Storage of Rice. XV.

Comparison of Calcium Oxide and Calcium Chloride as a Desiccating Material for Rice Stored in Tin Containers.

By

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I. Introduction.

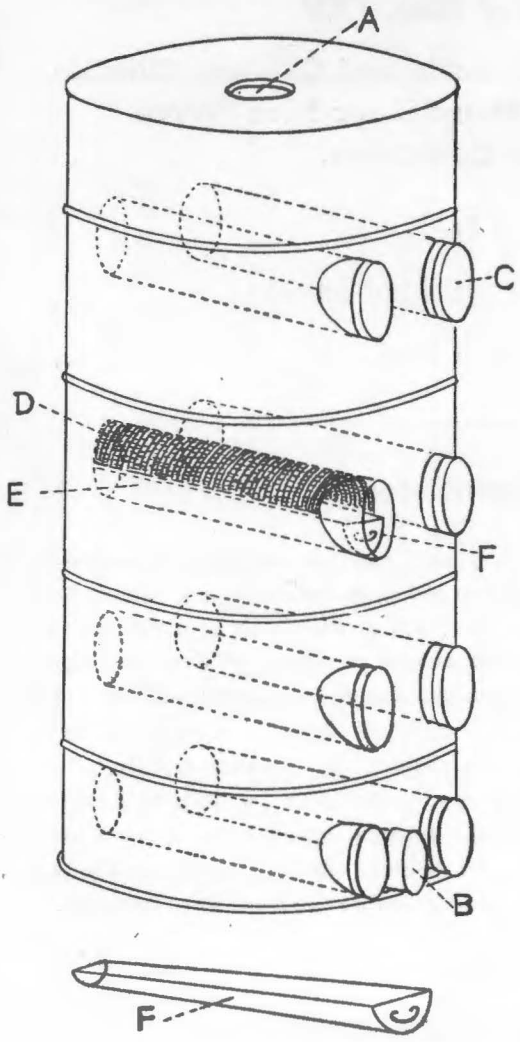
For the safe storage of hulled rice, particularly as regards the under-dried product, farmers should be encouraged to use large tin containers, having within receptacles of desiccating materials. There are several kinds of materials, which are suited for the purpose of desiccation as well as storage of rice. As reported in an earlier paper[1)2)] calcium chloride was found to be quite efficient. Later calcium oxide also was shown by the authors[3)] to be a suitable desiccating material for use during storage, since it absorbs the moisture rapidly, is much cheaper than calcium chloride, and is very convenient. In 1935, to confirm the results of the preceding experiments, the authors repeated the comparative experiments employing calcium oxide and calcium chloride on a practical scale, adopting large tin containers. In the present paper the results are reported.

II. Method of Experiment.

In this experiment the authors used the same tin containers with a capacity of 5 *Koku*s* as in the preceding experiments[1)2)]. (Plate XVII and Fig. 1.) As experimental material, Shinriki hulled rice of the harvest of 1934 with a moisture content of 15.6 per cent was used. As desiccating materials, 9 kgs. of calcium oxide and 3 kgs. of calcium chloride respectively were added for each *Koku* of hulled rice. The calcium oxide was divided into two parts ; half was added at the beginning of the storage and the other half on May 25. The rice was sealed hermetically in two containers and stored from January 22 to November 3, 1935.

* One *Koku* = 0.18 Kiloliter.

Fig. 1.
Construction of the Tin Container.



A . . . . . Inlet
B . . . . . Outlet
C, D, E . . . . Wire netting cylinders
F . . . . . Receptacles of a desiccating material

III. Results of Experiment.

1) *Extent of Desiccation.*

Each month, the quantity of water absorbed by CaO and $CaCl_2$ was determined and the moisture content of the rice was calculated. The results are shown in Table 1 and Figure 2:

As the table and graph show, the water absorption capacity of 9 kgs. of CaO and of 3 kgs. of $CaCl_2$ per *Koku* rice are about equal, but the rate of drying of ice by CaO is greater than that by $CaCl_2$. These facts coincide with the results

Table 1.

Quantity of Water Absorbed by CaO and $CaCl_2$ and Moisture Content of Rice Kernels, 1935.

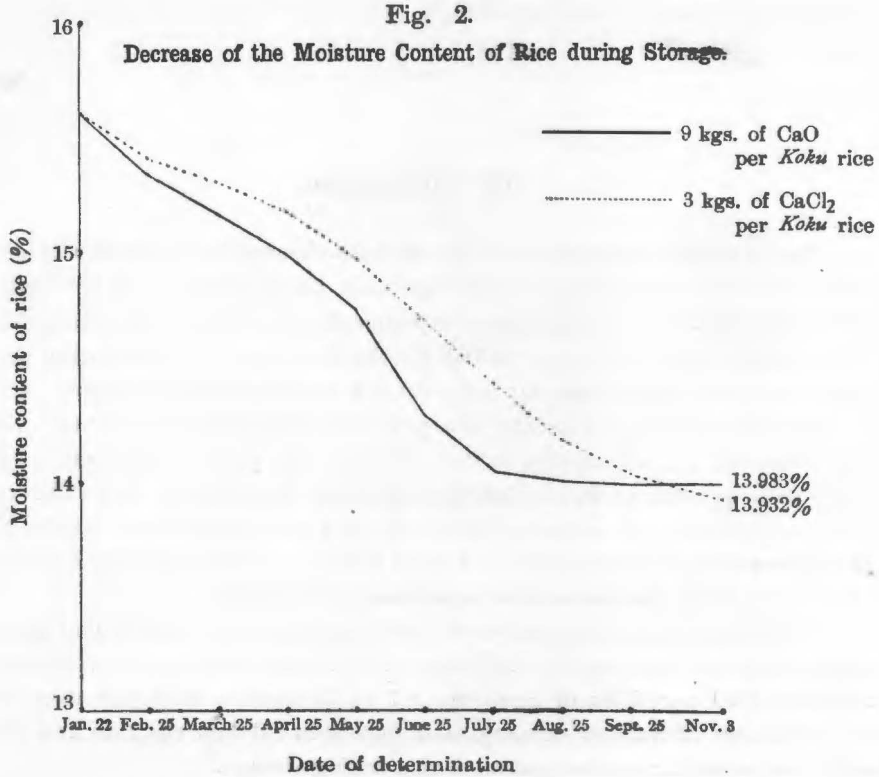
Initial moisture content of rice: 15.6%.

Date of determination	CaO			$CaCl_2$		
	Water absorbed each month	Total quantity of water absorbed	Moisture content of rice	Water absorbed each month	Total quantity of water absorbed	Moisture content of rice
	kg.	kg.	%	kg.	kg.	%
February 25, 1935	2.195	2.195	15.33	1.544	1.544	15.41
March 25, "	1.266	3.461	15.17	0.872	2.326	15.32
April 25, "	1.589	5.050	14.97	1.130	3.456	15.18
May 25, "	1.712	6.762	14.76	1.658	5.114	14.98
June 25, "	3.673 *	10.435 *	14.29	2.193	7.307	14.71
July 25, "	1.841	12.276	14.06	2.127	9.434	14.44
August 25, "	0.369	12.645	14.01	1.965	11.399	14.20
September 25, "	0.104	12.749	13.99	1.340	12.739	14.03
October 25, "	0.036	12.785	13.99	0.695	13.434	13.94
November 3, "	0.052	12.837	13.98	0.095	13.529	13.93

Note: * Since the other half part of the CaO was added on May 25, water absorbed increased greatly during June. (See Gragh)

Fig. 2.

Decrease of the Moisture Content of Rice during Storage.



in the earlier experiments[3]. In practice, since it is necessary to dry rice thoroughly before summer, the rapid absorption of moisture must be recognised as one of the superior qualities of CaO, as regards its use as a desiccant during storage of the grain. In the present experiment, 9 kgs. of CaO per *Koku* of rice were divided into two parts and added in January and May. The authors believe, however, that if the CaO were divided into three parts and added in January, April and June respectively, it would dry the rice still more rapidly and effectively. During the storage of 10 months, namely from January until November, 1.6 per cent of the moisture of the rice was removed.

2) *General Quality, Volume-weight and Germinating Power of Rice.*

On November 1935, at the end of storage, the containers were opened and the general quality, the volume-weight and germinating power were determined. During the storage the volume-weight of rice decreased slightly. At the beginning of the storage 1/4 L. of the rice weighed 213.7 g., but after storage 10 months with CaO and $CaCl_2$ it weighed only 210.1 and 208.8 g. and the germinating power of kernels was 24.3 and 24.8 per cent respectively. The retaintion of vitality was not perfect, because the moisture content had yet not been sufficiently reduced for it.

In spite of the decrease of the volume-weight as well as the vitality, as described above, the general quality of rice and the taste of the boiled rice were perfectly preserved without any change. For the practical view point the storage was successful.

IV. Discussion.

In the earlier experiments[1)2)], the authors observed that calcium chloride is well suited for the removal of moisture from underdried rice in tin containers during storage. In the laboratory experiment, the authors[3)] also demonstrated that calcium oxide is likewise suited for the desiccation of rice during storage, since it absorbs moisture rapidly; moreover it is cheap and convenient.

For the purpose of testing the practical application of calcium oxide to the storage of underdried rice in tin containers, the present comparative experiment with calcium oxide and calcium chloride was carried out. The results obtained show that, as expected, 9 kgs. of CaO per *Koku* of rice absorbs almost the same quantity of moisture as 3 kgs. of $CaCl_2$, and that the rate of absorption of moisture by the former is more rapid than by the latter.

After many repeated experiments by the authors, it is certain that the moisture content of rice may be decreased 1.6—1.7 per cent by 3 kgs. of $CaCl_2$ or 9 kgs. of CaO per *Koku* of rice during 7 to 10 months, when the storage is in tin containers of 5 *Kokus* capacity, and that both calcium chloride and calcium oxide are suited for the desiccation of rice during storage.

In the northern part of Japan, rice contains often as much as 16—17 per cent of moisture. If moisture to the extent of 1.6—1.7 per cent is removed by desiccation during storage, the rice can be safely kept in that cooler region, since the moisture content would be reduced to 14—15 per cent. In the southern part of Japan, the rice must be well dried, but even then it very often contains 14.5—15.0 per cent of moisture. If by desiccation during storage the moisture is removed to the extent of 1.6—1.7 per cent, the rice can be preserved in perfect condition in that warmer region, since the drying would reduce the moisture content to about 13 per cent. In conclusion, the method of storage of rice with an addition of 9 kgs. of CaO or 3 kgs. of $CaCl_2$ respectively per *Koku* rice can be recommended to farmers throughout the whole of Japan, from north to south, as a means of storage of the underdried product in safety, not only for one year but also for a long period.

In the authors' opinion, based on the results of the experiments, the application of calcium oxide is better suited for the purpose of storage of rice than calcium chloride, since it removes the moisture more rapidly and is cheaper and is more convenient. Moreover, if calcium oxide is divided into three portions and added in January, April and June respectively, the desiccation should be most effective, thereby drying the rice thoroughly before summer.

V. Summary.

1. To compare the practical use of calcium oxide and calcium chloride in the storage of underdried hulled rice, the present experiment was carried out during the period from January to November 1935.

2. Hulled rice of Shinriki with a moisture content of 15.6 per cent was stored in tin containers with a capacity of 5 *Kokus* and 9 kgs. of CaO and 3 kgs. of $CaCl_2$ per *Koku* of rice respectively were added.

3. The results of the storage show that the absorptive power of moisture from rice by 9 kgs. CaO and 3 kgs. $CaCl_2$ is almost equal and that after 10 months of storage the moisture content of the rice decreased 1.6—1.7 per cent. The moisture absorptive power of CaO and $CaCl_2$ is, therefore, in the proportion of 1 : 3, as was expected.

4. Since the moisture absorption of calcium oxide is more rapid than that of calcium chloride, the use of this substance for the purpose of storage appears to be more profitable than that of the latter. During the period of six months, that is before the summer months, the moisture already had been removed in sufficient quantities to insure keeping.

5. In the present experiments on the storage of rice with the addition of CaO as well as $CaCl_2$, both lots of the rice were safely preserved. Notwithstanding the fact that the rice was underdried, there was no change whatever in the general quality as well as in the taste of the boiled rice. The germinating

power of rice was not however perfectly retained and after one year from harvest, it was only 24 per cent of the full amount.

6. The application of calcium oxide rather than that of calcium chloride to the storage of rice may be recommended to farmers throughout the whole country, since the cost of 9 kgs. of CaO is only one fourth of that of 3 kgs. of $CaCl_2$, and moreover, it is much more convenient to use and desiccates the material more rapidly.

Literature.

1) KONDO, M. and OKAMURA, T.: Storage of rice, XII. Storage of rice in tin containers with calcium chloride with special reference to the underdried product, I. Ber. Ōhara Inst., VI: 335—339, 1934.

2) ———, ———: Storage of rice, XIII. Storage of rice in tin containers with calcium chloride, with special reference to the underdried product, II. Ber. Ōhara Inst., VII: 99—102, 1935.

3) KONDO, M. and ISSHIKI, S.: Storage of rice, XIV. Removal of moisture from the air in a granary and the hulled rice stored therein by a desiccating material. Ber. Ōhara Inst., VII: 227—237, 1936.

PLATE XVII.

Tin containers employed in the storage experiment of hulled rice. Receptacles of desiccating materials are particularly added to the bottoms of the containers.