Relation of insoluble amylose to texture characteristics of stored-rice

Wang Jinshui\textsuperscript{1}, Zhao Youmei\textsuperscript{1} and Bian Ke\textsuperscript{1}

Abstract

The changes in amylose, the optimal account of adding-water for cooking and texture characteristics after storage for 4 months at 37°C were studied. The results indicated that the increases occur in the content of amylose, the optimal account of water-adding for cooking and hardness after rice storage for 4 months at 37°C, while the stickiness decrease, stickiness/hardness ratio also decline. Moreover, it was found that the optimal account of water-adding for cooking determined according to the content of insoluble amylose is advantage over that according to the content of amylose. The increasing number of hardness of cooked-rice is positively correlation to that of insoluble amylose, and the decreasing number of stickiness of cooked-rice is negatively correlation to that of insoluble amylose after rice storage at 37°C for 4 months.

Introduction

It was easily thought that the content of amylose is the principal factor determining the texture characteristics of cooked rice. Low amylose rice are generally known to be sticky and moist, whereas those high in amylose are non-sticky, flaky, and dry (Juliano et al., 1965). However, deviations from this correlation exist, such as low-amylose rice that are nonsticky and vice versa. Also rice containing the same amylose content may differ substantially in hardness (firmness) and stickness (Perez and Juliano).\textsuperscript{2} Bhattacharya et al.\textsuperscript{3} found that there is difference between the composition and structure of amylose, which can be grouped under insoluble amylose and soluble amylose (dissolving in hot water) according to their solubility. It is found that the insoluble amylose is associated with the cooking properties of rice (Zhang and Qin).\textsuperscript{4}

One of the obvious changes during rice storage is in texture properties after cooking, and this change is related to the change in content of amylose.\textsuperscript{5,6} Because of the limitation of amylose in evaluating the texture properties of cooked rice, it makes many authors began to probe the mechanism affecting quality deterioration of stored rice.

The change in insoluble amylose and the relation of this change to the stored rice texture properties were investigated in this paper.

Materials and Methods

Samples

Twenty-three cultivars of rice from 1994's harvest year used in this experiment were provided by Hunan province Grain Scientific Research Institute, Zhengzhou Seed Company and Xinxian Seed Company. The fresh-harvested rice refers to that of harvested rice stored at 15°C, and processed and finally stored at 4°C. The aged rice means that the fresh-harvested rice packaged by PVC membranes (the moisture content of rice is about 12%) stored at 37°C for 4 months, and then stored at 4°C for experiments.

General chemical analysis

Moisture contents were determined by drying at 130°C for 1.5 h according to ICC standard 110/1. Amylose and insoluble amylose contents were determined according to Bhattacharya et al.\textsuperscript{7,8}

The texture properties of cooked rice

The texture properties of cooked rice were determined according to Zhang and Qin,\textsuperscript{4} and slight modification was made. The account of water-adding adopted in cooking is the same as that of fresh-harvested rice. The stickiness and hardness of cooked rice was determined by FUDOH RHEOMETER NRM-3002D (Tokyo Trading Co., LTD). The mean values were used by three duplications. The operation conditions of RHEOMETER are: charge range is 2 kg, and the speed of sample table is 2 cm/min, and the speed of paper is 12 cm/min.

Result and Discussion

Change in insoluble amylose contents during storage

Table 1 shows the change in rice insoluble amylose contents stored at 37°C for 4 months. It is indicated that the
contents of insoluble amylose increase stored at 37°C for 4 months. Of these, several varieties, such as Mingtewanxian, zhongyouzao 1, zhangyouzao 3, 92-180, 24-1 and Zaoyou 3, insoluble amylose/amylose ratio is higher, whereas the ratio in waxy rice is lower. Moreover, the contents of insoluble amylose are high correlation to those of amylose in fresh-harvested and aged rice (fresh-harvested rice \( r = 0.918^{**}, n = 23 \), aged rice \( r = 0.927^{**}, n = 20 \)).

Table 1. Change on content of insoluble amylose of stored rice.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Amylose content (%)</th>
<th>Fresh rice a</th>
<th>Aged rice a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhongyouzao 1 a</td>
<td>34.3</td>
<td>22.14</td>
<td>23</td>
</tr>
<tr>
<td>88zao229</td>
<td>33.8</td>
<td>20.81</td>
<td>22.51</td>
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<tr>
<td>24-1</td>
<td>28.6</td>
<td>16.13</td>
<td>16.35</td>
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<td>Zaoyou 3 a</td>
<td>31.6</td>
<td>20.62</td>
<td>1</td>
</tr>
<tr>
<td>90247</td>
<td>25.2</td>
<td>11.99</td>
<td>12.73</td>
</tr>
<tr>
<td>92-180</td>
<td>25.4</td>
<td>15.88</td>
<td>16.52</td>
</tr>
<tr>
<td>Mingtewanxian</td>
<td>25</td>
<td>10.78</td>
<td>12.66</td>
</tr>
<tr>
<td>8926</td>
<td>24.7</td>
<td>10.32</td>
<td>11.33</td>
</tr>
<tr>
<td>89277</td>
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<td>13.97</td>
</tr>
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<td>Xianyou 1 a</td>
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<td>12.35</td>
</tr>
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<td>Zhengao 1 a</td>
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<td>12.18</td>
<td>13.12</td>
</tr>
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<td>Huangqinping</td>
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<td>10.46</td>
<td>12.16</td>
</tr>
<tr>
<td>68-11</td>
<td>23</td>
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<td>10.78</td>
</tr>
<tr>
<td>yueng 5 a</td>
<td>22.9</td>
<td>10.11</td>
<td>11.8</td>
</tr>
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<td>838</td>
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</tr>
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<td>22.2</td>
<td>10.21</td>
<td>10.63</td>
</tr>
<tr>
<td>Zhengao 4 a</td>
<td>22.1</td>
<td>8.19</td>
<td>8.62</td>
</tr>
<tr>
<td>Huangeng 2 a</td>
<td>21.5</td>
<td>10.03</td>
<td>-</td>
</tr>
<tr>
<td>Huangeng 5 a</td>
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<td>6.03</td>
<td>6.44</td>
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<tr>
<td>90261</td>
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<td>383</td>
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<td>6.71</td>
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<td>Xiangyuzaonuo</td>
<td>3.8</td>
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<td>1</td>
</tr>
</tbody>
</table>

a indicates dry basis

Effect of storage on rice texture properties

Study on the optimal account of water-adding for rice cooking: The optimal account of water-adding for cooking adopted by different authors with respect to study on cooked rice texture properties is different. Juliano\(^8\) determined the account of water-adding \( W/R \) (ml of water/grams of rice) according to the content of amylose. \( W/R \) of waxy rice = 0.8 - 1.3, \( W/R \) of varieties low in amylose = 1.1 - 1.7, \( W/R \) of varieties meda and high in amylose = 1.5 - 2.5. Bhattacharya and Sowbhagya\(^9\) found that \( W/R \) of 2.5 rice can completely gelatinize during the optimal cooking time with respect to different varieties and different original samples. Okaba\(^10\) presoaked rice and then used \( W/R = 1.25 \) for evaluating cooked-rice properties or quality. Generally, many authors used the same cooking time and account of water-adding studying different rice quality of cooked-rice. But many reports indicated that it is difficult to ensure the best cooking quality for different varieties and different origins.\(^12,13,14\)

As mentioned above, we determined the optimal account of water-adding for cooking, i.e. it can have the best Rm stickiness of cooked-rice according to the amylose. It is necessary to presoak rice in water for a while before cooking for ensuring rice starch's complete gelatinization during chosen cooking time. Table 2 shows the account of water-adding for cooking.

It can be found from Table 2 that the optimal account of water-adding for cooking during rice storage increase. The optimal account of water-adding in aged rice is higher than that of fresh-harvested rice. Otherwise, the higher the contents of amylose, the more the optimal account of water-adding in fresh-harvested rice is. The content of amylose is positively correlation to the account of water-adding, and is notable (\( r = 0.764^{**}, p > 0.01, n = 23 \)). The correlative quotation is:

\[
y = 0.075x(\text{content of amylose}) + 0.048
\]

The content of insoluble amylose is also positively correlation to the account of water-adding (\( r = 0.852^{**}, p > 0.01, n = 23 \)). The correlative quotation is:

\[
y = 0.104x(\text{content of insoluble amylose}) + 0.58
\]

There was also positive correlation between the content of insoluble amylose and account of water-adding in aged rice (\( r = 0.897^{**}, p < 0.01, n = 8 \)). The correlative quotation is:

\[
y = 0.137x(\text{content of insoluble amylose}) + 0.258
\]

These indicated that the account of water-adding for cooking determined according to the content of insoluble amylose is superior to that according to content of amylose directly.

Change in texture qualities during rice storage

Texture property parameters of cooked fresh-harvested rice and aged rice are shown in Table 3. The hardness of fresh-harvested rice in waxy and low amylose after cooking is obviously lower than that of media and high amylose rice. It is consistent with the report by Juliano et al. The values in stickiness of aged rice are all lower than those of fresh-harvested rice, whereas the hardness of aged rice is higher than that of fresh-harvested rice except for 90247. The stickiness/hardness ratios of aged rice are all lower than those of fresh-harvested rice. These indicated that the quality of rice cooking began to deteriorate after storage at 37°C for 4 months.

As mentioned above, it is found that there was obvious change in cooking texture properties as insoluble amylose
increased. There is obvious negative correlation between stickiness (stickiness of fresh-harvested rice-stickiness of aged rice) and increasing value of insoluble amylose after storage at 37°C for 4 months. The correlative coefficient is $r = 0.769^{**}$, whereas there is positive correlation between the increasing value of hardness and the increasing number of insoluble amylose, $r = 0.867^{**}$. These showed that there is a good correlation between insoluble amylose and texture properties of cooked rice.

**Conclusion**

The relation of the content of insoluble amylose to cooking quality after rice storage is studied in present research. By means of analysis, the following conclusions can be derived: There is an increasing in insoluble amylose after rice storage at 37°C for 4 months.
It is advantage of water-adding for cooking according to the content of insoluble amylose over that of amylose. The content of insoluble amylose is connected with cooking quality of rice. The optimal account of rice water-adding for cooking increases after rice storage. The stickiness declines and hardness increases in cooked rice after storage at 37°C for 4 months. The stickiness/hardness ratio has decreased.

There is an obvious negative correlation between the increasing value of insoluble amylose and the decrease number of stickiness.

There is positive correlation between the increase value of insoluble amylose and the increasing value of hardness.

The insoluble amylose is an important factor influencing the texture properties of cooked rice.

Acknowledgement

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References