Quality Test for the Breeding of Malting Barley in Relation to Alpha-Amylase Activity

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Two aspects concerning quality test in relation to AA (alpha-amylase activity) in malt were investigated for the breeding of malting barley using 11 to 36 cultivars and superior lines of barley as materials. In the first place, a new simplified method was tested for analysing AA of many small scale samples in practical breeding. The method was a modification of the Banasik method (1971), and in the modified method, the procedure for heating--inactivation of beta-amylase in the sample solution was automated and the centrifugation of the sample solution after heating--inactivation of beta-amylase was omitted. As a result, the whole analysis could be performed with an Auto-Analyzer. The data obtained with this method were closely correlated with those obtained with the standard ASBC method. Secondly, environmental conditions affecting AA in malt and interrelations between AA and the other malt quality characters were investigated. The years of harvest and the locations were selected as experimental factors representing the crop cultivation environment, and malting procedures (sample scale for malting) were selected as those relating to the malting conditions. The results of statistical analysis suggested that the quality tests in relation to AA might be used for selection in practical breeding but were somewhat difficult to evaluate as compared with DP (diastatic power) tests since AA was more liable to vary with environmental conditions. AA showed a high positive or negative correlation with soluble nitrogen content (SN), Kolbach index (KI), malt yield (MY) and wort colour (WC). Comparison between AA and DP led to the conclusion that the AA test should be performed independently of the DP test.

KEY WORDS: Barley breeding, alpha-amylase activity, malt quality, simple analysis method, environmental variations

Introduction

There are several kinds of amylases in barley malt and their activities are important components in malt quality. Quality tests related to DP (diastatic power), which is associated with the combined saccharifying activity of alpha- and beta-amylases in malt, have been carried out for the breeding of malting barley in Japan. A large part of DP value corresponds to the value of beta-amylase activity, and high levels of DP are required for saccharifying adjuncts in the brewing process. For the quality tests, Kawaguchi et al. (1976) developed a new simplified method of analysis of DP. But the analysis of AA (alpha-amylase activity) has never been tried for the breeding of malting barley in Japan.

With economic reasons, there is a recent trend of shortening the duration of malting process in many Japanese Brewers’ factories, and hence new cultivars in which the degradation of endosperm proceeds rapidly are required. Since alpha-amylase plays a leading role in the degradation of starch in the endosperm of barley seed (Schuster 1962), screening varieties with high AA is important in a breeding program. However, in practical

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breeding it is necessary to analyse a large number of materials using small scale samples. Although Banasik (1971) succeeded in developing a simple method of analysis of AA, the method is still not satisfactory for handling a large number of materials.

In addition, the influence of environmental factors on malt quality is an important problem for quality tests. However, there are only a few studies about the effect of environmental factors on AA (Munekata et al. 1957, Hayter et al. 1973, Piendl 1975).

The following two aspects relating to quality tests are being considered in order to select properly superior lines with high AA: (1) establishment of a simplified method of AA in malt, (2) investigation of the environmental conditions affecting AA in malt and analysis of interrelations between AA and the other malt quality characters.

Establishment of a simple method of analysis of AA (alpha-amylase activity)

The standard method applied to determine AA in malt is the ASBC method (American Society of Brewing Chemists 1976) which analyses the dextrinizing activity of alpha-amylase. Banasik (1971) determined the saccharifying activity of alpha-amylase with an Auto-Analyser (Technicon Coop, U.S.A.). The data obtained with this method were found to be closely correlated with the ASBC method. In the Banasik method, sample solutions which were heated to inactivate beta-amylase and centrifuged to eliminate denatured protein after heating treatment, were used for the measurements with the Auto-Analyser. However, the Banasik method is not satisfactory for handling a large number of materials, because the procedures of heating-inactivation and centrifugation are complicated and time-consuming. Therefore, an attempt was made to modify the Banasik method so as to automate the procedure for heating-inactivation of beta-amylase in the sample solution, and also to omit the centrifugation of the sample solution after heating-inactivation of beta-amylase.

The simplified method newly devised by us is shown in Fig. 1 as a flow diagram obtained with the Auto-Analyser. The main different points from the Banasik method are as follows: (1) the sample solution is mixed with a 0.2% calcium acetate and 0.5% sodium chloride solution, and transferred into a glass coil tube in a heating bath kept at 70°C for 15 minutes to inactivate beta-amylase, (2) after heating, the sample solution placed in a water bath at 20°C is made to react with a 2% soluble strach solution for 30 minutes, and (3) ferricyanide solution is added to the hydrolysate kept in a heating bath at 70°C. As a result, the whole analysis can be performed with an Auto-Analyser.

The experimental malts were prepared from 32 barley cultivars harvested in the field of the Tochigi Branch in 1978. The malting method applied was that reported by Takeda et al. (1981) and Takeda and Seko (1981).

The measurement of AA using the simplified method proceeded satisfactorily except for the deposition of denatured protein which took place in the tubes placed in the Auto-Analyser after the sample solution was heated in a bath. The tubes were washed with a chromic acid mixture after treatment of about 120 samples, and no adverse effect was resulted from the procedure on the analysis due to its simplicity. Fig. 2 shows the correlation between the data obtained with the simplified method and the standard ASBC method. The correlation coefficient was as high as 0.95 indicating that the AA estimated with the simplified method was closely correlated with those of the standard ASBC method,
although the simplified method gave slightly lower values than the ASBC method. This coefficient (r=0.95) is slightly lower than the result of the BANASIK method (r=0.98). But, as compared with the BANASIK method, our simplified method is more efficient for determining AA, because the heating-inactivation procedure of beta-amylase (which is performed manually in the BANASIK method) is automated and the centrifugation is omitted.
Consequently, it is considered that our simplified method can be adequately used for the analysis of AA.

Variations of AA (alpha-amylase activity) due to different environmental conditions and interrelation between AA and other malt quality characters

Materials and Methods

Variation of AA due to environmental factors were studied referring to DP (diastatic power) data. The years of harvest and the locations were selected as factors representative of the conditions of cultivation, and malting procedures (sample scale for malting) as those of the malting conditions. Materials and experimental conditions are shown in Table 1.

Test A (Influence of the years of harvest); Seeds of each variety were sown at Tochigi Agr. Exp. Sta. late in October in a row of 4.0 m long, spacing 0.6 m apart (2.4 m²), and plants were harvested from May to June in the next year. Materials were grown three times in 1978 to 1980 seasons.

Test B (Influence of the locations); All the materials consisted of foreign cultivars which were grown in three locations. In Kitami, seeds were sown in mid May and plants were harvested in August. In Tochigi, the materials were grown under the same conditions as those described in Test A. In Fukuoka, seeds were sown late in November and plants were harvested from May to June in the next year.

Table 1. Materials and experimental conditions

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Number of varieties</th>
<th>Location¹</th>
<th>Year of harvest</th>
<th>Malting procedure²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year (Test A)</td>
<td>36</td>
<td>Tochigi Agr. Exp. Sta.</td>
<td>1978~1980</td>
<td>250g</td>
</tr>
<tr>
<td>Location (Test B)</td>
<td>11</td>
<td>Kitami</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
<td>Tochigi</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
<td>Fukuoka</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Malting procedure (Test C)</td>
<td>18b)</td>
<td>Tochigi</td>
<td>&quot;</td>
<td>15g, 40g, 250g</td>
</tr>
</tbody>
</table>

¹: Kitami Agr. Exp. Sta. is situated at lat. 43°47'N. and long. 143°42'E.
   Tochigi Agr. Exp. Sta. is situated at lat. 36°25'N. and long. 139°47'E.
   Fukuoka Agr. Exp. Sta. is situated at lat. 33°30'N. and long. 130°39'E.

²: Numerals show sample scale of barley grains per sample container.

b: Numerals include both cultivars and superior lines in the breeding process.
Test C (Influence of malting procedures); Important environmental factors relating to malt quality include the malting conditions as well as the conditions of cultivation. Effect of sample scale for malting was investigated as the factor representative of the malting conditions. Three types of malting procedures, in which 250 g, 40 g and 15 g barley grains per each sample container were used, were investigated. Materials consisted of superior lines and standard cultivars which were tested in yield trials for practical breeding, and were identical with those used in the experiment reported by Takeda et al. (1981).

In order to investigate the interrelation between AA and other malt quality characters, the average values of AA and the other 10 characters covering a three-year period in the 36 cultivars (used in Test A) were evaluated.

Malt analysis; The malting method proposed by Takeda et al. (1981) and Takeda and Seko (1981) was applied. AA determination was carried out according to the simplified method reported in this study. Determination of DP was carried out in applying the procedures reported by Kawaguchi et al. (1976). DP was expressed as "WK units, although °WK per TN (total nitrogen content) units are often used to eliminate the effect of nitrogen levels in the field. Both units were used in this study. The other malt quality characters were analysed mainly after the EBC method (European Brewery Convention 1975) and partly after the ASBC method.

Results and Discussion

The mean values and range of AA and DP in the cultivars for the respective year, location or malting procedure are shown in Table 2. According to Table 2, the values of AA and DP varied with the year of harvest, the location and malting procedure. The values of AA were generally highest in Kitami Agr. Exp. Sta. of three locations and the DP values (°WK unit) were lowest in Fukuoka Agr. Exp. Sta. but the DP values (°WK/°WK/TN))

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Number of varieties</th>
<th>AA (alpha-amylase activity) °WK</th>
<th>DP (diastatic power) °WK unit</th>
<th>DP (diastatic power) °WK/TN unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean value</td>
<td>Range</td>
<td>Mean value</td>
</tr>
<tr>
<td>Year (Test A)</td>
<td>1978</td>
<td>45.3</td>
<td>29.8</td>
<td>266</td>
</tr>
<tr>
<td></td>
<td>1979</td>
<td>31.7</td>
<td>11.9</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>53.6</td>
<td>28.0</td>
<td>285</td>
</tr>
<tr>
<td>Location (Test B)</td>
<td>Kitami</td>
<td>39.3</td>
<td>8.7</td>
<td>248</td>
</tr>
<tr>
<td></td>
<td>Tochigi</td>
<td>33.8</td>
<td>9.2</td>
<td>272</td>
</tr>
<tr>
<td></td>
<td>Fukuoka</td>
<td>33.7</td>
<td>7.7</td>
<td>134</td>
</tr>
<tr>
<td>Malting procedure (Test C)</td>
<td>250g</td>
<td>45.2</td>
<td>16.1</td>
<td>245</td>
</tr>
<tr>
<td></td>
<td>40g</td>
<td>55.0</td>
<td>23.0</td>
<td>261</td>
</tr>
<tr>
<td></td>
<td>15g</td>
<td>54.0</td>
<td>25.4</td>
<td>270</td>
</tr>
</tbody>
</table>

1) TN: Total nitrogen content
2) Values show the mean values of AA or DP in the cultivars for the respective year, location and malting procedure.
3) Values show the range of AA or DP in the cultivars for the respective year, location and malting procedure.
Table 3. Correlation coefficients of AA (alpha-amylase activity) or DP (diastatic power) between different years, locations and malting procedures

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Number of varieties</th>
<th>AA (alpha-amylase activity)</th>
<th>DP (diastatic power)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>WK unit</td>
</tr>
<tr>
<td>Year (Test A)</td>
<td>1978 vs 1979</td>
<td>36</td>
<td>0.60**</td>
</tr>
<tr>
<td></td>
<td>1979 vs 1980</td>
<td>36</td>
<td>0.62**</td>
</tr>
<tr>
<td></td>
<td>1978 vs 1980</td>
<td>36</td>
<td>0.63**</td>
</tr>
<tr>
<td>Location (Test B)</td>
<td>Kitami vs Tochigi</td>
<td>11</td>
<td>0.71**</td>
</tr>
<tr>
<td></td>
<td>Tochigi vs Fukuoka</td>
<td></td>
<td>0.77**</td>
</tr>
<tr>
<td></td>
<td>Kitami vs Fukuoka</td>
<td></td>
<td>0.74**</td>
</tr>
<tr>
<td>Malting procedure</td>
<td>250g vs 40g</td>
<td>18</td>
<td>0.83**</td>
</tr>
<tr>
<td>(Test C)</td>
<td>40g vs 15g</td>
<td></td>
<td>0.87**</td>
</tr>
<tr>
<td></td>
<td>250g vs 15g</td>
<td></td>
<td>0.86**</td>
</tr>
</tbody>
</table>

** : Significant at 1% level.

Table 4. Analysis of variance for the effect of the years of harvest on AA (alpha-amylase activity) and DP (diastatic power) (Test A)

<table>
<thead>
<tr>
<th>Character</th>
<th>Source of variation</th>
<th>d.f.</th>
<th>mean square</th>
<th>F value</th>
<th>Variance component</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Variety (V)</td>
<td>35</td>
<td>51.56</td>
<td>4.04**</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>Year (Y)</td>
<td>2</td>
<td>4397.12</td>
<td>344.33**</td>
<td>121.8</td>
</tr>
<tr>
<td></td>
<td>V×Y</td>
<td>70</td>
<td>12.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP (WK unit)</td>
<td>Variety (V)</td>
<td>35</td>
<td>7578.47</td>
<td>10.74**</td>
<td>2290.9</td>
</tr>
<tr>
<td></td>
<td>Year (Y)</td>
<td>2</td>
<td>3188.86</td>
<td>4.52**</td>
<td>69.0</td>
</tr>
<tr>
<td></td>
<td>V×Y</td>
<td>70</td>
<td>705.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP (WK/TN unit)</td>
<td>Variety (V)</td>
<td>35</td>
<td>1475.09</td>
<td>10.00**</td>
<td>442.6</td>
</tr>
<tr>
<td></td>
<td>Year (Y)</td>
<td>2</td>
<td>9487.57</td>
<td>64.35**</td>
<td>263.4</td>
</tr>
<tr>
<td></td>
<td>V×Y</td>
<td>70</td>
<td>147.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** : Significant at 1% level.

1) Values (σ²) were estimated according to the following equation,

σ²=(MS-MSVE)/n

where, MS is mean square attributable to variety or environmental factors, MSVE is error mean square (interaction between variety and environment), and n is the number of varieties or environmental factors.

Table 5. Analysis of variance for the effect of locations on AA (alpha-amylase activity) and DP (diastatic power) (Test B)

<table>
<thead>
<tr>
<th>Character</th>
<th>Source of variation</th>
<th>d.f.</th>
<th>mean square</th>
<th>F value</th>
<th>Variance component</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Variety (V)</td>
<td>10</td>
<td>13.89</td>
<td>8.70**</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>Location (L)</td>
<td>2</td>
<td>126.15</td>
<td>66.02**</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>V×L</td>
<td>20</td>
<td>1.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP (WK unit)</td>
<td>Variety (V)</td>
<td>10</td>
<td>8646.51</td>
<td>6.73**</td>
<td>2383.8</td>
</tr>
<tr>
<td></td>
<td>Location (L)</td>
<td>2</td>
<td>61766.36</td>
<td>47.98**</td>
<td>1827.4</td>
</tr>
<tr>
<td></td>
<td>V×L</td>
<td>20</td>
<td>1263.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP (WK/TN unit)</td>
<td>Variety (V)</td>
<td>10</td>
<td>2437.97</td>
<td>14.03**</td>
<td>686.3</td>
</tr>
<tr>
<td></td>
<td>Location (L)</td>
<td>2</td>
<td>1709.53</td>
<td>12.76**</td>
<td>51.6</td>
</tr>
<tr>
<td></td>
<td>V×L</td>
<td>20</td>
<td>194.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** : Significant at 1% level.
Table 6. Analysis of variance for the effect of malting procedures (sample scale for malting) on AA (alpha-amylase activity) and DP (diastatic power) (Test C)

<table>
<thead>
<tr>
<th>Character</th>
<th>Source of variation</th>
<th>d.f.</th>
<th>mean square</th>
<th>F value</th>
<th>Variance component</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Variety (V)</td>
<td>17</td>
<td>92.08</td>
<td>14.16**</td>
<td>23.5</td>
</tr>
<tr>
<td></td>
<td>Malting procedure (M)</td>
<td>2</td>
<td>527.21</td>
<td>81.10**</td>
<td>28.9</td>
</tr>
<tr>
<td></td>
<td>V×M</td>
<td>34</td>
<td>6.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP (&quot;WK unit)</td>
<td>Variety (V)</td>
<td>17</td>
<td>3359.46</td>
<td>18.67**</td>
<td>1059.8</td>
</tr>
<tr>
<td></td>
<td>Malting procedure (M)</td>
<td>2</td>
<td>2902.80</td>
<td>16.13**</td>
<td>75.6</td>
</tr>
<tr>
<td></td>
<td>V×M</td>
<td>34</td>
<td>179.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP (&quot;WK/TN unit)</td>
<td>Variety (V)</td>
<td>17</td>
<td>835.72</td>
<td>16.14**</td>
<td>261.3</td>
</tr>
<tr>
<td></td>
<td>Malting procedure (M)</td>
<td>2</td>
<td>1133.91</td>
<td>21.89**</td>
<td>60.1</td>
</tr>
<tr>
<td></td>
<td>V×M</td>
<td>34</td>
<td>51.79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**: Significant at 1% level.

TN unit) which are used to eliminate the effect of nitrogen levels were approximate to those in the other two locations. The values of AA and DP were higher in 15 g and 40 g types than 250 g types of malting procedures.

Table 3 shows the correlation coefficients of environmental factors for AA and DP in the respective cultivars. Also Table 4, 5 and 6 show the analysis of variance for Test A, B and C, respectively. In these cases, the mean square relating to the interaction between varieties and environmental factors was used for the calculation as the mean square of error.

According to the results shown in Table 3, the correlation coefficients between years for AA were 0.60~0.68, which were lower than those for DP. The correlation coefficients between locations for AA were 0.71~0.77, which were slightly lower than those for DP ("WK/TN unit). The correlation coefficients between malting procedures were high for AA (0.83~0.87), and nearly equal to those for DP. F values listed in Table 4, 5 and 6 showed that the effect of the varietal differences and environmental factors for AA and DP were all significant at 1% level. Also F value for each environmental factor was larger in AA than DP. Estimated component of variance for years in AA was larger than that for the variety (Table 4), and variances for locations and malting procedures were almost equal to those for the variety (Table 5 and 6). Variances for all the environmental factors in DP were smaller than those for the variety (Table 4, 5 and 6).

Thus, it is estimated that quality tests relating to AA are somewhat difficult to evaluate compared to those relating to DP tests since AA was liable to vary with environmental conditions. But, as there was found high correlation for AA between years or between locations (Table 3), selection for AA in practical breeding can be effectively performed.

Hayter et al. (1973) reported that AA did not respond to nitrogenous fertilizer. Gothard (1974) also reported that the effect of environmental factors on barley plant in the field did not appear to affect AA. However, Munekata et al. (1956) reported that yearly change of AA in barley cultivated in Japan was larger than that of beta-amylase activity. Our results were comparable to the results by Munekata et al. In Japan, environmental conditions throughout the growth of barley plant, especially the climatic conditions, show considerable variations with the year and location in many cases. Such large variations
Table 7. Correlation coefficients of varieties between AA (alpha-amylase activity) and several malt characters (n=36)

<table>
<thead>
<tr>
<th></th>
<th>DP (diastatic power)</th>
<th>Malt extract</th>
<th>Extract yield</th>
<th>Total nitrogen content (TN)</th>
<th>Soluble nitrogen content (SN)</th>
<th>Kolbach index (KI)</th>
<th>Marks for malt quality (MQ)</th>
<th>Malt Yield</th>
<th>Wort colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;WK&quot;</td>
<td>unit</td>
<td>unit</td>
<td>(EX)</td>
<td>(EY)</td>
<td>0.20</td>
<td>0.70**</td>
<td>0.85**</td>
<td>0.95**</td>
<td>-0.75**</td>
</tr>
<tr>
<td>&quot;WK/ TN&quot;</td>
<td>unit</td>
<td></td>
<td>(SN)</td>
<td>(KI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* and **: Significant at 5% and 1% levels, respectively.
EX: Soluble extracts in "wort (saccharified solution of malt)"
EY: (EX) × (MY)
KI: (SN)/(TN) (%)
MQ: Marks for malt quality including DP, EX, EY, TN, SN and KI.
MY: Yield ratio of malt to original seeds.
WC: Degree of colour density of wort determined by the EBC method (1975).

Fig. 3. Relation between AA (alpha-amylase activity) and DP (diastatic power) in 36 barley cultivars.
**: Significant at 1% level.

In the climatic conditions may affect AA more significantly than DP in barley malts. Correlation coefficients between AA and the other 10 malt characters covering a three-year period in the 36 cultivars (used in Test A), are shown in Table 7. AA showed a high positive correlation with soluble nitrogen content (SN), Kolbach index (KI) and wort colour (WC), and a low positive correlation with marks for malt quality (MQ), DP and malt extract (EX). On the other hand, AA showed insignificant correlation with extract yield (EY) and total nitrogen content (TN). These results agree with those reported by other investigators (Rutger et al. 1967, Standridge et al. 1970). In addition, AA showed a high negative correlation with malt yield (MY). Piendl (1975) reported that there was an increase in AA and wort colour (WC) and a decrease in malt yield (MY), as the steeping degree increased. In this study, the malting process was carried out under conditions whereby the steeping degree remained constant for testing the varietal difference. Moreover, the data used were the average values for three years. So, it is assumed that the close correlation between AA and soluble nitrogen content (SN), Kolbach index (KI), malt yield (MY) and wort colour (WC) in Table 7 is genetically controlled, on condition that a large part of varietal variance is due to genetical variance.

The relation between AA and DP ("WK/ TN unit) in the 36 cultivars is illustrated in Fig.3. The cultivars such as Kanto Nijo 19 and Nirasaki Nijo 10 showed high values of AA and low DP values, while the cultivars such as Miho Golden, Kanto Nijo 13 and Aichi Wase 13 showed low AA and comparatively high DP values. However, Nirasaki Nijo 9, Klages and UM 570 showed high AA and DP values and especially UM 570.
showed extremely high DP (210 °WK/TN units).

Thus, the cultivars with high DP values did not always show a high value of AA. 

Preece (1947) reported that the cultivars with high DP values tended to have high AA values whereas it was difficult to estimate the latter from the former. Based on these results, it is assumed that superior lines with high AA can not be satisfactorily selected only by the selection of DP.

Therefore, it is concluded that (1) quality tests relating to AA may be practical for selection but somewhat difficult to evaluate as compared with those relating to DP, (2) AA may have a high genetical correlation with soluble nitrogen content (SN), Kolbach index (KI), malt yield (MY) and wort colour (WC), and (3) it is necessary to perform AA tests independently of DP tests.

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醸造用大麦育種におけるアルファアミラーゼ活性に関する品質検定

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麦芽の AA（アルファアミラーゼ活性）に関する醸造用大麦育種における品質検定上の問題点のうち、2つの側面について、11から36の品種及び有利系統を供試材料として用いて、検討を行った。

はじめに、実際の育種過程において多数・少量の試料の迅速な分析を可能にするため、AA測定のための簡便な分析方法を検討した。この方法は Banasik の方法（Banasik 1971）を改良して考案したものであり、改良点は試料液中のベータアミラーゼの不活性化処理を自動化したこと、及びベータアミラーゼの加熱不活性化後の試料液の遠心分離処理を省略したことであった。その結果、分析の操作を全てオートアナライザーによって自動化することができた。この簡便法から得られたデータは標準の ASBC 法から得られたものと高い相関があった。

次に、環境条件の影響による AA の変動性及び AA と他の麦芽形質との相関関係を検討し、品質検定上の問題点について考察した。作物の栽培環境条件として収穫年次及び栽培場所について検討し、麦芽製造条件として製麦タイプ（製麦のための試料の量）について検討した。統計分析の結果から、AAに関する品質検定は遺伝的な選抜に役立つが、AA は DP（ジアスターゼ力）よりも環境条件によって変動しやすいので、DP にくらべて幾分選抜が難しいことが推定された。さらに、36 品種の AA と他の 10 の麦芽諸形質との関係を検討した結果、AA は可溶性窒素含量（SN）、コールパッハ数（KI）、麦芽収量率（MY）及び麦汁色度（WC）と高い正または負の相関を示した。また、AA と DP の関係から、AA の検定を DP の検定とは別個に行う必要があると考えられた。

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