Preventive Effect of Germinated Barley Foodstuff on Diarrhea Induced by Water-soluble Dietary Fiber in Rats

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We investigated the preventive effect of germinated barley foodstuff (GBF) added to the diet on diarrhea induced by the dietary water-soluble dietary fibers, polydextrose, hemicellulose, and poly-acrylic acid sodium salt, in Sprague-Dawley rats. The minimum content of GBF necessary for blocking diarrhea was 3% (by weight) of the diet.

Since GBF is mainly derived from the aleurone and scutellum of malted barley, we assessed the physiological effects of the aleurone and scutellum fractions derived from barley grains before and after germination. The addition of fractions containing only germinated barley, and not barley collected before germination, increased the fecal output and jejunal mucosal protein content. The effects of malted barley were very similar to those of GBF.

It was concluded that germination was necessary to bring about the physiological effects of GBF. Since non-lignified hemicellulose and Gln-rich protein were newly synthesized during germination, these might have contributed to the increased fecal output and jejunal mucosal protein content.

Key words: intestine; dietary fiber; germination; diarrhea; barley

Under experimental conditions, some dietary fibers have been found to reduce diarrhea.2–7 While dietary fiber generally improves defecation,8,9 there have been some reported cases of dietary fiber aggravating constipation or diarrhea because of its indigestibility and stimulation of the gastrointestinal tract.10–13 In our previous study,14 rats fed on the water-soluble dietary fiber, polydextrose, developed experimentally diarrhea.

Germinated barley foodstuff (GBF) increases the fecal output and jejunal mucosal protein content, and GBF is thought to thicken the intestinal mucosa. Therefore, GBF could be expected to improve defecation under normal conditions, as well to alleviate the diarrhea induced by an inclusion in the diet of water-soluble dietary fiber.

We consider that germination provides the major difference between GBF and other dietary fiber sources. There are few foodstuffs containing germinated seed other than malt or bean sprouts. In our previous study, we proposed that germination would be necessary to produce the physiological effects of GBF.14 During germination, the scutellum of barley has been reported to synthesize non-lignified hemicellulose,15 which ferments well is the lower gastrointestinal tract,16 and induces the production volatile fatty acids (VFA). These VFA are thought to increase the intestinal mucosal protein content or the growth of enterocytes.12–15

We collected the aleurone and scutellum fractions of barley grain before and after germination by threshing, and we assessed their physiological effects on rats. If germination is indeed necessary for these physiological effects, these fractions of the barley grain collected before germination would not have any potency for increasing the fecal output and jejunal mucosal protein content. In this study, we examined the preventive effect of GBF on diarrhea and whether germination was necessary to manifest the increased fecal output and protein content in intestinal mucosa.

Materials and Methods

Materials. Based on our previous studies, we selected water-soluble dietary fibers that caused diarrhea.14–16 These were polydextrose (PD; purchased from Pfizer Co., Tokyo, Japan), poly-acrylic acid sodium salt (PAC; Aonuis MS, purchased from Nihon Junyaku Co., Tokyo), and water-soluble hemicellulose (HC; Nihon Shokuhin Kakou Co., Tokyo). All the dietary components, except for corn oil (Ajinomoto Co., Tokyo) and corn starch (Nacalai Tesque Co., Tokyo), were purchased from Oriental Yeast Co. (Tokyo). All reagents were purchased from Wako Pure Chemical Industries Co. (Osaka, Japan). GBF was obtained by Kishii's method.16 Barley grains before germination (raw barley; RB) and after germination (malted barley; MB) at Kirin Brewery Takasaki Factory (Gunma, Japan) were used.

Methods. Experiment 1. In this experiment, we evaluated the preventive effect of GBF on diarrhea in rats fed on the PD-, PAC-, and HC-containing diets. Male Sprague-Dawley rats weighing about 50 g each were purchased from Charles River Japan (Yokohama, Japan). They were individually housed in metal cages in a room kept at 22 ± 1°C, with a 12-h light and dark cycle (light from 8:00 a.m. to 8:00 p.m.). The rats were fed ad libitum with a commercial diet (EC2, Nihon Clea, Tokyo) for 7 days during the acclimatization period, and were then randomly allocated to the 3 groups respectively given PD, PAC, and HC. These 3 groups were divided into 2 sub-groups respectively given cellulose (CE) and GBF-containing diets. There were thus 6 groups, each fed on PD with CE (PD-CE) or GBF (PD-GBF), PAC with CE (PAC-CE) or GBF (PAC-GBF), and HC with CE (HC-CE), or GBF (HC-GBF). The protein and neutral detergent fiber

† To whom all correspondence should be addressed.
The protein and neutral detergent fiber in all diet groups was adjusted to the same level.

The vitamin mixture was prepared according to the AIN 93 vitamin mixture protocol.\(^1^\)

The mineral mixture was prepared according to the AIN 93G mineral mixture protocol.\(^2^\)

PD, polydextrose.

HC, hemicellulose (water soluble).

GBF, germinated barley foodstuff.

PD-CE, mixed PD and CE diet.

PD-GBF, mixed PD and GBF diet.

PAC-CE, mixed PAC and CE diet.

PAC-GBF, mixed PAC and GBF diet.

HC-CE, mixed and CE diet.

HC-GBF, mixed HC and GBF diet.

Table I. Composition of the Experimental Diets (Experiment 1)

<table>
<thead>
<tr>
<th></th>
<th>PD-CE(^a)</th>
<th>PD-GBF(^b)</th>
<th>PAC-CE(^c)</th>
<th>PAC-GBF(^d)</th>
<th>HC-CE(^e)</th>
<th>HC-GBF(^f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>146</td>
<td>100</td>
<td>146</td>
<td>100</td>
<td>146</td>
<td>100</td>
</tr>
<tr>
<td>Vitamin mixture(^a)</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Mineral mixture(^a)</td>
<td>35.0</td>
<td>35.0</td>
<td>35.0</td>
<td>35.0</td>
<td>35.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Choline chloride</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>PD-CE</td>
<td>60.0</td>
<td>60.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAC(^c)</td>
<td>3.0</td>
<td>3.0</td>
<td>20.0</td>
<td>20.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Cellulose</td>
<td>100.0</td>
<td></td>
<td>100.0</td>
<td></td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Corn oil</td>
<td>643</td>
<td>667</td>
<td>707</td>
<td>683</td>
<td>667</td>
<td>643</td>
</tr>
<tr>
<td>Corn starch</td>
<td>707</td>
<td></td>
<td>683</td>
<td></td>
<td>667</td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) The vitamin mixture was prepared according to the AIN 93 vitamin mixture protocol.\(^1^\)

\(^{b}\) The mineral mixture was prepared according to the AIN 93G mineral mixture protocol.\(^2^\)

\(^{c}\) PD, polydextrose.

\(^{d}\) HC, hemicellulose (water soluble).

\(^{e}\) GBF, germinated barley foodstuff.

\(^{f}\) PD-CE, mixed PD and CE diet.

\(^{g}\) PD-GBF, mixed PD and GBF diet.

\(^{h}\) PAC-CE, mixed PAC and CE diet.

\(^{i}\) PAC-GBF, mixed PAC and GBF diet.

\(^{j}\) HC-CE, mixed and CE diet.

\(^{k}\) HC-GBF, mixed HC and GBF diet.

Table II. Composition of the Experimental Diets (Experiment 2)

<table>
<thead>
<tr>
<th></th>
<th>PAC-CE(^c)</th>
<th>PAC-10% GBF(^f)</th>
<th>PAC-5% GBF(^g)</th>
<th>PAC-3% GBF(^h)</th>
<th>PAC-1% GBF(^i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>146</td>
<td>100</td>
<td>123</td>
<td>132</td>
<td>141</td>
</tr>
<tr>
<td>Vitamin mixture(^a)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Mineral mixture(^a)</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Choline chloride</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>PAC(^c)</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Cellulose</td>
<td>30</td>
<td>15</td>
<td>21</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Corn oil</td>
<td>30</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Corn starch</td>
<td>707</td>
<td>683</td>
<td>695</td>
<td>700</td>
<td>705</td>
</tr>
</tbody>
</table>

\(^{a,b,d}\) See the legend to Table I.

\(^{c}\) PAC, polyacrylic acid sodium salt.

\(^{d}\) PAC-CE, 3% cellulose and 2% PAC diet.

\(^{e}\) PAC-10% GBF, 10% GBF and PAC diet.

\(^{f}\) PAC-5% GBF, 5% GBF and PAC diet.

\(^{g}\) PAC-3% GBF, 5% GBF and PAC diet.

\(^{h}\) PAC-1% GBF, 1% GBF and PAC diet.

Protein and neutral detergent fiber of all diet groups were adjusted to the same level.

of the jejunal mucosa from each rat was determined.

Analytical methods. The protein content (N × 6.25) of GBF, the aleurone and scutellum fractions of RB, and the same fractions of GB were measured by the Kjeldahl method. The NDF contents of the samples were measured by the method of Van Soest and Wine,\(^3^\) while the methods for excising the jejunal and assaying the protein content of its mucosa were described in our previous study.\(^3^\) Briefly, the jejunal was defined as 15–30 cm of the small intestine from the pylorus, its mucosa was obtained by scraping and the protein content was measured by using a commercial eye-binding kit. The contents of DNA and RNA of the jejunal mucosa were determined by Schneider’s method.\(^3^\)
Table III. Chemical Composition of Raw Barley and Malted Barley

<table>
<thead>
<tr>
<th></th>
<th>Raw barley (RB)</th>
<th>Malted barley (MB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (g/kg of sample)</td>
<td>6.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Protein</td>
<td>18.0</td>
<td>11.5</td>
</tr>
<tr>
<td>Lipid</td>
<td>6.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Dietary fiber</td>
<td>31.0</td>
<td>30.7</td>
</tr>
<tr>
<td>Ash</td>
<td>5.8</td>
<td>5.5</td>
</tr>
<tr>
<td>Other carbohydrates</td>
<td>32.1</td>
<td>38.4</td>
</tr>
</tbody>
</table>

Composition of dietary fiber (%)

<table>
<thead>
<tr>
<th></th>
<th>RB</th>
<th>MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose</td>
<td>36.7</td>
<td>21.6</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>57.1</td>
<td>73.6</td>
</tr>
<tr>
<td>Lignin</td>
<td>6.2</td>
<td>4.7</td>
</tr>
</tbody>
</table>

a RB, the aleurone and scutellum fraction of raw barley.
b MB, the aleurone and scutellum fraction of malted barley.
c As neutral detergent fiber.
d This value was calculated as follows: 100 = water content - protein content - lipid content - dietary fiber content - ash content (%).

Table IV. Composition of the Experimental Diets (Experiment 3)

<table>
<thead>
<tr>
<th></th>
<th>CE&lt;sup&gt;a&lt;/sup&gt;</th>
<th>GBE&lt;sup&gt;b&lt;/sup&gt;</th>
<th>RB&lt;sup&gt;b&lt;/sup&gt;</th>
<th>MB&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(g/kg of diet)</td>
<td>146</td>
<td>100</td>
<td>128</td>
<td>135</td>
</tr>
<tr>
<td>Casein</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin mixture&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Mineral mixture&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Choline chloride</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Cellulose</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>GFB&lt;sup&gt;e&lt;/sup&gt;</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>RB&lt;sup&gt;f&lt;/sup&gt;</td>
<td>727</td>
<td>703</td>
<td>675</td>
<td>669</td>
</tr>
<tr>
<td>MB&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> See the legend to Table I.<n>
intake were comparable across the groups. The number of
feces, and the fecal dry weight in the GBF and MB groups
were significantly higher than those in the CE group. There
was no significant difference between the GBF and MB
group in the number of feces and fecal dry weight. The
jejunal mucosal protein content in the GBF group and the
MB group was significantly higher than that in the CE or
the RB group. As shown in Table VIII, the DNA and RNA
content of the jejunum in the GBF group was significantly
higher than that in the CE group.

Discussion
It has been reported that water-soluble dietary fiber does
not generally increase the fecal output,7) and in some
circumstances, it has been reported to cause diarrhea.2,3,7)  
In particular, PD is known to cause severe diarrhea in
healthy volunteers.2,8) It has been assumed that this diarrhea
was caused by the increased osmotic pressure, inhibition of
electrolyte absorption, or a change in the microflora in the
gastrointestinal tract.22,23)
Dietary GBF increased not only the mucosal protein
content, but also the DNA and RNA contents. This
indicates that the number of enterocytes in the GBF-fed
rats was increased. Furthermore, as it has been reported
that one of the main components of feces is dropped
enterocytes,24) so that the increase in the number of
enterocytes by dietary GBF would be related to the increase
in fecal output. However, the increased number of
enterocytes in our experiments is thought to have been
different from that in diseased hyperplasia, because no
Effect of Germinated Barley Foodstuff on Diarrhea

**Table VII.** Body Weight Gain, Food Intake, Number of Feces, Fecal Weight, and Mucosal Protein Content (Experiment 3)

<table>
<thead>
<tr>
<th>Group*</th>
<th>Body weight gain** (g/14 days)</th>
<th>Food intake (g/day)</th>
<th>Feces Number (/3 days)</th>
<th>Dry weight (g/3 days)</th>
<th>Mucosal protein (mg/cm of jejunum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>89.2 ± 3.1</td>
<td>21.5 ± 0.5</td>
<td>46.8 ± 4.7</td>
<td>2.86 ± 0.23</td>
<td>4.50 ± 0.28</td>
</tr>
<tr>
<td>GBF</td>
<td>102 ± 4.1</td>
<td>21.8 ± 0.7</td>
<td>69.0 ± 2.7</td>
<td>3.46 ± 0.13</td>
<td>4.80 ± 0.11</td>
</tr>
<tr>
<td>RB</td>
<td>99.6 ± 3.9</td>
<td>21.7 ± 0.6</td>
<td>51.8 ± 3.2</td>
<td>2.98 ± 0.12</td>
<td>3.98 ± 0.12</td>
</tr>
<tr>
<td>MB</td>
<td>103 ± 2.8</td>
<td>23.5 ± 0.4</td>
<td>60.8 ± 1.1</td>
<td>3.29 ± 0.06</td>
<td>4.95 ± 0.11</td>
</tr>
</tbody>
</table>

*1 Abbreviations are the same as those shown in the legend to Table IV.

*2 Each value is the mean ± SE for 6 to 8 rats, and means showing a common superscript letter within the same column are significantly different (p < 0.05). The overall mean for the initial body weight was 98.6 ± 1.3 g.

abnormal symptoms have been found with the long-term GBF feeding to some animals.16 Although GBF is defined as a type of dietary fiber, it has the distinctive characteristic of suppressing diarrhea and lessening injury to the mucosa.2-7 Dietary GBF also resulted in the normal excretion of feces without any decrease in the mucosal protein content in an induced diarrhea model.

The inclusion of at least 3% GBF in the diet was found to be necessary to prevent diarrhea. When GBF was given at 1%, it did not completely prevent diarrhea. As dietary fiber affects excretion due to its bulk and density,3,6 digestion of the volume of GBF that is transported to the lower intestine would be necessary to manifest the effect of GBF in blocking diarrhea. A detailed dose-response study of the appropriate ingestion level of GBF is needed. It is clear that GBF itself did not cause diarrhea, and that GBF prevented the diarrhea produced by other water-soluble dietary fibers. The risk of diarrhea by a massive quantity of ingested GBF should be very low.

In addition to the diarrhea caused by certain water-soluble dietary fibers, severe diarrhea can be caused by some drug administrations as described next. The methotrexate-induced diarrhea model22 and the dextran sulfate-induced colitis model have been reported to result in severe damage to the intestinal mucosa,26,27 and in these models, a deficiency in nutrients and electrolytes would arise. That is to say, diarrhea might be intimately related to the condition of the intestinal mucosa. As GBF increases the mucosal enterocyte population and restores defecation to normal levels in rats fed on water-soluble dietary fiber, GBF might improve defecation in these disease models as well. We intend to study this possibility in future.

GBF is derived from germinated seed and can be isolated from the husk fraction of Brewer's spent grain. We tested the aleurone and scutellum fractions of GBF and MB to clarify the effect of germination on the manifestation of the increased fecal output and intestinal mucosal protein content. During the germination process, the hemicellulose content in the aleurone and scutellum fractions decreased, while the lignin content decreased.19 These results suggest that synthesis of non-lignified hemicellulose occurred during germination. Non-lignified hemicellulose is considered to be efficiently utilized in the lower gastrointestinal tract, leading to the production of VFA, which is thought to increase the number of enterocytes.28,29

The protein content of the aleurone and scutellum fractions decreases during germination, and the protein has been reported to be partly converted to some hydrolytic enzymes in the embryo. Although the protein content was less after germination, the proportion of MB to the total nitrogen content has been reported to be increased by germination.10 This increment of GlN seems to contribute to the increased number of enterocytes.26,31 To increase the mucosal condition and defecation, it is necessary to increase the content of not only non-lignified hemicellulose but also of GlN.

In this study, we examined the effects of GBF on the jejunal mucosa and on defecation in a model of diarrhea induced by water-soluble dietary fiber. Germination is thought to be very important to manifest the physiological effects of GBF. As dietary GBF and MB caused an increase in the mucosal protein content and improved the defecation

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**Table VIII.** DNA and RNA Contents of the Jejunal Mucosa in Rats Fed on the CE- and GBF-containing Diets (Experiment 3)

<table>
<thead>
<tr>
<th>Group*</th>
<th>DNA** (µg/cm of jejunum)</th>
<th>RNA** (µg/cm of jejunum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>310 ± 15</td>
<td>366 ± 14</td>
</tr>
<tr>
<td>GBF</td>
<td>527 ± 3.3*</td>
<td>460 ± 9.9*</td>
</tr>
</tbody>
</table>

* Abbreviations are the same as those shown in the legend to Table IV.

** Each value is the mean ± SE for 6 to 8 rats, and means showing an asterisk within the same column are significantly different from the corresponding value for the CE group (p < 0.05).
in rats, they might also aid defecation and prevent mal-
nutrition due to malabsorption by the mucosa in patients
with enterocolitis and other diseases. We are planning to
examine these effects of GBF and MB.

In conclusion, GBF effectively blocked the diarrhea
caused by water-soluble dietary fiber, and MB increased the
jejunal mucosal protein content and fecal output. Germina-
tion resulting in an increased Gln content and non-lignified
hemicellulose content, appears to have played an important
role in manifesting these effects of GBF and MB.

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Kanemoto (Satake Co., Hiroshima, Japan) for preparing the aleurone and
scutellum fractions from barley and malted barley. We also thank
Toshihiko Iwunaga (Professor of the Department of Veterinary Anatomy,
Hokkaido University School of Veterinary Medicine) and Naomu Ishiwaki
(Kirin Brewery Co.) for their helpful advice.

References
   (1997).
2) K. Saku, K. Yoshinaga, Y. Okura, H. Yong, R. Harada, and K.
3) P. M. Newberne, M. W. Corner, and P. Estes, Toxicologic Pathology,
4) K. Chikamatsu, C. Kitano, Y. Sato, M. Fujita, M. Ishiguro, T.
   Ohkuma, T. Iikutaka, and T. Hirano, J. Japan. Soc. Dialysis Therapy
5) K. Doi and S. Baba, Internal Medicine (in Japanese), 47, 785-789
6) Y. Tsuji, Y. Katsuki, T. Yasuda, and A. Nishimura, JJIPEN, 17,
   441-448 (1989).
9) K. Ewe, B. Ueberschaer, and A. G. Press, Pharmacology, 47, 242-248
   (1993).
10) D. E. Briggs, in "Barley: Genetics, Biochemistry, Molecular Biology
    and Biotechnology," ed. by P. R. Shewry, C. A. B. International,
13) M. D. Levat, S. R. Behr, C. Remesy, and C. Demigne, J. Nutr.,
17) P. G. Reeves, K. L. Rossow, and J. Lindlauf, J. Nutr., 123, 1923-
    50-55 (1967).
20) T. Shimada and H. Terayama, in "Seikakakuzikkenkouza, Vol. 2,
    Kakusan no Kagaku" (in Japanese), 1st Ed., ed. by T. Yozakawa,
    Tokyo-Kagakudojin, Tokyo, Japan, 1974, pp. 5-20.
    Ichihara, Nankodo, Tokyo, Japan, 1990, pp. 150-155.
22) T. Oka, "Dietary Fiber" (in Japanese), 1st Ed., ed. by S. Inami
    88-101.
    6th Ed., ed. by M. L. Brown, International Life Sciences Institute,
25) A. C. Fox, S. A. Kriple, J. D. Paula, J. M. Berman, R. G. Settle,
    and J. L. Rombeau, J. Parenteral Enteral Nutrition, 12, 325-331
    (1988).
27) Y. Umemoto, H. Taninuma, K. Ishimoto, K. Masaki, Y. Maniwa,
    K. Uchiyama, K. Murakami, M. Saita, T. Takizawa, and H.
30) S. Arai, S. Tanabe, and M. Watanabe, Reports of the Research
31) J. Shabet and N. Ehrlich, in "The Ultimate Nutrient Glutamine"
    (in Japanese), 1st Japanese language ed. by Miwa-Shoten Ltd.,
    Tokyo, 1994, pp. 21-33.