Storage of Rice. XII.

Storage of Rice in Tin Containers with Calcium Chloride, with Special Reference to the Underdried Product. I.

By

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I. Introduction.

After many experiments, the authors have concluded that considering all the chemical, physical, biological, and culinary properties of hulled rice, it may be said that 13 per cent is the allowable limit of moisture for storage during several years in Okayama Prefecture and that it is sufficient to store merely in hermetically sealed containers. It may be added, however, that a moisture content of 14 per cent is not too high for only one year storage.

It often happens in practice that it is desired to store hulled rice which has not been dried to a moisture content of 13 per cent. In such a case, desiccating apparatus must be placed in the container. In an earlier paper the authors reported on the influence of a desiccating material, such as calcium chloride, upon the preservation of the germinating power of hulled rice, differing in its moisture content and stored at various temperatures. In conclusion they reported that when the moisture content is high and the temperature during storage high, the vitality of the rice and the activity of its catalase decreases in like degree. By the addition of calcium chloride, the germinating power is better preserved, the effect at high temperatures being particularly marked. It was found the addition should be in the proportion of one kg. of CaCl₂ to one Koku of hulled rice for absorption of one per cent of moisture. When the CaCl₂ deliquesces, it should be dried and used again. By the repeated use of CaCl₂, the rice will be dried to a moisture content of 13 per cent.

Having reached these conclusions, it appears very important to ascertain the influence of CaCl₂ on hulled rice, which has not been sufficiently dried but has been sealed in a large tin container. With this practical point in view, the present experiment was carried out.
II. Method of Experiment.

Two lots of hulled rice with a moisture content of 14.16 per cent and 16.9 per cent respectively were sealed hermatically in large tin containers with a capacity of 5 Koku. Each container was so constructed that within, in the upper, middle, and lower part, six wire netting cylinders, having inside receptacles with CaCl₂, are inserted. (Photograph and Figure.) The results of the earlier experiment indicate that by the repeated use, when deliquesced, 1-2 kg. of CaCl₂ would be required for each Koku of hulled rice, but, as a precaution, since it was necessary to desiccate the rice as quickly as possible before summer, in this experiment, 3 kg. of CaCl₂ to each Koku of hulled rice were added and the desiccating effect studied. The tin container is 1.7 meters high and 0.9 meter in diameter. This size, although perhaps the largest feasible, is still the one best suited for farmers' use.

Tin Container of Rice.

The quantity of rice, its moisture content, and quantity of CaCl₂ used were as follows:

(After the design of U. Yamagami)
Moisture of hulled rice Quantity of rice Quantity of CaCl₂
14.16% . . . . . . 4.7 Koku . . 3 kg. per 1 Koku of rice
16.9% . . . . . . 4.8 Koku . . 3 kg. per 1 Koku of rice

The rice of the 1932 crop was used in the experiment and on April 1, 1933 it was stored in the containers. The summer of that year was extraordinarily hot. On October 8, just one year from the time the crop was harvested, the containers were opened and the rice was examined with reference to its moisture content, its quality, and its germinating power.

III. Results of Experiment.

1. Moisture Content.

Determinations of moisture gave the following results:

<table>
<thead>
<tr>
<th>Part of container</th>
<th>Rice with an initial moisture of 14.16%</th>
<th>Rice with an initial moisture of 16.9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper part</td>
<td>11.88%</td>
<td>14.70%</td>
</tr>
<tr>
<td>Middle part</td>
<td>12.90%</td>
<td>15.40%</td>
</tr>
<tr>
<td>Lower part</td>
<td>13.20%</td>
<td>15.55%</td>
</tr>
<tr>
<td>Average</td>
<td>12.66%</td>
<td>15.22%</td>
</tr>
<tr>
<td>Reduction of moisture during storage</td>
<td>1.5%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

As the above table shows, the moisture content of the rice in the two lots decreased respectively 1.5 and 1.7 per cent. It may be said, in general, that one kg. of CaCl₂ per one Koku of rice absorbs water equivalent to 0.5 per cent during a single summer. Obviously much depends upon the construction of the desiccating apparatus within the containers. The table shows that the rice in the upper part of the containers dried out more easily than that in the lower. In practice it would therefore be necessary to modify the apparatus so as to dry the lowest part more easily.

2. General Quality.

The rice with a moisture content of 14.2 per cent had dried during storage to a moisture content of 12.7 per cent, which is just the amount required for safe storage. It was, therefore, preserved in perfect condition without any change in taste whatsoever. As regards the other lot containing 16.9 per cent of moisture, it may be said that it is exceedingly difficult to store rice with such a high moisture content through the summer in this locality. During storage
the CaCl$_2$ absorbed sufficient moisture to reduce the content to 15.2 per cent which still is excessive. Owing to the addition of CaCl$_2$, however, the rice was preserved in fairly good condition. The taste of the boiled rice was quite good.


From the four parts, namely upper, upper middle, lower middle, and bottom, of the tin containers, portions of the rice were taken and their germinating power was determined with the following results:

<table>
<thead>
<tr>
<th>Part of container</th>
<th>Initial moisture content of rice 14.16%</th>
<th>Initial moisture content of rice 16.9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>99%</td>
<td>54%</td>
</tr>
<tr>
<td>Upper middle</td>
<td>93%</td>
<td>48%</td>
</tr>
<tr>
<td>Lower middle</td>
<td>95%</td>
<td>38%</td>
</tr>
<tr>
<td>Bottom</td>
<td>88%</td>
<td>20%</td>
</tr>
</tbody>
</table>

From the above table it may be seen that the rice with an initial moisture content of 14.16 per cent retained almost entirely its germinating capacity after one year from harvest and the rice with an initial moisture content of 16.9 per cent also retained its germinating capacity relatively well. The germinating power coincides with the general quality of rice as stated above.

The table shows that the rice at the upper part of the container had a higher germinating power than that at the lower. This fact is consistent with the moisture content. For practical use, the container accordingly must be so modified as to secure more thorough drying in the lowest part.

IV. Summary.

1. Lots of rice with moisture content of 14.2 and 16.9 per cent respectively were stored in tin containers of a capacity of 5 Koku. The containers, specially constructed by the authors, were sealed air-tight. Three kg. of CaCl$_2$ were added for each Koku of rice. The rice was harvested in 1932 and storage in tin containers was from April to October 8, 1933.

2. The results obtained show that the rice with a moisture content of 14.2 and 16.9 per cent stored hermetically in tin containers from April to October with CaCl$_2$ in the proportion named lost 1.5 and 1.7 per cent of moisture respectively.

3. The general quality of the rice with an initial moisture content of 14.2 per cent was quite good, and its germinating capacity was 93 to 99 per cent,
except at the bottom of the container where the moisture content was higher and the germinating capacity had decreased to 86 per cent. The taste of the boiled rice was quite good.

4. The general quality of the rice with an initial moisture content of 16.9 per cent was not so good as that above, but it came out of storage in fairly good condition. The taste of the boiled rice was quite good. The germinating capacity was 38 to 54 per cent, except at the bottom of the containers where it was only 20 per cent.

5. As a desiccating material for rice in a container, CaCl₂ was found to be quite well suited for the purpose.

6. It was noted that in the lower part of the containers the desiccation was somewhat insufficient and that the germinating power was proportionately less. The container must be so constructed as to remedy this defect.

**Literature.**


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