COMMUNICATION TO THE EDITOR

Dehulling of oats in the laboratory

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ABSTRACT

The protein content of oat material obtained from a combined dehulling/milling operation, using a Brabender Junior Quadramat mill in combination with a sieving step, was lower and the dietary fibre content higher than for corresponding samples dehulled manually. Flour from the flour tray of the Quadramat mill had much lower protein and dietary fibre contents than manually de-hulled samples.

In determining oat hull content it was found necessary to dehull (manually) at least 70 grains/sample in order to obtain the result within ±1% of the hull content with an assurance of 80%.

Introduction

The dehulling of oats in the laboratory is necessary for analytical purposes, for the determination of hull content, and also for providing material for small-scale processing tests. Several workers have outlined procedures for dehulling oats on a laboratory scale. These range from hand separation (1) to the use of air jets (2) and impact hullers (3). Samples can also be passed through a laboratory roller mill at a wide setting; this pinches the grain and the hulls can be separated by blowing and hand picking (4). The procedure used will depend on the equipment available and also on the use for which the groats are intended. For analytical purposes it is usually necessary to have a good separation of hull and groat; the groat should also be intact in the sense that none of the bran should be removed from it. This is important because of the much higher protein and dietary fibre contents of the bran compared with the endosperm (5).

In the absence of specialised equipment, the dehulling of oats at laboratory level is usually done manually; alternatively the suitability of existing laboratory milling equipment, with or without modification, for this purpose can be investigated. Manual dehulling is very time-consuming and is only suitable for providing small samples and for assessing hull content. For this reason tests were carried out to determine the number of grains that need to be dehulled by hand to give a good estimate of the hull content of a sample. In the second part of the test the suitability of a Brabender Junior Quadrumat mill for a combined dehulling/milling operation to provide samples suitable for analysis for protein and dietary fibre content was investigated. The dietary fibre and protein contents and the colour of the dehulled/milled material was deter-
mined and the data compared with those obtained for the same samples dehulled manually.

Methods

Manual dehulling
Seven samples of winter-sown oats grown in Ireland (cv Dula and Bulwark from location 1; Peniarth and W17128 from location 2; Cabana and Leanda from location 3; Leanda from location 4) were obtained and 10 subsamples x 10 grains of each cultivar were dehulled by hand. The weights of the hulls and groats were recorded and the percentage hull content calculated: The standard deviation (SD) for the percentage hull content of each cultivar was calculated from the data for the 10 sub-samples. The SD for all 70 samples was also obtained and the values were entered in equation 1 (6) to determine the number of 10-grain subsamples that need to be dehulled for a result of a desired precision.

\[ n = \frac{(kSD)^2}{e^2} \]  
where,
\[ n = \text{number of 10-grain samples required for a result of a desired precision} \]
\[ k = \text{number of standard deviations} \]
\[ SD = \text{standard deviation} \]
\[ e = \text{desired precision, i.e. percentage on each side of the mean} \]

Mechanical dehulling/milling
A Brabender Quadrumat Junior laboratory mill was used for a combined dehulling/milling operation. Three procedures were compared:

Procedure 1 – Control: Samples of Dula, Cabana and Leanda were dehulled by hand and the resulting groats milled in a Glen Creston hammer mill (model no. DFH48, 1 mm sieve) to give a wholemeal flour; all the material passed through the sieve and was collected. This is referred to as ‘control wholemeal’.

Procedure 2 – Quadrumat-flour fraction: Forty-gram samples of oats with hulls attached (cv Dula, Cabana, Leanda) were passed through the Quadrumat Junior mill and the material in the flour tray was collected; this is referred to as ‘Quad-flour fraction’. The material in the bran tray was discarded.

Procedure 3 – Quadrumat-combined fraction: As in (2) above except the material in the flour and bran trays was collected. The bran tray contained hulls but also bran and some endosperm; these materials were sieved (Simon sifter) for 3 min and the fraction passing through the three sieves (1,500, 900, and 750 µm) was collected and combined with the oat flour from the flour tray to give the “Quad-combined fraction”.

Preliminary tests had shown that samples of oat hulls, passed through the Quadrumat mill, ended up in the bran tray; all this material was retained by the three sieves mentioned above (see Results and Discussion).

Protein was determined on meal/flour from procedures 1–3 above using a semi-micro Kjeldahl method (N x 6.25) and dietary fibre using a modified Southgate procedure (7). Flour colour was measured on a Hunter Colour Difference meter fitted with a 5.08 cm specimen port; samples were presented in a perspex container and L (whiteness) and b (yellowness) values were recorded.

Results and Discussion

Manual dehulling
The data (Table 1) show the mean percentage hull content for each cultivar and the corresponding within ±1% of the considered adequate assumes a value of ±1% of the mean ± 1.28 (90% k) and equation 1 becomes

\[ n = \frac{(1.28 SD)^2}{e^2} \]

Entering the data from Table 1 shows the number that need to be tested in order to determine the limits of precision (80%) chosen above

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dula</td>
<td>At</td>
</tr>
<tr>
<td>Bulwark</td>
<td>At</td>
</tr>
<tr>
<td>Peniarth</td>
<td>Ch</td>
</tr>
<tr>
<td>W17128</td>
<td>Ch</td>
</tr>
<tr>
<td>Cabana</td>
<td>Ba</td>
</tr>
<tr>
<td>Leanda</td>
<td>Ba</td>
</tr>
</tbody>
</table>

All 70 samples

1Based on 10 samples
2Number of 10-kernel
referred to as 'control

Umat-flour fraction:
of oats with hulls:
the flour tray was
collected. Hulls but also bran
these materials were
for 3 min and the
the three sieves
was collected and
flour from the flour
combined fraction”.

Quad-combined e
excess the material
trays was collected.

Quad-flour fraction:
Umat-flour fraction:

3 min and the
the three sieves
was collected and
flour from the flour
combined fraction”.

shown that samples
ugh the Quadrumat
bran tray; all this
by the three sieves
results and Discussion
ned on meal/flour
bove using a semi-
(N = 25) and
 modifies. Southgate
flour was measured
tence meter fitted
port; samples were
container and L
ness) values were

Discussion

1Based on 10 samples × 10 kernels for each cultivar; dehulling by hand
2Number of 10-kernel samples required for a precision of ±1% and an assurance of 80% (see text)

the corresponding SD values. If a result
within ±1% of the hull content is con-
sidered adequate then e (equation 1)
assumes a value of unity. An 80% assurance
(chosen arbitrarily) corresponds to a k
value of 1.28 (90% = 1.65 k, 95% = 1.95 k)
and equation 1 becomes:

\[ n = (1.28 \text{ SD})^2 \] ......... equation 2

Entering the data from Table 1 in equation
2 shows the number of 10-grain samples
that need to be tested to obtain an estimate
of the hull content of each cultivar to within
±1% of the mean value with an assurance of
80% (Table 1). It can be seen from equation
1 that as the value of e decreases (greater
precision) and the value of k increases
(greater assurance) the number of samples
(n) that need to be tested increases dramati-
cally. The data (Table 1) show that at
least 70 grains should be dehulled by hand
in order to determine hull content within
the limits of precision (±1%) and assurance
(80%) chosen above.

Mechanical dehulling/milling
Data describing the colour and content of
protein and dietary fibre in the oat materials
prepared by the three procedures outlined
above are presented in Table 2. The control
wholemeal represents the preferred material
for analysis, i.e. whole oats with hulls
removed. The results suggest that the Quad-
flour fraction (procedure 2) was deficient
in oat bran as indicated by the low protein
dietary fibre contents and also the white
colour. Barnes (5) has shown that oat bran
contains about 19.2% protein and 18.5%
dietary fibre (both on a wet basis).

The Quad-combined fraction (procedure
3) was closer to the control wholemeal in
terms of composition and colour (Table 2);
however, the lower protein content (for all
three cultivars) and the elevated dietary fibre
values (in the case of Cabana and Leanda)
suggest that this fraction was slightly
deficient in oat bran (some retained on the
sieves) and contained a small amount of hull
material (passed through sieves); pure oat
hulls have a dietary fibre content of 70–80%
(8). The time taken for dehulling/milling and
sievina 40g oat sample using procedure 3
was less than 15 min.

The relative protein content of the culti-
vars Cabana and Leanda was different for

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Location</th>
<th>Hull content (%)</th>
<th>Standard deviation</th>
<th>Required no. of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dula</td>
<td>Athenry</td>
<td>25.9</td>
<td>1.60</td>
<td>5</td>
</tr>
<tr>
<td>Bulwark</td>
<td>Athenry</td>
<td>28.0</td>
<td>1.93</td>
<td>7</td>
</tr>
<tr>
<td>Peniarth</td>
<td>Clonakilty</td>
<td>23.8</td>
<td>0.59</td>
<td>1</td>
</tr>
<tr>
<td>W1728</td>
<td>Clonakilty</td>
<td>24.5</td>
<td>1.75</td>
<td>6</td>
</tr>
<tr>
<td>Cabana</td>
<td>Ballyhaise</td>
<td>23.6</td>
<td>0.86</td>
<td>2</td>
</tr>
<tr>
<td>Leanda</td>
<td>Ballyhaise</td>
<td>25.3</td>
<td>0.70</td>
<td>1</td>
</tr>
<tr>
<td>Leanda</td>
<td>Donegal</td>
<td>26.6</td>
<td>1.72</td>
<td>5</td>
</tr>
<tr>
<td>All 70 samples</td>
<td></td>
<td>25.4</td>
<td>2.00</td>
<td>7</td>
</tr>
</tbody>
</table>

1Based on 10 samples × 10 kernels for each cultivar; dehulling by hand
2Number of 10-kernel samples required for a precision of ±1% and an assurance of 80% (see text)
TABLE 2: Protein, dietary fibre and colour values for oat samples dehulled by hand and in a Brabender Quadrumat Junior mill

<table>
<thead>
<tr>
<th>De-hulling</th>
<th>Cultivar</th>
<th>Protein</th>
<th>Dietary fibre</th>
<th>Colour-Hunter meter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(%)</td>
<td>(%)</td>
<td>L</td>
</tr>
<tr>
<td>By-hand³</td>
<td>Dula</td>
<td>13.4</td>
<td>8.2</td>
<td>78.0</td>
</tr>
<tr>
<td></td>
<td>Cabana</td>
<td>15.4</td>
<td>8.4</td>
<td>75.5</td>
</tr>
<tr>
<td></td>
<td>Leanda</td>
<td>14.6</td>
<td>8.6</td>
<td>75.6</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>14.5</td>
<td>8.4</td>
<td>76.4</td>
</tr>
<tr>
<td>Quadrumat⁴</td>
<td>Dula</td>
<td>10.9</td>
<td>3.4</td>
<td>84.6</td>
</tr>
<tr>
<td>- flour fraction</td>
<td>Cabana</td>
<td>12.0</td>
<td>4.1</td>
<td>81.7</td>
</tr>
<tr>
<td></td>
<td>Leanda</td>
<td>12.1</td>
<td>4.4</td>
<td>81.9</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>11.7</td>
<td>4.0</td>
<td>82.7</td>
</tr>
<tr>
<td>Quadrumat⁵</td>
<td>Dula</td>
<td>12.9</td>
<td>8.0</td>
<td>77.9</td>
</tr>
<tr>
<td>- combined fractions</td>
<td>Cabana</td>
<td>13.2</td>
<td>12.0</td>
<td>76.7</td>
</tr>
<tr>
<td></td>
<td>Leanda</td>
<td>13.6</td>
<td>11.2</td>
<td>77.1</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>13.2</td>
<td>10.4</td>
<td>77.2</td>
</tr>
</tbody>
</table>

1. On a dry matter basis
2. Powdered samples presented on 5.08 cm aperture in sample cup
3. Dehulled sample milled on a Glen Creston mill
4. Fraction taken from flour tray
5. Fraction from flour tray combined with sievings from bran tray – see details in text

the samples dehulled manually compared with those from Quadrumat procedures 2 or 3 (Table 2). This also occurred for the dietary fibre content of these cultivars from procedure 3 in comparison with procedures 1 and 2. These data show the difficulty in obtaining mechanically-dehulled oat material, using the Quadrumat mill, which is similar in composition to that obtained by manual dehulling.

The decision to use three sieves, rather than one, for the sieving step was based on trial and error. The use of three sieves reduced the volume of material on any one sieve thus facilitating the separation of the hulls from the bran and/or endosperm. The decision on sieve size, and especially that of the finest sieve was based on its ability to retain 100% of hull material from a number of test samples. The hulls were obtained by hand dehulling and were run through the Quadrumat prior to sieving. However, as indicated above, when samples from the bran tray (hulls plus some bran and endosperm) were sieved, traces of hulls seemed to be carried through the finest sieve. This happened to a greater extent for the Cabana and Leanda samples than for Dula, based on the dietary fibre values in Table 2.

I thank Mr. P. W. for dietary fibre also the Department of Oat Cultivation.

4. Greenhalgh, A. Personal communication.
ed by hand and in a Brabender Colour-Hunter meter²

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>b</th>
<th>L/b</th>
</tr>
</thead>
<tbody>
<tr>
<td>78.0</td>
<td>11.5</td>
<td>6.78</td>
<td></td>
</tr>
<tr>
<td>75.5</td>
<td>12.7</td>
<td>5.94</td>
<td></td>
</tr>
<tr>
<td>75.6</td>
<td>13.0</td>
<td>5.82</td>
<td></td>
</tr>
<tr>
<td>76.4</td>
<td>12.4</td>
<td>6.18</td>
<td></td>
</tr>
<tr>
<td>74.6</td>
<td>8.5</td>
<td>9.95</td>
<td></td>
</tr>
<tr>
<td>71.7</td>
<td>9.9</td>
<td>8.25</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>10.2</td>
<td>8.03</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>9.5</td>
<td>8.74</td>
<td></td>
</tr>
<tr>
<td>7.9</td>
<td>9.4</td>
<td>8.28</td>
<td></td>
</tr>
<tr>
<td>5.7</td>
<td>10.7</td>
<td>7.17</td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>11.0</td>
<td>7.01</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>10.4</td>
<td>7.49</td>
<td></td>
</tr>
</tbody>
</table>

in text

Acknowledgments

I thank Mr. P. Walshe and Mr. A. Morrissey for dietary fibre and protein analyses and also the Department of Agriculture for making oat samples available for these tests.

References


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