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RESEARCH ARTICLE

QUANTIFICATION OF GLUTEN CONTENT IN VARIOUS GRAIN FLOUR SAMPLES FROM YEMEN

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Abstract

This study aimed to quantify the gluten content in a range of grain flour samples, including wheat, whole wheat, and gluten-free grains, collected from Yemen. Gluten content was determined using a standard wet gluten extraction method, and fiber content was analyzed using the AOAC method. The results showed that the white flour samples had the highest gluten content, ranging from 16.9% to 17.8%. In contrast, whole wheat flour samples had relatively lower gluten content (15.0% to 15.8%), but higher fiber levels. The gluten-free grain flours, such as soya, millet, sorghum, and oats, contained no detectable gluten, making them suitable alternatives for individuals with gluten-related disorders. The study also revealed variations in gluten content between different brands of the same flour type, highlighting the importance of product-specific analysis. These findings provide valuable insights into the dietary implications of gluten-containing and gluten-free foods, which can assist healthcare professionals, food manufacturers, and consumers in making informed decisions.

Keywords: Gluten; Grain flour; Celiac disease; Gluten sensitivity; Gluten-free diet.

1. Introduction

Authors Wheat is one of the most important cereal crops worldwide, in terms of production and utilization. It is a major source of energy, protein and dietary fiber in human nutrition and animal feeding. It provides approximately one-fifth of the total calorific input of the world's population [1].

The ability of wheat flour to be processed into different foods is largely determined by the proteins. According to previously obtained results, the content of total protein in bread and durum wheat genotypes ranged from 10.87 to 13.04 and 11.46 to 16.53%, respectively [2].

Gluten is a complex mixture of hundreds of related but distinct proteins in wheat, with gliadins and glutenins as the major components [3]. Similar proteins exist in other grains like rye, barley, and oats [4]. The structure (**Figure1**) and interactions of this protein matrix contribute to the unique functional properties of gluten, which are crucial in determining the quality of baked products [5-11].

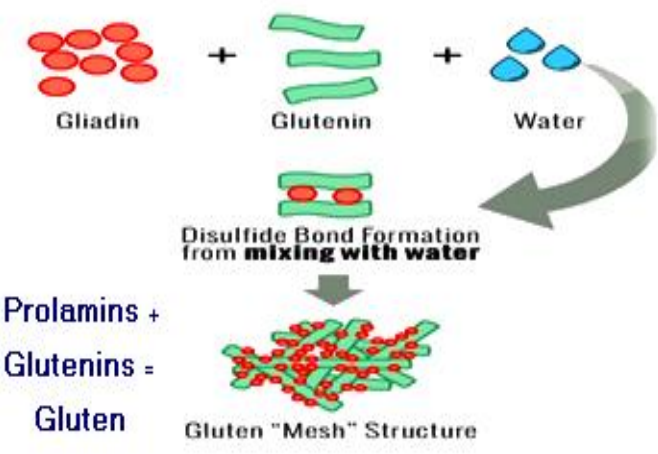

Fig. 1: Structure of Gluten (Adopted from Rosentrater et al., 2018).

There is current evidence on the adherence to a gluten-free diet (GFD), with particular attention to the impact on women's health [12]. There are several gluten-related disorders, including coeliac disease (CD), non-coeliac gluten sensitivity (NCGS), and gluten-sensitive irritable bowel syndrome (IBS) [13].

The objective of this study was to quantify the gluten content in various grain flour samples, including wheat, whole wheat, and gluten-free grains. This information is important for understanding the dietary implications of gluten-containing and gluten-free foods, especially for individuals with gluten-related disorders.

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2. Materials and Methods

The gluten content of the flour samples was determined using a standard wet gluten extraction method [14-16]. Briefly, 25 g of flour was weighed into a plastic bowl, and 15 mL of water was added to form a dough ball. The dough ball was then immersed in water for 1 hour to ensure proper hydration.

The hydrated dough was gently kneaded and washed under running water over a fine sieve until the washed-out liquid was clear. This process removed the starch, sugars, water-soluble proteins, and other minor components, leaving behind the wet gluten. The wet gluten was then pressed as dry as possible, cut into thin pieces, and spread over a petri dish.

The petri dish containing the wet gluten was dried in a hot air oven at 100°C for 1 hour. After drying, the petri dish was cooled in a desiccator and weighed to a constant weight to obtain the dry gluten weight. The weight of the empty petri dish (W1 = 8.072 g) and the weight of the petri dish with the dry gluten (W2) were recorded. The dry gluten percentage was calculated using the following formula:

$$\text{Dry gluten (\%)} = [(W2 - W1) / 25] \times 100 \qquad (1)$$

where: Weight of flour = 25 g and the weight of empty petri dish wash = 8.072 g

Alternatively, the fiber content of the flour samples was determined using the AOAC standard method [17]. Briefly, 2 g of the flour sample was treated with hot sulfuric acid and sodium hydroxide solutions to remove non-fiber components. The remaining residue was washed, dried, and weighed to determine the fiber content.

The results are shown in **Table 1**.

3. Results

The gluten contents were found to be: White flour "Al-Sanabel" (17.8%), White flour "Al-Maha" (16.9%), Whole Wheat flour "Al-Maha" (15%), Whole Wheat flour "WFP" (15.8%), Baby Barley (10.6%), Soya (0%), Millet flour (0%), White sorghum (0%), and Oatmeal (0%) (Table 1).

Table 1: Gluten and Fiber Content in Various Grain Flour Samples

Name of Sample	Gluten Content (%)* ±SD (CV)	Fiber Content (%)±SD
White Flour "Al-Sanabel"	17.8±0.15 (0.84)	2.5±0.15
White Flour "Al-Maha"	16.9±0.12 (0.71)	2.8±0.12
Whole Wheat Flour "Al-Maha"	15 ±0.20 (1.33)	4.2±0.20
Whole Wheat Flour "WFP"	15.8 ±0.18 (1.14)	4.5±0.18
Baby Barley	10.6 ±0.14 (1.32)	6.1±0.10
Soya Flour	0	8.2±0.09
Millet Flour	0	7.9±0.08
White Sorghum	0	6.8±0.08
Oatmeal	0	9.3±0.07

Note: * Four times replicates; SD = Standard Deviation; CV = Coefficient of Variation (%)

4. Discussion

The results show that the white flour samples had significantly higher gluten contents compared to the whole wheat and gluten-free grain flour samples (**Figure 2**). This finding is consistent with previous studies [13,14]. The higher gluten content in white flour can be attributed to the milling process, which removes the bran and germ fractions, thereby concentrating the gluten-rich endosperm. In contrast, whole grain flours contain the entire wheat kernel, including the bran and germ, which dilute the gluten content.

Interestingly, the study also revealed variations in gluten content between different brands of the same flour type. This observation highlights the importance of product-specific analysis, as gluten levels can vary even among seemingly similar flour products. The factors contributing to these brand-to-brand differences may include differences in wheat cultivars, growing conditions, and milling techniques.

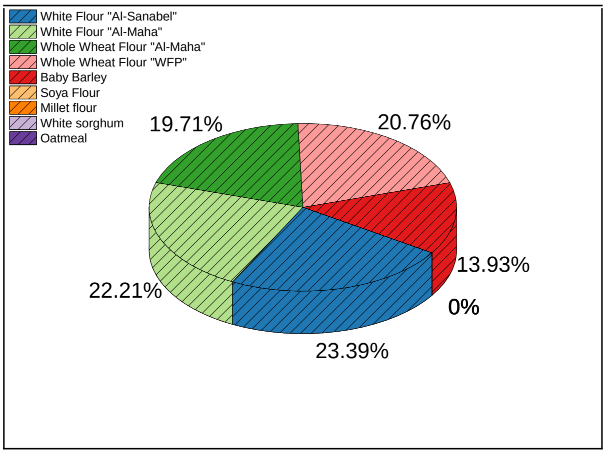

Fig. 2: Comparison of Gluten Content in Different Grain Flour Samples.

The standard deviation values indicate the variability within each sample group. The white flour samples have the lowest standard deviations, suggesting a more consistent gluten content across the replicates. The whole wheat flour samples and the baby barley sample show slightly higher standard deviations, indicating more variability in their gluten content. Similarly, the coefficient of variation (CV) values, expressed as a percentage, provide a measure of the relative variability within each sample group. The white flour samples have the lowest CV values, ranging from 0.71% to 0.84%, indicating the most consistent gluten content. The whole wheat flour samples and the baby barley sample have higher CV values, ranging from 1.14% to 1.33%, suggesting more variability in their gluten content.

Whole grain flours, while lower in gluten content, exhibited higher fiber levels compared to the white flour samples. This makes whole grain flours a healthier option, as the increased fiber content can provide additional nutritional benefits and promote better gut health. The gluten-free grain flours, such as soya, millet, sorghum, and oats, were found to contain no detectable gluten, making them suitable alternatives for individuals with celiac disease, gluten sensitivity, and wheat allergy [1, 15-22]. Consuming these gluten-free grains can help these individuals maintain a balanced and nutritious diet while avoiding the adverse effects associated with gluten intake.

Overall, these findings underscore the importance of understanding the gluten content and composition of various grain flour products, particularly for individuals with gluten-related disorders. The data provided in this study can assist healthcare professionals, food manufacturers, and consumers in making informed decisions regarding the dietary implications of gluten-containing and gluten-free foods.

Conclusion

This comprehensive study quantified the gluten content in various grain flour samples, including wheat, whole wheat, and gluten-free grains. The results provide important insights into the dietary implications of gluten-containing and gluten-free foods.

The white flour samples exhibited the highest gluten content, ranging from 16.9% to 17.8%. In contrast, the whole wheat flour samples had relatively lower gluten content, between 15.0% and 15.8%. This finding suggests that whole grain flours, while lower in gluten, offer higher fiber content, making them a healthier alternative.

The gluten-free grain flours, such as soya, millet, sorghum, and oats, were found to contain no detectable gluten. These grains are suitable options for individuals with gluten-related disorders, including celiac disease, non-celiac gluten sensitivity, and wheat allergy.

The variation in gluten content observed between different brands of the same flour type underscores the importance of accurate labeling and consumer awareness. Individuals with gluten sensitivities must carefully scrutinize product information to make informed dietary choices.

In conclusion, this study provides valuable data on the gluten content of various grain flours, which can assist healthcare professionals, food manufacturers, and consumers in understanding the dietary implications of gluten-containing and gluten-free foods. Promoting the use of gluten-free grains and whole grain flours can help support the nutritional needs of individuals with gluten-related disorders and contribute to overall health and well-being.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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مقالة بحثية

تقدير محتوى الجلوتين في عينات مختلفة من دقيق الحبوب من اليمن

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المُلخّص

هدفت الدراسة إلى قياس محتوى الجلوتين في مجموعة من عينات دقيق الحبوب، بما في ذلك القمح، والقمح الكامل، والحبوب الخالية من الجلوتين، والتي جُمعت من اليمن. تم تحديد محتوى الجلوتين باستخدام طريقة استخراج الجلوتين الرطبة القياسية، كما تم تحليل محتوى الألياف باستخدام طريقة الجمعية الأمريكية للعلوم الغذائية (AOAC). أظهرت النتائج أن عينات الدقيق الأبيض احتوت على أعلى محتوى من الجلوتين، تراوح بين 16.9% و17.8%. بالمقابل، كانت عينات دقيق القمح الكامل تحتوي على محتوى جلوتين أقل نسبياً (15.0% إلى 15.8%)، مع ارتفاع مستويات الألياف. أما الدقيق المصنوع من الحبوب الخالية من الجلوتين، مثل فول الصويا، والذرة، والذرة الرفيعة، والشوفان، فلم يُكشف عن وجود جلوتين فيها، مما يجعلها بدائل مناسبة للأشخاص الذين يعانون من اضطرابات مرتبطة بالجلوتين. كما كشفت الدراسة عن وجود اختلافات في محتوى الجلوتين بين علامات تجارية مختلفة لنفس نوع الدقيق، مما يسلط الضوء على أهمية التحليل الخاص بالمنتج. تقدم هذه النتائج رؤى قيمة حول الآثار الغذائية للأطعمة التي تحتوي على الجلوتين وتلك الخالية منه، الأمر الذي يمكن أن يساعد المهنيين الصحيين، ومصنعي الأغذية، والمستهلكين على اتخاذ قرارات مستنيرة.

الكلمات المفتاحية: الجلوتين، دقيق الحبوب؛ مرض السيلياك؛ حساسية الجلوتين؛ النظام الغذائي الخالي من الجلوتين.

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