Vol. 2, No. (9) oct. 2026

ISSN: 4556-3489

Arab Journal of Advanced Research and Development (AJARD)

المجلة العربية للبحوث المتقدمة والتنمية

Evaluation of Wheat Flour Extraction Rate by Ash Content in Tobruk Market and Its Health Implications

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Abstract

Objective :This study evaluated the extraction rate of four commercial wheat flour brands available in the Tobruk market (Alnouran, Prima, Almosim, and Alssafwa). Method :Ash content was determined using the oven incineration method according to the approved methods of the American Association of Cereal Chemists (AACC, 2000). The ash values obtained were 0.57% for Alnouran, 0.65% for Prima, 0.65% for Almosim, and 0.69% for Alssafwa. Wet gluten content was determined using the manual method approved by AACC (1976). Results :showed gluten percentages of 30% for Alnouran, 30% for Prima, 27% for Almosim, and 25% for Alssafwa. It also, revealed variations in extraction rate among the analyzed flour types. Most samples exceeded the Libyan standard extraction level based on ash content. However, the flour remained suitable for bread production. Three samples (Alnouran, Prima, and Almosim) met the Libyan gluten specification for bread flour, while Alssafwa showed slightly lower gluten content. Conclusion :These findings indicate that the increases in extraction rate is not necessarily reduce the quality of wheat flour for bread making.

Keywords: Wheat Flour, Ash Content, Extraction Rate, Wet Gluten, Bread Quality, Tobruk Market .

الملخص:

الهدف: هدفت هذه الدراسة إلى تقييم معدل استخلاص لأربعة أنواع تجارية من دقيق القمح متوفرة في سوق طبرق (النوران، بريما، الموسيم، والصفوة). المنهجية: تم تحديد محتوى الرماد باستخدام طريقة الحرق في الفرن وفقًا للطرق المعتمدة من قبل الجمعية الأمريكية لكيميائيي الحبوب (AACC، 2000). وكانت قيم الرماد المُقاسة 0.57% للنوران، و0.65% لبريما، و0.65% للموسيم، و0.69% للصفوة. تم تحديد محتوى الغلوتين الرطب باستخدام الطريقة اليدوية المعتمدة من قبل الجمعية الأمريكية لكيميائيي الحبوب (1976). النتائج: أظهرت النتائج نسب غلوتين بلغت 30% للنوران، و30% لبريما، و27% للموسيم، و25% للصفوة. كما كشفت الدراسة عن اختلافات في معدل الاستخلاص بين أنواع الدقيق المُحللة. تجاوزت معظم العينات مستوى الاستخلاص القياسي الليبي بناءً على محتوى الرماد. ومع ذلك، ظل الدقيق مناسبًا لإنتاج الخبز. استوفت ثلاث عينات من الدقيق مواصفات الغلوتين الليبية، بينما

كانت عينة واحدة أقل بقليل من المعيار. الخلاصة: تشير هذه النتائج إلى أن الزيادات المعتدلة في معدل الاستخلاص لا تؤدي بالضرورة إلى انخفاض الجودة التقنية لدقيق القمح المستخدم في صناعة الخبز.

الكلمات المفتاحية :دقيق القمح، محتوى الرماد، نسبة الاستخلاص، الجلوتين الرطب، جودة الخبز، سوق طبرق.

1. Introduction

Wheat is one of the most important cereal crops worldwide and represents a fundamental component of the human diet (Gooding, 2009). Wheat is among the oldest crops in the world , Wheat is the leading cereal grains produced in the world, used for food (67%), feed (20%), and seed (7%). Durum and hard wheat contain more protein (12–16%) than soft wheat (8–10%) (USDA/NASS, 2001. (Wrigley et.al . 2009) Composition The wheat kernel consists of dietary fiber rich bran layers, starchy endosperm and fatty germ. Valuable nutritional compounds, such as micronutrients, phytochemicals and fibers are concentrated in germ and bran (Barron et. al. 2006). Wheat flour extraction rate (also referred to as milling extraction rate), which is closely associated with the processing quality and nutritional quality of wheat flour, refers to the mass fraction of the finished wheat flour relative to the total mass of whole wheat kernels. During industrial milling, refined flour is often produced by removing wheat bran and germ, with extraction rates typically below 75 %, resulting in significant nutrient loss (Zhang, l. et al., 2024). Comparative analyses have demonstrated that reducing the extraction rate from 95 % to 61.5 % leads to a 14 % loss of protein (primarily albumin and globulin), and a 29 % loss of dietary fiber in wheat flour (Yılmaz, et al., 2018). Increasing the extraction rate of wheat flour (>75 %) provides a solution to reduce waste while preserving higher contents of nutrients, particularly protein, during industrial milling. (Zhang, l. et al., 2024) reported that the proportion of total protein, albumin, globulin, and wheat bran dietary fiber in wheat flour increased significantly with flour extraction rate. However, the mere retention of more nutrients in wheat flour does not inherently translate to higher nutritional value. The nutritional value of wheat flour is also determined by the digestibility and fermentability of its nutrients (Fang et al., 2025) . Concurrently, elevated undigested carbohydrates (e.g., starch and dietary fiber), whose levels are also modulated by extraction rate-dependent changes in endogenous components, promote the production of short-chain fatty acids and inhibit the growth of harmful gut microbiota in the colon, thus promoting host health (Faubel et al., 2025). However, existing studies usually focus on the regulation of gut microbiota by a single macronutrient, such as dietary fiber, overlooking the synergistic interactions between multiple components in wheat flour as modulated by extraction rates, in regulating the gut microenvironment.

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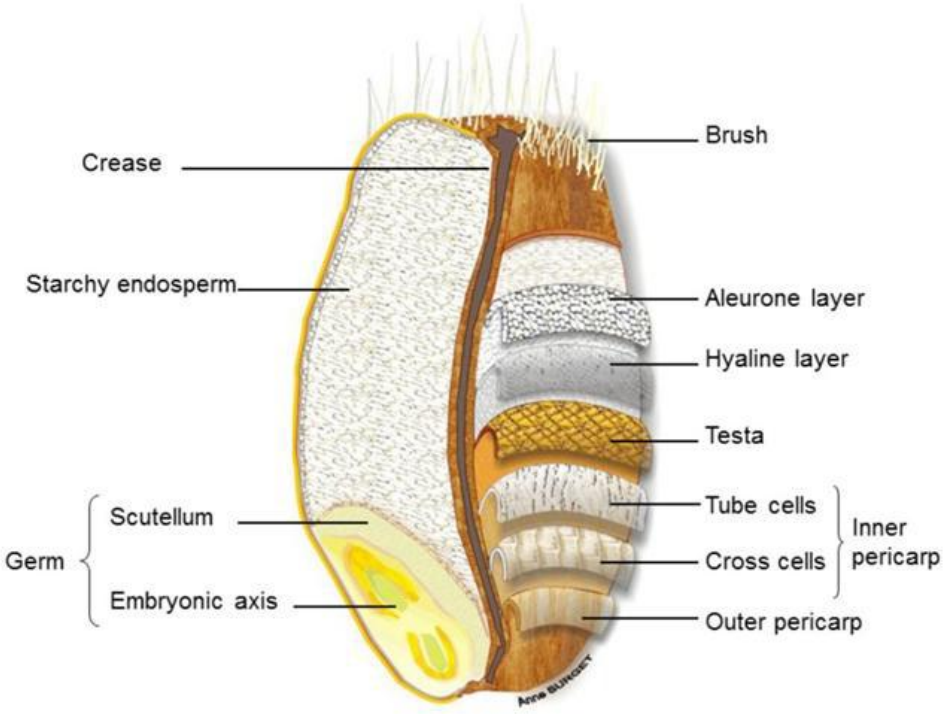

The structure of the wheat grain: different bran layers are illustrated from aluerone to outer pericarp (Surget et .al . 2005).

The endosperm together with the aluerone layer contributes more than 80 % of the grain mass (Bechtel et al. 2009). White flour is made of the endosperm, where cells are packed with starch granules embedded in a protein matrix. Most of the protein is gluten which is the storage protein of wheat. The starch granules are lens-shaped and up to 40 µm in length. The starchy endosperm is composed of three types of cells: peripheral, prismatic and central. The cells vary in size, shape and location. The peripheral cells are the first row inside the aluerone layer, The prismatic cells are found inside of the peripheral cells, and the central cells are inside the prismatic cells. . The endosperm cell walls are composed of pentosanes', other hemicelluloses, and β-glucans (Hoseney.1986). The germ of wheat comprises 2.5 to 3.5 % of the kernel. The germ is composed of the embryonic axis and the scutellum. The scutellum functions as a storage organ for wheat. The germ contains 25 % protein, 18 % sugar and 16 % lipids. The sugars are mainly sucrose and raffinose. The germ does not contain starch but is rich in B vitamins. It also contains many enzymes. (Hoseney, 1986) . Wheat bran has several layers: outer and inner pericarp, testa/seed coat, hyaline layer and aleurone layer seen in Figure 1. The pericarp is composed of intermediate cells, cross cells and tube cells. The total pericarp comprises about 5 % of the grain. It consists of approximately 20 % cellulose, 6 % protein, 2 % ash, and 0.5 % fat. It is also rich in xylans and insoluble fiber (Hemery et. al. 2007) and (Hoseney, 1986). Wheat flour is the most important product of wheat milling. It is used

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on an industrial scale in baking and in producing confectionaries, pasta and food concentrate , Wheat flour producing by a combination of roll milling and sieving processes. Many varieties of wheat and many processing procedures are necessary in order to produce commercial wheat flour for various uses (0). Ash is one of the major indicators of wheat flour's quality and use .(Cardoso, R.V ,etal ..2019) . Ash, an index of the mineral content of the flour, gives an indication of the grade or the extraction rate of the flour, This is because the mineral content of the endosperm is very low, as compared to the outer bran layers, Thus, low-grade flours, rich in powdered bran give higher ash contents as compared to more refined or patent flours (Eliasson .etal .1993). The ash obtained from flours consists of mineral compounds of phosphorous, potassium, calcium, magnesium, iron, zinc, and copper. Phosphorus (approximately 45%), potassium (approximately 38%), magnesium, and calcium (approximately 13% and 3%, respectively) are the main elements present in ash, while the other elements amount to only 1% [Carson, 2009]. In addition, lipids from wheat bran are reported to be of potentially high value for food and pharmaceutical industries Wheat bran, with 13–18% of proteins, is a potentially valuable source for food industry and can be used as an additive in a variety of food products such as beverages, meat, etc. (Sozer et al,2017). due to having essential unsaturated fatty acids (Jung et al., 2010). The whole wheat grain contains 1.17–2.96% of the mineral constituents.Wheat is one of the cereals used extensively in many parts of the world for the preparation of bread and many bakery products (Fincher et. all .1986) , Flour performance depends on its composition, which in turn depends on wheat characteristics and milling. Milling separates the bran and germ fractions from the endosperm, which is used to make flour, and reduces endosperm particles to the correct size (Obert et.al ,2004) , Flours differ in their extraction rate, which is defined as the proportion of flour by weight, derived by milling from a known quantity of grains . The quality of wheat affects the quality of flour and bran (hardness, flour yield, amount of starch damage and energy requirements in processing). The quality of wheat is a structural and biochemical feature. It varies greatly among different wheat crops, strains, climate conditions, harvesting conditions and processing technology. (Bechtel et. al. 2009). The proteins of the wheat gluten complex are of critical importance in determining bread-making quality . Bread wheat grain proteins are generally divided into gluten and non-gluten proteins . Both gluten and non-gluten proteins are located mainly in the embryo, aleurone layer and endosperm of the grain, with the endosperm containing most of the gluten. The gluten protein fraction accounts for about 85% of total grain protein. Based on the solubility in aqueous alcohols and acid solution (Sapirstein,1998) . cereal foods in its various forms are essential components of the daily diet and nutritionally, they are an important source of carbohydrates, protein, dietary fiber and many vitamins and non-nutrients (Liu *et al*., 2000) .

The whole grains intake is reported to be associated with health benefit including improved regulation of blood glucose level and decreased risk of diabetes cardiovascular disease, and certain cancers (Jacobs et al., 1998). Bakery products, particularly sourdough

breads produced from high extraction rate flours are the best potential source of fiber to reduce cardio-vascular disease, gastrointestinal disorders and diabetes (Pomeranz et al., 1977).

The main Objectives of our study are :

• Compare commercial flour samples with Libyan standard specifications.

• Evaluate the relationship between extraction rate and flour quality.

• Assess the nutritional relevance of fiber associated with higher extraction flour.

2. Materials and Methods

2.1 methods

• AACC. 2000. Approved methods of American Association of Cereal Chemists. 15th ed. American Association of Cereal Chemists, Arlington, VA.

• Determined the wet gluten by Manual method approved from A.A.C.C.1976.

2.2 Sample Collection

Four wheat flour brands were obtained from local markets in Tobruk, Libya: Alnouran, Prima, Almosim, and Alssafwa.

2.32 Ash Determination

Ash content was determined according to AACC Method 08-01 (AACC, 2000). Approximately 5 g of flour sample was placed in a pre-weighed crucible and incinerated in a muffle furnace at 550°C until constant weight was obtained.

2.4 Wet Gluten Determination

Wet gluten was determined using the manual washing method approved by AACC (1976). Flour (25 g) was mixed with water to form dough, and the starch was washed out under running water. The remaining cohesive mass represented wet gluten, which was dried to obtain constant weight.

2.5 Statistical Analysis

All analyses were performed in triplicate, and results were expressed as arithmetic mean values.

3. Results and Discussion

The experiment was conducted on the four types of flour, repeated three times. After obtaining the results, statistical operations were performed, namely the arithmetic mean and standard deviation. The results were as follows:

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The ash content results for the four samples after statistical analysis are shown in the following table:

3.1 Ash Content

Ash%	Flour type
0.57	**Alnouran**
0.65	Prima
0.65	**Almosim**
0.69	**Alssafwa**

The results indicate that Prima, Almosim, and Alssafwa have ash values corresponding to relatively high extraction rates, while Alnouran showed a lower ash value closer to the recommended standard.

3.2 Wet Gluten Content

Flour type	Wet gluten %
Alnouran	**30**
prima	**30**
almosim	**27**
alssafwa	**25**

Three samples (Alnouran, Prima, and Almosim) met the Libyan gluten specification for bread flour, while Alssafwa showed slightly lower gluten content.

Discussion

The results of this study showed that the ash content of three flour types (Prima, Almosim, and Alssafwa) increased to approximately 0.65%, indicating an extraction rate above 80%, which does not comply with the Libyan standard specifications for flour extraction. In contrast, the ash content of Alnouran flour was below 0.60%, which is close to the 75% extraction rate and therefore agrees with the Libyan standard extraction requirements. These findings indicate that complete flour extraction was not achieved in most samples.

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Despite this variation, the flour remains suitable for the baking industry because fiber content does not significantly affect baking performance when present within reasonable limits. This finding agrees with Pratt (1971), who reported that low ash content is not directly associated with bread quality. Although flour containing bran does not produce bread of superior quality, it can still produce bread that is acceptable to consumers.

Most of the obtained results, except for Nouran flour, are consistent with the findings of Michalska (2007) and Pederson (1994). This may be attributed to bran containing relatively high concentrations of minerals, some of which are associated with dietary fiber components.

A gluten quantity test was also conducted to confirm whether the increase in extraction rate, and consequently the increase in ash content, was associated with gluten content. The results confirmed this relationship and were consistent with Vetrimani et al. (2005), who reported that gluten content decreases as extraction rate increases. However, the present findings differ from those reported by Azizi et al. (2006).

4. Conclusions

The findings of this study demonstrate that ash content is a reliable indicator of flour extraction rate and can be used to assess flour quality characteristics. Most of the tested flour samples exhibited relatively high extraction rates, as reflected by increased ash content, compared with the Libyan standard specifications. Prima, Almosim, and Alssafwa flour showed extraction rates above the recommended limits, whereas Alnouran flour was closer to the standard extraction level.

Despite the higher extraction rates observed in most flour samples, the results indicate that these flours remain technologically suitable for bread production. Although increased extraction rates are associated with higher ash and fiber contents, these factors did not significantly reduce the acceptability of the final baked products when present within reasonable limits. Furthermore, flour with higher extraction rates contains greater amounts of bran-associated minerals and dietary fiber, which may provide additional nutritional and potential health benefits.

The relationship observed between extraction rate, ash content, and gluten quantity confirms that flour composition changes with increasing extraction levels. Therefore, ash determination remains an important quality assessment parameter for evaluating flour extraction efficiency and predicting technological properties relevant to the baking industry.

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