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Giving Food a Fiber Boost: Adding High Beta-Glucan Ingredient from Barley to Everyday Foods

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Abstract

Lack of dietary fiber contributes to many health issues, particularly chronic vascular diseases. Mixed linkage β-1.3 - 1.4 beta-glucan (beta-glucan, in this paper) is a confirmed beneficial ingredient for the human diet through reduction of cholesterol and the glycemic index. Barley contains the highest beta-glucan content of all the grains, and in this study, a percentage of flour from two high beta glucan lines was, each, added to an array of wheat-based food products to measure how it impacted total dietary fiber. Results showed that beta-glucan content was higher in all the products containing the added high beta-glucan flour, along with increased total dietary fiber content. Protein content in the food products is also increased with the higher protein in the barley flours added. Beta-glucan content in the barley-added products increased to 1.2% - 4.0% versus 0.2% - 0.5% in the pure wheat products, while the dietary fibers increased to 3.5% - 24.4% versus 2.1% - 9.1% in pure wheat product controls. This research provided experimental evidence that using a high beta-glucan barley ingredient in food can increase dietary fiber to benefit health.

Keywords

Food, High Fiber, Barley Ingredient, Beta-Glucan, Human Health

1. Introduction

It is known that dietary fiber intake is very important for human health. Lack of enough fiber in the diet is related to serious health-related issues. The single most common health problem is heart disease which is the leading cause of death attributed to chronic vascular issues in the US followed by stroke and high blood pressure. All the chronic vascular diseases (CVD) are affected by diet, particularly fiber intake. It is estimated that more than 130 million adults in the US (45.1%) are projected to have some form of CVD, and total costs of CVD are expected to reach $1.1 trillion in 2035 [1]. Addition of fiber to common foods may help reduce the prevalence of CVD.

Molecular structures of dietary fibers determine different functional roles each has in health. Dietary fiber generally has two components, water soluble which includes viscous or fermentable fibers that are fermented in the colon, and water insoluble fibers which mainly have bulking action or are fermented in the colon to a limited extent. Soluble fibers are linked to vascular health and beta-glucan (specifically referring to the β-1.3 - 1.4 mixed linkage glucan in plants), is the most important soluble fiber with an established effect on the reduction of vascular disease. Insoluble dietary fibers include lignin, cellulose, hemicellulose, chitin, resistant starch, and resistant dextrin which have a laxative effect and contribute to general human health. Though soluble and insoluble fibers are available from all the plant products including vegetables and fruits, the most beneficial fiber, beta-glucan, is available in limited plant species, mainly barley and oat grains [2].

The serum cholesterol level is correlated to chronic heart diseases. Beta-glucan has been reported to lower cholesterol in numerous studies of humans and rats [3] [4] [5] [6] [7]. Kalra and Jood [5] used rat feeding experiments to demonstrate that a beta-glucan-rich diet reduced serum cholesterol, low-density cholesterol, and triglycerides by 1.3- to 2.5-fold when compared with the control diet. Clinical trials also showed cholesterol-lowering effects of beta-glucan on humans [8]. Another study showed that after six-weeks of adding 5 g of barley beta-glucan to the diet each day, the mean LDL cholesterol level of the subject decreased 15% and 13% with high molecular weight (HMW) and low molecular weight (LMW) beta-glucan supplements respectively [7]. A meta-analysis of eight human subject trials showed that the consumption of beta-glucan from barley produced lowered low-density lipoprotein (LDL) cholesterol and triglycerides without affecting high-density lipoprotein (HDL) cholesterol [9]. In addition to cholesterol reduction, a diet containing beta-glucan-rich barley products can decrease the glucose level in human blood [10] [11] [12]. All these effects can benefit by reducing heart disease and diabetes, both of which are important public health problems in developed countries.

Oat is a traditional source of beta-glucan. Oatmeal and other oat-based food products have been on the market for a long time. Although oat could have high protein and total dietary fiber [13], the beneficial fiber beta-glucan remained around 4%. We have not seen any commercially used oat variety with stable beta-glucan over 6% yet. It is good to use an all-oat ingredient in food products to maintain beta-glucan levels in a food like oatmeal, but it is not ideal to use oat as a partial ingredient to boost the beta-glucan content in the final food products because of the lower beta-glucan content. More recently, food barley has emerged as a complement to oat due to its high beta-glucan contents. High beta-glucan barley is an alternative to oat in a wide range of food products where the beta-glucan needs to be improved. Food barley is a relatively new type of barley and contains higher beta-glucan contents, relative to oats. Commercial food barley cultivars with 6% - 8% grain beta-glucan include CDC Alamo [14], Julie [15], Salute, BG006, and Kardia [16]. Other varieties have 8% - 10% grain beta-glucan such as BG012, Transit [17], and Goldenhart [18]. Salute, BG0006, and BG012 were developed by Westbred company and are currently owned by Highland Specialty Grains company (Michael McKay, personal communication).

Since it is difficult to change people's dietary traditions or habits, it is not realistic to expect people to eat significantly more barley or oat specific foods. Though some food recipes using barley are available (https://www.eatbarley.com/barley-blog/), application to a wider range of products needs to be investigated for more options. One alternative is to boost fiber using barley in the traditional or popular foods by substituting a percentage of the flour ingredient with a high beta-glucan barley flour. In this paper, we focused on the evaluation of fiber, particularly beta-glucan changes of six different food products after adding 20% of high beta-glucan barley flour. This experiment was primarily focused on increases in beta-glucan and the subsequent increase in total dietary fiber. Beyond this demonstration of improvements to dietary fiber in some common foods, we propose that the food industry could continue with investigation into optimization and marketing of the more heart and diabetic friendly barley-containing foods as well as other traits in food production.

2. Materials and Methods

2.1. Raw Materials

Barley flour samples were from Goldenhart cultivar and CM1 line. Goldenhart is a two-rowed spring type hulless variety which has 9% - 10% beta-glucan [18]. CM1 resulted from a chemical mutation and contains over 12% beta-glucan (patent # US9681620B2). It is also a two-rowed spring type hulless line. The two barley lines were planted at the Aberdeen, Idaho experimental field trials in 2020. The harvested grains were cleaned by seed cleaners in the seed laboratory of the barley breeding program in USDA-ARS, Aberdeen, Idaho, and ground in a Nutrimill. Three different wheat flours were used by the Wheat Marketing Center, Portland, Oregon, and one was used for each class of food product. All flour samples were tested for the major nutritional characters of total dietary fiber and beta-glucan. The flour composition of each food is detailed in **Table 1**.

2.2. Food Products Processing

Six food products were made using each barley and wheat flours at Wheat Marketing Center, Portland, Oregon. Products were based on their recipes and were produced at their location. The six food products include pan bread, pita bread, tortilla, instant noodle, mini-muffin, and cracker. Three recipes were used separately for each product: A: pure wheat, B 80% wheat + 20% CM1, and C: 80%

Table 1. The food products and the ingredients used.

Product	Types of Mixed flour		
	A	B	C
Pita Bread	100% wheat	80% wheat + 20 CM1 barley	80% wheat + 20 Goldenhart barley
Pan Bread	100% wheat	80% wheat + 20 CM1 barley	80% wheat + 20 Goldenhart barley
Tortilla	100% wheat	80% wheat + 20 CM1 barley	80% wheat + 20 Goldenhart barley
Instant Noodle	100% wheat	80% wheat + 20 CM1 barley	80% wheat + 20 Goldenhart barley
Mini-Muffin	100% wheat	80% wheat + 20 CM1 barley	80% wheat + 20 Goldenhart barley
Cracker	100% wheat	80% wheat + 20 CM1 barley	80% wheat + 20 Goldenhart barley

Note. The percentages are weight basis.

wheat + 20% Goldenhart. The rest of the ingredients for each recipe remained the same. The 20% barley ingredients selected in the experiments is based on the optimized tests (Andrew Ross in Oregon State University, personal communication). The product compositions are summarized in Table 1. The same recipe was repeated twice. All the repeats were analyzed for total dietary fiber and beta-glucan contents and reported as the average value for each product.

2.3. Food Sample Preparation for Nutritional Trait Analysis

Ground flours and food samples that were torn into small pieces were prepared by drying material in a convection oven set at 40˚C - 50˚C for at least 48 hours. The dried food samples were then broken into smaller pieces and ground in a coffee grinder, and afterward poured into 50 mL centrifuge tubes for storage in a desiccator until analysis was performed. Flour samples were dried and poured into the centrifuge tubes. Samples that exceeded 10% oil, based on the lab's recipes, were defatted using petroleum ether by placing no more than two grams of ground material plus approximately 35 - 40 mL petroleum ether in a 50 mL conical centrifuge tube with a stir bar. Samples were capped and stirred for 15 minutes, centrifuged at 3000 rpm, and the supernatant poured off. This was repeated three times, and the samples were allowed to dry before placing them in the oven at 40˚C - 50˚C for up to 48 hours. For both drying and defatting, samples were weighed before and after each step. Weight loss due to drying and defatting were recorded and used later as corrections in the dietary fiber calculations. The final percentage calculated for the trait is AS IS basis.

2.4. The Dietary Fiber Protocol

Samples were tested based on method two (total dietary fiber) of the Megazyme

Total Dietary Fiber Assay (based on AACC method 32-05.01 and AOAC Method 985.29).

2.5. Protein Measurement

The residues from the fiber assay and their untested form were used to measure the protein content. One hundred to 150 mg of dried material were placed in foil papers and analyzed on a Leco FP 528 Nitrogen Determinator. Results were multiplied by the appropriate protein factor and were reported on an AS IS basis.

Beta-Glucan Measurement.

Ground samples were tested based on the protocol of Hu and Burton [19].

2.6. Data Analysis

All the food products were duplicated at the time of preparation. There were no biological repeats in food production because of the high cost. The duplicated food samples were treated as technical repeats. Therefore, the results are reported as the average value of the duplicates with the variation ranges and no traditional statistical analyses was conducted.

3. Results

Twenty-three samples, including 18 food samples, three wheat, and two barley flours, analyzed twice, were tested for total dietary fiber, beta-glucan, and protein. The six food products (pita bread, pan bread, tortilla, instant noodles, mini-muffins, and crackers) were created using only wheat flour as a control group. The barley flour, from each of Goldenhart and CM1, replaced 20% of the wheat flour in the other two treatments of each food product. Relative to whole wheat products, the barley lines contributed an increase in beta-glucan and dietary fiber when substituted at 20% in each recipe. The fiber contents of the flour samples are summarized in **Table 2** and beta-glucan in **Table 3**. All the products were tested for their total fiber and beta-glucan. Protein content was also measured for use in the dietary fiber calculations. The dietary fiber, beta-glucan, and protein results reveal that adding 20% barley high beta-glucan flour to typical foods can increase the nutritional value of those foods.

Table 2. Contents of nutrition components in the raw materials.

Flour sample	Beta-glucan %	Dietary Fiber %	Protein %
Wheat Flour for tortilla, Pita bread, noodles	0.3 ± 0.0	6.4 ± 0.6	12.8 ± 0.0
Wheat Flour for muffins, and crackers	0.4 ± 0.0	7.0 ± 0.0	9.1 ± 0.0
Wheat Flour for pan bread	0.3 ± 0.1	6.9 ± 0.1	15.0 ± 0.0
Goldenhart barley flour	11.4 ± 0.1	39.9 ± 0.0	12.4 ± 0.2
CM1 barley flour	14.9 ± 0.4	56.1 ± 0.4	19.0 ± 0.0

Note. Each result is averaged from two measurements. The values are reported as dry matter basis.

3.1. Appearance Effect of the Food Products

The food products derived from different ingredients are in Figure 1. Product size varied with barley ingredients roughly judged by observation without measuring. Bread size from whole wheat flour is the biggest (Figure 1(a)-A), followed by 20% Goldenhart barley flour (Figure 1(a)-C), and 20% CM1 flour (Figure 1(a)-B). Whole wheat flour with the least beta-glucan content (Table 2) has the largest bread. CM1 has the highest beta-glucan content and resulted in the smallest bread volume when it is added as an ingredient. Goldenhart has 11.4% beta-glucan which is between CM1 and wheat flour samples and the resulting bread is larger than CM1 added and smaller than whole wheat. Since all

Table 3. The Beta-glucan content of the food products from different ingredients.

Food product	Beta-glucan content %		
	Wheat	20% Goldenhart	20% CM1
Tortilla	0.3 ± 0.0	1.4 ± 0.1	1.5 ± 0.1
Pita Bread	0.4 ± 0.0	2.5 ± 0.0	3.4 ± 0.3
Pan Bread	0.5 ± 0.0	2.9 ± 0.5	4.0 ± 1.0
Mini-Muffin	0.2 ± 0.1	1.2 ± 0.0	1.4 ± 0.1
Instant Noodle	0.3 ± 0.1	2.1 ± 0.3	2.8 ± 0.4
Cracker	0.3 ± 0.1	1.8 ± 0.1	2.4 ± 0.0

Note. 20% Goldenhart = 80% wheat flour + 20% Goldenhart flour. 20% CM1 = 80% wheat flour + 20% CM1 flour. The values are reported as dry matter basis. The value was averaged from two measurements.

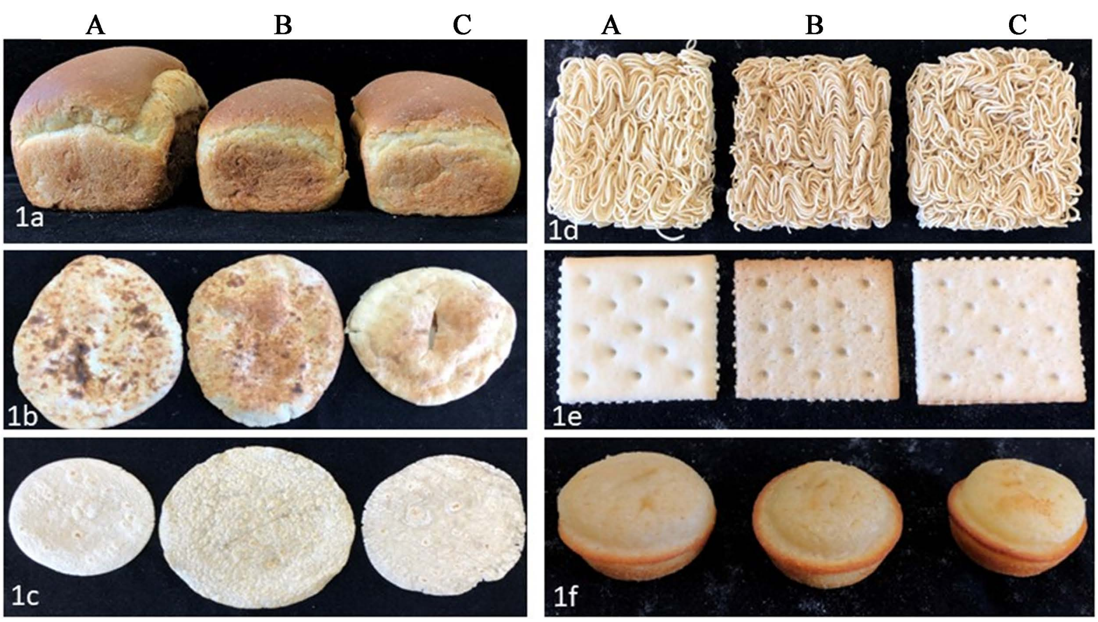

Figure 1. Food products evaluated. Total six panels as (a)-(f) representing Bread, Pita bread, Tortilla, noodles, Crackers, and mini-Muffin. The capital letters A, B, and C representing the ingredients used as pure wheat, 80% wheat + 20% Goldenhart barley, and 80% wheat + 20% CM1 barley.

the bread used the same amount of flour, smaller size might typically be due to the disruption of gluten structure in the foods reported in another study [20]. In summary, barley flour resulted in smaller bread size. In terms of bread color, all the bread samples (**Figure 1(a)**) showed similar color by observation.

Three pita samples from whole wheat, 20% CM1, and 20% Goldenhart barley flours, seemed non-sensitive to fiber content for their sizes and colors (**Figure 1(b)**) though the 20% Goldenhart pita showed a little smaller size, it is more like random variation of the size change rather than relating to fiber content.

Pan (Arabic) bread appearance is interesting. The size relates to the total fiber content in the flour samples in that the whole wheat is the smallest one (**Figure 1(c)-A**), CM1 added is the largest (**Figure 1(c)-B**), while Goldenhart added is between (**Figure 1(c)-C**). The color seems a little darker for the barley added samples. The size and color variations are consistent among the different pieces of the same product.

Noodle (**Figure 1(d)**) and cracker (**Figure 1(e)**) samples do not show clear differences in the size among the products using different ingredients. However, the CM1 highest fiber barley added products showed a darker color.

Wheat mini-muffins showed the best rise compared with barley added (**Figure 1(f)**). CM1 and Goldenhart added have no apparent differences in size. The three types are similar in color. The effect of barley flour or its fiber contents on size and color are like the bread.

The texture for food products is not evaluated because of lack of expertise. The only observation is that the CM1 added noodles were more fragile than the ones derived from whole wheat flour and Goldenhart added flour.

3.2. Nutritional Effect

The main purpose of this study was to evaluate nutritional effects of the barley ingredients. Food barley contains high fiber, particularly high beta-glucan, but lacks ideal food processing properties such as the ability of the dough to rise. Poor food processing properties limited its use although it is a rich fiber source. Adding food barley to traditional foods could be an alternative to improve the food processing features of pure barley while also enhancing the nutritional value of fiber.

The beta-glucan results are summarized in **Table 3**. Since the beta-glucan values are reported as the dry-matter basis, moisture content in the foods is not a factor to be considered. Pure wheat food products have beta-glucan from 0.2% to 0.5%, while the Goldenhart added samples varied from 1.2% to 2.9%, and CM1 added varied from 1.4% to 4.0% (**Table 3**). Goldenhart flour addition increased beta-glucan content by 5 - 6-fold, while CM1 flour addition increased beta-glucan by 8-9-fold (**Table 3**). Based on the theoretical calculation of beta-glucan content, 20% Goldenhart products should average (0.3% × 80%) + (11.4% × 20%)/2 = 2.5% beta-glucan and CM1 added products should have (0.3% × 80%) + (14.9% × 20%) = 3.2%. The products within the theoretical beta-glucan ranges are pita bread, bread, noodle, and crackers (**Table 3**), while tortilla and muffin showed lower values than the theoretical calculations (Table 3). The beta-glucan in the food products made from pure wheat flour aligns well with the flour contents (Table 2), indicating that the processing does not significantly affect beta-glucan.

As the major nutritional trait, total dietary fiber was measured from all the food products to evaluate the impact of the ingredients. Pure wheat products ranged from 4.6% to 9.1%, the 20% Goldenhart ranged from 7.4% to 18.0%, and the 20% CM1 ranged from 8.4% to 24.4% (Table 4). To calculate the theoretical contents of dietary fiber, pure wheat products should be 6.8% to 7.5% (Table 2). However, the values lower than the calculations are bread and muffin (Table 4). Noodles with just dry correction showed fiber content of 8.3%, close to the theoretical value, but dry and defatted corrections lowered the value more, although the fiber increase patterns with the barley addition were maintained (Table 4). All the Goldenhart added should have fiber content of (7.5% × 80%) + (39.9% × 20%) = 14.0% and all the CM1 added products should have (7.5% × 80%) + (56.1% × 20%) = 17.2%. Values showed for tortilla, pita, dry-corrected Noodles, and crackers are close to the calculated ranges, while others are lower (Table 4). It needs to be noticed that noodles with just dry correction were close to the theoretical value, but dry plus defatted correction resulted in a much lower value (Table 4), indicating the defat treatment lowered the fiber measurement value. Beta-glucan contents across the food products varied (Fig. 2), indicating that the food processing indeed affects the beta-glucan content in the final products. However, the variation of the values from different treatments in the same type of food maintained the same trend. The results clearly demonstrated that barley fiber increased the total dietary fiber content in all foods which is the major point in this experiment. Therefore, the main conclusion is that dietary fiber in the foods is greatly increased when the barley ingredient is added, and

Table 4. Dietary fiber and protein contents of the food products from different ingredients.

Food product	Dietary fiber %			Correction For dietary fiber	Protein %		
	Wheat	20% Goldenhart	20% CM1		Wheat	20% Goldenhart	20% CM1
Tortilla	7.3 ± 0.5	15.4 ± 1.7	16.4 ± 0.6	dried	11.2 ± 0.2	11.3 ± 0.1	12.4 ± 0.0
Pita Bread	8.0 ± 0.9	13.7 ± 0.9	17.7 ± 1.5	dried	12.7 ± 0.3	12.6 ± 0.8	13.6 ± 0.8
Pan Bread	4.6 ± 0.4	8.4 ± 0.9	10.5 ± 0.5	dried	14.7 ± 0.0	13.9 ± 0.0	14.9 ± 0.0
Mini-Muffin	6.8 ± 0.0	10.3 ± 0.3	11.7 ± 0.7	dried	11.5 ± 0.4	11.6 ± 0.9	12.5 ± 0.6
	3.2 ± 0.2	4.6 ± 0.0	5.2 ± 0.5	Dried + defatted	NA	NA	NA
Instant Noodle	7.9 ± 0.0	15.1 ± 0.5	18.9 ± 0.5	dried	12.8 ± 0.1	12.4 ± 0.2	13.8 ± 0.3
	2.1 ± 0.2	3.5 ± 0.5	4.5 ± 1.0	Dried + defatted	NA	NA	NA
Cracker	9.1 ± 0.5	18.0 ± 0.2	24.4 ± 1.4	dried	7.9 ± 0.1	8.3 ± 0.1	9.4 ± 0.0

Note. 20% Goldenhart = 80% wheat flour + 20% Goldenhart flour. 20% CM1 = 80% wheat flour + 20% CM1 flour. Noodles and Muffin are corrected by dried and defatted process based on the kit protocol due to the high oil contents. The values reported are the averaged of two measurements.

the increased levels correspond to the content in barley samples though not exactly in a linear pattern. The non-linear pattern could be from three possibilities: the foods process for some products resulted in degradation; The sample preparation step for the measurement caused some degradation; or measurement variation. Since our measurement procedure has been used for long time and no any degradation noticed, the food processing step is the most likely reason for variation.

Protein was also evaluated in the foods. Wheat flour for muffin and crackers have lower protein compared to other samples and CM1 barley has high protein (**Table 2**). Pure wheat products have a protein range from 7.9% to 14.7% (**Table 4**), while protein contents containing Goldenhart barley ingredient ranged from 8.3% to 14.0%, and CM1 containing products have 9.4% to 14.9% protein (**Table 4**). Most products have similar protein because of the similar protein contents in the raw materials though the wheat flour for crackers and muffins have low protein (**Table 2**).

It was noticed that beta-glucan, dietary fiber, and protein contents varied among the pure wheat products (**Table 3**, **Table 4**). Those differences could be due to the wheat variety used for those particular food products.

4. Discussion

We know that adding barley flour to foods will increase the nutritional value of the food products. In addition to the possible impact of barley ingredients on food texture and flavor, another likely reason that the approach is not largely used in the market is lack of enough scientific data to convince the industry and society. Results of this study with multiple food products confirmed that a barley flour as an ingredient could increase fiber, particularly beta-glucan in the foods, and its increase is proportional to the amount added. For example, pure wheat bread contains 0.5% beta-glucan, while the 20% CM1 flour bread contains 4.0% beta-glucan. Beta-glucan in pure muffin is 0.2% and in 20%CM muffin is 1.4%. The increased portion equals the input from barley flour: (14.9% × 20% CM1 + 0.3% wheat × 80%) = 3.1% in mixed flour which equals roughly ten times the beta-glucan in the wheat bread. Those results indicate that the impact of the food processing procedure for beta-glucan is minimized. Addition of barley in food production could be an alternative to boost beta-glucan in the diet.

With the same importance as beta-glucan in food health value, dietary fiber was evaluated. Wheat products all had about 7-8% dietary fiber, but barley added products more than doubled dietary fiber contents (**Table 4**). This clearly demonstrated that it is a working strategy in increasing food fiber by adding a high beta-glucan barley ingredient. And as the optimal portion of barley needs to be considered, each specific product needs further study to determine the best balance of nutrition and food properties that will satisfy the market. The negative impact of replacing wheat ingredients with 10% - 40% barley flour on the gluten micro-structure and bread dough mixing behavior were reported [21].

The bread size appears smaller in our experiment (**Figure 1**) when barley flour was added. In another study, 20% - 40% barley flour additions were reported in biscuit making, the crude fiber was increased to over 4% in the products [22]. The crackers in our study revealed similar results. The cracker sizes did not show any clear difference although the color in the 20% CM1 sample was darker which is likely due to the pigmentation in CM1 (**Figure 1**), but dietary fiber and beta-glucan increased significantly after barley addition (**Table 3**; **Table 4**). The crackers seem less sensitive to the dough behaviors and could handle more barley flour replacement if the taste and texture are acceptable.

It requires special ingredient samples to realize the boosting of food product fiber. The fiber content in the barley source must be high enough to boost the final content with an amount small enough to avoid significantly disrupting other desirable traits of the foods. Barley has the potential of increasing the content of beta-glucan and, thus, fiber. Food barley lines could be raised for fiber contents by planting them in water limited environments which may sacrifice some yield and seed character traits such as seed plumpness. We have CM1 seeds with about 17% beta-glucan. If barley lines could produce 15% beta-glucan seeds, we could reach about the same beta-glucan level in foods by adding only 14% barley flour instead of 20% barley flour giving a 10% beta-glucan boost. Reduction of the amount of barley flour in making a product may have less effect on the desirable food properties. As another alternative, using 20% barley flour with 15% beta-glucan, the food product could be boosted to 3% beta-glucan. A person who eats two servings of bread will get about half of the proposed beta-glucan intake recommended by the FDA (3 grams is the current recommendation). Therefore, adding high beta-glucan barley flour should be a promising approach to increase the beta-glucan intake for a healthy diet. It would be better if industry could develop some foods which are less sensitive to the barley ingredient ratio. The crackers and muffins examined in this study looked very interesting because of their size and color. Of course, we still need food industry expertise to evaluate properties such as texture, flavor, shelf-life, and storage.

Another possibility is that different product processing retains different levels of the beta-glucan which is observed in **Figure 2**. It may be a valuable clue for the food industry to test their own products or to develop new products for high beta-glucan to compete with or create their own healthy food markets for barley. Society would also benefit for their health, particularly those lacking fiber intake in their diet.

This study is the beginning of the research using high fiber food barley as an ingredient in the food production to improve the nutritional value. We are trying to focus the nutritional profile changes of foods using a high fiber barley replacement as a starting point for further research. If the food industry decides to be involved, healthier food products using high fiber barley ingredients will be available for public consumption which may contribute to lower medical costs

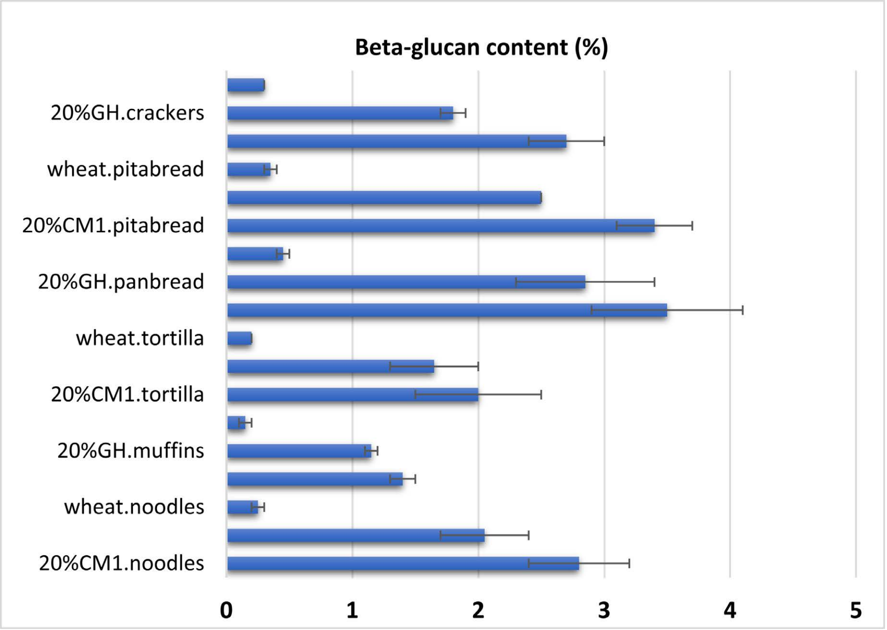

Figure 2. Beta-glucan contents measured from the final food products. Th unit is presented as percentage on dry-matter basis.

and improved quality of life. The food service we used in this study is closely related to the food industry and, thus, the results are more relevant to commercial production.

5. Conclusion

Many people in modern society lack sufficient dietary fiber. Boosting fiber intake is critical to reduce health-related problems such as high blood pressure, high cholesterol, chronic heart disease, and diabetes. Food barley varieties contain high dietary fiber in the form of beta-glucan and could be best used to supplement nutritional fiber deficiencies in highly processed foods. Replacements of 20% wheat flour with either Goldenhart or CM1 barley lines in the six common food products were evaluated for the beta-glucan and dietary fiber changes. The results confirmed that adding 20% of a high beta glucan barley could significantly increase dietary fiber, which makes it easier to meet the fiber intake recommendations from the FDA. This experiment focused on fiber changes, not food properties including texture, flavor, and shelf-life which require a specialized food science study. Continuous improvement of food barley lines, with higher beta-glucan content, could help the food industry improve nutritional value and keep desirable and palate-pleasing properties in our foods.

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Data Availability

Experimental data used were imbedded in the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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