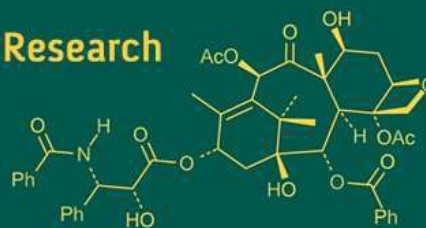


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## Effects of storage practices on nutritional biochemistry of sorghum grains

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### Abstract

Sorghum (*Sorghum bicolor*), a vital cereal crop cultivated predominantly in arid and semi-arid regions, plays a crucial role in ensuring food security and nutritional well-being. Despite its resilience to harsh climatic conditions, improper storage practices significantly impact the grain's nutritional biochemistry, leading to losses in macronutrients, bioactive compounds, and overall grain quality. This article examines the effects of various storage practices on the biochemical composition of sorghum grains, focusing on factors such as moisture content, temperature, pest infestation, and microbial contamination. Additionally, advanced storage strategies, including hermetic storage, low-temperature environments, and biopesticides, are discussed as effective methods to mitigate nutrient loss. This comprehensive review offers insights for researchers, policymakers, and stakeholders to enhance the post-harvest management of sorghum and ensure its contribution to global food security.

**Keywords:** *Sorghum bicolor*, cereal crop, arid and semi-arid regions, food security

### Introduction

Sorghum is a drought-tolerant cereal crop cultivated widely across Asia, Africa, and parts of the Americas. It serves as a staple food for millions of people, particularly in regions with limited access to diverse food sources. Sorghum's nutritional composition, rich in carbohydrates, proteins, lipids, and dietary fiber, as well as essential micronutrients like iron, zinc, and calcium, underscores its importance in addressing malnutrition and food insecurity (Awika & Rooney, 2004; Beta *et al.*, 2005) <sup>[1, 2]</sup>. Furthermore, bioactive compounds such as phenolic acids and flavonoids contribute to its antioxidant properties and potential health benefits. However, sorghum grains are highly susceptible to quality degradation during storage. Factors such as moisture, temperature fluctuations, pest infestations, and microbial activity contribute to significant losses in nutritional value and safety. These challenges are exacerbated by inadequate storage infrastructure and reliance on traditional methods in many developing countries. This article explores the biochemical changes that occur in sorghum grains during storage, the impact of improper practices, and modern storage techniques that can preserve the grain's nutritional integrity.

### Objective

The objective of this paper is to analyze the effects of various storage practices on the nutritional biochemistry of sorghum grains, a crucial cereal crop for food security in arid and semi-arid regions.

### Nutritional Composition of Sorghum

Sorghum is composed of approximately 65–75% carbohydrates, 7–15% protein, 1.5–3% lipids, and 8–12% dietary fiber (Nusrat & Julie, 2018) <sup>[7]</sup>. It is a rich source of essential minerals, including calcium, magnesium, and iron, and vitamins such as thiamine, riboflavin, and niacin. Sorghum is also known for its high levels of bioactive compounds, including phenolics, flavonoids, and tannins, which are responsible for its strong antioxidant activity (Beta *et al.*, 2005) <sup>[2]</sup>.

These nutrients and bioactive compounds play a critical role in human health, supporting energy production, immune function, and chronic disease prevention. However, the stability of these components during storage is influenced by environmental and biological factors, necessitating proper storage techniques to maintain sorghum's nutritional value.

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**Table 1:** Nutritional Composition of Sorghum

| Nutrient                | Composition (per 100 g) |
|-------------------------|-------------------------|
| Carbohydrates           | 65-75 g                 |
| Protein                 | 7-15 g                  |
| Lipids                  | 1.5-3 g                 |
| Dietary Fiber           | 8-12 g                  |
| Calcium                 | 13-28 mg                |
| Magnesium               | 50-150 mg               |
| Iron                    | 1.6-8.4 mg              |
| Vitamin B1 (Thiamine)   | 0.33 mg                 |
| Vitamin B2 (Riboflavin) | 0.14 mg                 |
| Vitamin B3 (Niacin)     | 2.9 mg                  |

## Biochemical Changes during Storage

### Moisture Content and Stability

Moisture is a key determinant of grain stability during storage. Sorghum grains stored at high moisture levels (>13%) experience increased enzymatic activity and microbial growth, leading to the degradation of starch, proteins, and lipids (Obadina *et al.*, 2014) [8]. High moisture also promotes the growth of fungi, particularly *Aspergillus* species, which produce aflatoxins—potent carcinogenic compounds that pose significant health risks. Aflatoxin contamination not only reduces the safety of sorghum grains but also depletes antioxidants and essential nutrients.

### Temperature Effects

Temperature fluctuations during storage have a profound impact on sorghum's biochemical stability. High temperatures accelerate lipid oxidation, resulting in rancidity and the loss of essential fatty acids. Proteins are particularly sensitive to thermal stress, undergoing denaturation and enzymatic hydrolysis, which reduce their digestibility and nutritional quality (Park *et al.*, 2012) [9]. Phenolic compounds, essential for antioxidant activity, are also degraded under prolonged exposure to high temperatures.

### Pest Infestations

Pests such as weevils and grain borers cause physical and biochemical damage to sorghum grains. Pest activity reduces carbohydrate reserves, as insects consume starch, and also leads to losses in protein and lipid content (Tefera *et al.*, 2011) [10]. Pest-damaged grains are more vulnerable to secondary microbial contamination, further exacerbating nutrient losses and compromising grain safety.

### Microbial Contamination

Fungal and bacterial contamination is a major concern in sorghum storage, particularly in humid environments. *Aspergillus* and *Penicillium* species are common culprits, producing mycotoxins that degrade grain quality and pose health risks (Hell & Mutegi, 2011) [5]. Microbial activity also depletes essential nutrients and diminishes the grain's antioxidant properties, reducing its nutritional and economic value.

## Strategies to Mitigate Nutritional Losses during Storage

### 1. Hermetic Storage Systems

Hermetic storage technologies, including airtight containers and multilayer polyethylene bags, have proven highly effective in reducing post-harvest losses. These systems create an oxygen-deprived environment that inhibits pest

activity and microbial growth, preserving both macronutrients and bioactive compounds (De Groote *et al.*, 2013) [3]. Hermetic storage has been shown to retain the antioxidant properties of sorghum by minimizing oxidative stress.

### 2. Low-Temperature Storage

Low-temperature storage significantly reduces enzymatic activity and microbial growth, thereby preserving sorghum's nutritional and biochemical stability. Park *et al.* (2012) [9] reported that refrigeration minimizes lipid oxidation and protein denaturation, ensuring the grain's functional and nutritional quality. However, the high energy and infrastructure costs associated with cold storage limit its application in resource-poor settings.

### 3. Improved Drying Techniques

Proper drying before storage is essential to reduce moisture content and prevent microbial contamination. Solar drying, an affordable and environmentally friendly method, effectively lowers moisture levels while maintaining nutrient integrity (Obadina *et al.*, 2014) [8]. Mechanical drying offers greater precision and is suitable for large-scale operations, though it requires significant initial investment.

### 4. Biopesticides and Natural Preservatives

The use of biopesticides, such as neem extracts, provides an eco-friendly solution for controlling pest infestations. Tefera *et al.* (2011) [10] demonstrated that natural preservatives effectively reduce pest activity without leaving harmful residues, preserving the nutritional quality and safety of stored sorghum grains.

### 5. Chemical Treatments

Chemical fumigants, such as phosphine, are commonly used to control pests. While effective, excessive use of these chemicals can result in residue issues and health concerns. Combining chemical treatments with hermetic storage or natural alternatives offers a balanced approach to grain preservation (Navarro *et al.*, 2012) [6].

## Conclusion

Storage practices profoundly affect the nutritional biochemistry of sorghum grains, influencing their macronutrient content, bioactive compounds, and overall quality. Moisture, temperature, pest activity, and microbial contamination are the primary factors contributing to nutrient loss during storage. Advanced storage techniques, including hermetic systems, low-temperature environments, and biopesticides, have proven effective in mitigating these losses and preserving sorghum's nutritional integrity. Future research should focus on developing cost-effective and scalable storage solutions tailored to resource-constrained settings. Integrating modern storage practices with agricultural and food systems will enhance the sustainability and resilience of sorghum production, ensuring its continued role in addressing global food security challenges.

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