was still the same. In the present paper it is also clear that the rice stored air-tight or in CO$_2$ perfectly preserved its germination power and that its chemical composition and vitamin-B were quite unaltered for 4 years. There was no remarkable difference between the results of air-tight and CO$_2$ storage. The writers like therefore to propose to encourage the people at first to dry rice thoroughly and then to store it air-tight. 

It is really an ideal method of storage of rice to store it in hermetically sealed vessels.

IV. Summary.

1. In the present paper, the results of investigation of the germination power, chemical composition and vitamin-B of hulled rice are reported, which is stored 4 years air-tight, in CO$_2$ or in straw-bags.

2. Hulled rice stored 4 years air-tight or in carbon-dioxide retained its germination power perfectly.

3. Hulled rice in straw-bags lost protein, fat and ash in a great degree during 4 years, but rice stored air-tight or in CO$_2$, on the contrary preserved these elements in safety, during 4 years.

4. Hulled rice could contain its vitamin-B perfectly like the new rice during 4 years, when it was stored air-tight or in CO$_2$.

5. It is an ideal method of rice storage to store it in hermetically sealed vessels.

Literature.


Explanation of Plate XXVIII.

Control, new rice “Omachi”, harvested in 1927.

No. 1. Exclusively fed on polished rice, fowls suffered from neuritis.
No. 4. Embryo is added to polished rice, fowls are in good health.

Rice “Omachi” harvested in 1924 and stored to 1928 air-tight.

No. 6. Exclusively fed on polished rice, fowls suffered from neuritis.
No. 7. Embryo is added to polished rice, fowls are in good health.

Rice “Omachi” harvested in 1924 and stored to 1928 in carbon dioxide.

No. 7. Exclusively fed on polished rice, fowls suffered from neuritis.
No. 12. Embryo is added to polished rice, fowls are in good health.
PLATE XXVIII.

No. 1.

No. 4.

No. 6.

No. 7.

No. 9.

No. 12.