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Potato storage research in W.A.

D. C. Hosking,
Adviser, Vegetable Branch

Preliminary results of research into refrigerated storage of potatoes indicate that quality and out-turn are influenced more by the variety of potato stored than by storage conditions.

Potato production in Western Australia is controlled by the W.A. Potato Marketing Board which licenses growers to produce defined crop areas in early, mid-season and late cropping periods. The objective is to supply local demand throughout the season without creating large, seasonal surpluses.

A major difficulty is that while the mid-season crops planted in August-October in the Manjimup-Pemberton districts produce the State's highest average yields at the lowest cost per tonne, these potatoes cannot be carried long into the ensuing period because of deterioration under normal farm storage methods.

Potatoes sold pre-washed for fresh consumption should have a minimum of skin blemishes. Such blemishes are of less significance in processing potatoes provided they do not add appreciably to peeling and trimming losses.

At the same time, potato processors require tubers with a high solids content but a low percentage of reducing sugars to produce high yields of chips, crisps with acceptable texture, light colour and maximum shelf life. Solids contents of not less than 19 per cent (1.075 specific gravity) and reducing sugars of not more than 0.25 per cent are commonly specified.

The trials reported here were conducted to examine the possibility of storing mid-season planted/summer harvested potatoes without the tubers undergoing excessive weight or quality losses. The trials used the Delaware variety in 1975, and Delaware and Cadima* varieties in 1976.

*Cadima was selected in Western Australia from seedling material introduced from Victoria in 1964. Trials have indicated it to have a high yield and percentage of No. 1 grade, good processing and culinary quality, long tuber dormancy and a lower susceptibility to early blight disease than Delaware (the variety most generally grown in W.A.).
Figure 2—Effect of storage temperature on crisp colour. Left: crisps from fresh tubers. Centre: after storage at 10°C for 4 months. Right: after storage at 4°C for 4 months. Delaware variety.

Facilities used included an insulated storage chamber of 70 cu metre capacity subdivided into four 10 cu metre chambers and a 30 cu metre central access area. The chambers were supplied with refrigerated air at 70 to 90 per cent relative humidity. Other equipment allowed automatic monitoring of humidity and temperature data.

At loading out from storage, crisping and specific gravity characteristics were determined and compared with similar data obtained from random samples of potatoes from the original field plots. Crisping tests were done with three medium sized (200 to 300 g) potatoes and the results compared with a standard colour chart prepared by Potato Chip International, Cleveland, Ohio, U.S.A.

### Table 1.—1975 Trial 1: Treatments and results storage, from January 17 to May 8

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Shrinkage*</th>
<th>No. 1 Grade %</th>
<th>Rejects**</th>
<th>Crisp colour ***</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Bagged potatoes 10°C 70% RH  No forced air†</td>
<td>7.7</td>
<td>61.9‡</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>C. Bagged 4°C 90% RH  Forced air at 68 m³/t/hr</td>
<td>6.0</td>
<td>66.5</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>E. Open 0.5 t bins 4°C 90% RH  Forced air at 68 m³/t/hr</td>
<td>5.7</td>
<td>77.0</td>
<td>17</td>
<td>0</td>
</tr>
</tbody>
</table>

* Moisture and dry matter loss caused by evaporation and respiration.
** Most rejects due to early blight rot but including sprouts.
*** Colour of fried potato crisps was rated from 0 to 9, with 0 indicating a very dark brown and 9 indicating a uniform, pale golden colour. For comparison, fresh January-dug Manjimup Delaware potatoes gave a score of 5 (SG 1.065) and fresh May-dug Grasmere potatoes (usually suitable for crisping) gave a score of 7 (SG 1.070).
‡ Too shrivelled for domestic or processing purposes.

Fully detailed results are available from the author.

### 1975 Trial 1

Table 1 summarises the treatments and results associated with this trial, which involved 156 x 63 kg bags of Delaware potatoes harvested at Manjimup in the first week of January 1975. The bags were loaded into store on January 17 and unloaded for weighing, testing and grading on May 8.

Early blight storage rot was the main cause of loss at grading.

Apart from results included in the Table, the Treatment A potatoes dusted with sprout inhibitor were firm and sprout free when taken from store. However, they were affected by early blight storage rot to the same extent as undusted tubers and developed severe skin scalds wherever moisture had condensed following leakage in door seals.

### 1975 Trial 2

Table 2 summarises the treatments and results associated with the second 1975 trial, which involved 32 x 63 kg bags of Delaware potatoes harvested at Grassmere in May 1975. The bags were loaded into store on May 8, and unloaded on October 1, 1975.

### Conclusions from 1975 trials

Stored potatoes remained firm and sprout free when stored at 4°C and 90 per cent relative humidity, but produced excessively dark crisps. Potatoes stored at 10°C or higher without sprout inhibitor
treatment were excessively sprouted and shrivelled after four months' storage.

CIPC 2.5 per cent dust at 1 kg/t potatoes prevented sprouting during 10°C storage but caused severe scald on the skins of tubers treated when damp, or which became damp because of condensation during storage.

1976 Trial

Table 3 summarises treatments and results for the 1976 trial, which involved 48 bags each of the Delaware and Cadima varieties. The crops were harvested in late January and loaded into store on February 9. Because of the high daily temperatures (35 to 38°C) between harvesting and storage, some potatoes were breaking down with soft rot. They were therefore promptly cooled to 10°C. Half were then treated with CIPC and all were returned to store on March 10. A few tubers with soft rot were removed from each bag but not before some adjacent tubers had become moistened.

Conclusions from the 1976 Trial

CIPC treatment increased the grading losses of both varieties under low temperature storage because of increased skin scald resulting from high humidity in the storage chambers. Scald was also prevalent on CIPC-treated potatoes moistened with exudate from soft rotted tubers.

The Cadima variety stored better and graded better than Delaware at 12°C with or without CIPC treatment. Cadima also graded out better in the absence than in the presence of CIPC in the 8°C and 4°C storage temperatures. Early blight rot caused significant losses in most Delaware treatments, but was insignificant in Cadima.

Delaware potatoes from all storage treatments produced unacceptably dark crisps. Delawares crisped fresh after harvest produced crisps with a colour score of 6 (borderline). Crisps from Cadimas crisped fresh or after 12°C storage were an acceptable light colour but were too dark after 8°C or 4°C storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Shrinkage %</th>
<th>No. 1 Grade %</th>
<th>Rejects %</th>
<th>Crisp colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. Bagged potatoes natural temperature and humidity conditions outside store</td>
<td>8.9</td>
<td>79.3*</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>G. Bagged potatoes stored as in (F) but with 2.5% CIPC</td>
<td>7.2</td>
<td>85.9</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>I. Bagged potatoes 8°C 90% RH forced air at 34 m³/t/hr and 2.5% CIPC</td>
<td>4.4</td>
<td>94.6</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>J. Bagged potatoes 4°C 90% RH forced air at 34 m³/t/hr and 2.5% CIPC</td>
<td>2.4</td>
<td>94.6</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

* Very shrivelled.
Table 3.—1976 Trial: Treatments and results from storages, March 10 to July 20.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Shrinkage %</th>
<th>No. 1 Grade %</th>
<th>Rejects %</th>
<th>Sprouts*</th>
<th>Early blight*</th>
<th>Crisp colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. Bagged Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12°C 70% RH with CIPC</td>
<td>11.5</td>
<td>62.4</td>
<td>26.0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>M. Bagged Cadima</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12°C 70% RH with CIPC</td>
<td>9.7</td>
<td>81.2</td>
<td>9.1</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>O. Bagged Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8°C 90% RH with CIPC</td>
<td>7.2</td>
<td>77.3</td>
<td>15.6</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>R. Bagged Cadima</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8°C 90% RH without CIPC</td>
<td>7.0</td>
<td>82.9</td>
<td>10.0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>T. Bagged Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4°C 90% RH without CIPC</td>
<td>6.5</td>
<td>83.9</td>
<td>9.6</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>V. Bagged Cadima</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4°C 90% RH without CIPC</td>
<td>6.1</td>
<td>83.3</td>
<td>10.6</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

* Assessed on a 0 (Nil) to 5 (severe) scale.

Overall, compared with stored Delawares, stored Cadimas were slower to sprout, less susceptible to early blight storage rot and produced lighter coloured crisps.

It is too early to draw firm conclusions regarding the potential for summer potato storage in W.A. Further research in 1977, again including the Delaware and Cadima varieties, will examine the effects of times of planting and harvesting on storage out-turn and quality. Attention will also be paid to harvest treatments influencing the development and spread of early blight and bacterial soft rots during storage.

Acknowledgments

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A simple recipe for making yoghurt at home

by the Dairy Division

Yoghurt is made from milk by the action of special strains of acid-producing bacteria. Yoghurt can be made from whole milk, low-fat milk or non-fat milk.

During yoghurt production, different bacteria grow at different rates. First, the lactose-fermenting strain, *Streptococcus thermophilus* forms lactic acid from the milk sugar, lactose. The other strain, *Lactobacillus bulgaricus* breaks down the protein in the milk, liberating amino acids which the lactose-fermenting strain can feed on.

The most important action is the fermenting of the lactose to produce lactic acid which gives the pleasant acid flavour of a well-made yoghurt. The break-down of protein helps make yoghurt easy to digest.

Making yoghurt at home

The bacterial cultures required are not normally available commercially, but actual yoghurt which can be bought from shops is a good substitute. Do not use yoghurt left over from the last home-made batch, as a few undesirable bacteria may be introduced each time a batch is made.

All equipment used must be sterilised to avoid contaminating the yoghurt with micro-organisms which can produce off-flavours or fermentation.

The flavour and texture are improved if 40 grams of skim milk powder are added to each litre of milk used. If the actual milk is made from powder, 110 grams of powder should be added to each litre of water.

The desired quantity of milk should be heated to between 82 and 85°C for 30 minutes. To maintain this temperature without burning the milk, immerse the container of milk in a much larger container of water. This heat will kill off undesirable bacteria.

The break-down of protein helps make yoghurt easy to digest.

Rapidly cool the mixture down to about 42°C and immediately add 10 cc (2 teaspoons) of yoghurt to each litre of milk. Fruit may be added at this stage, although fresh fruit may contaminate the culture with yeasts and moulds, which would reduce the keeping quality.

Stir gently for a few minutes, then maintain the 42 to 43°C until the yoghurt sets. This may take three to four hours, but the time depends on the culture.

One way of maintaining the temperature, is to put the yoghurt container in a large saucepan of water, and apply a gentle heat. Another method is to pour the mix into a thermos flask which has been sterilised with boiling water.

When the yoghurt has set, it should have a texture like a soft junket, and a consistency like a pouring custard. Keep cool in the refrigerator until it is eaten.

Normally, well-made yoghurt will keep for up to 10 days, but it will keep best unopened in containers, each sufficient for a single serving.