

## Exploring the Prevalence and Risks of Wheat Adulteration in Gorakhpur City, Uttar Pradesh, India

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### ABSTRACT:

Adulteration in food products is a significant concern in India, particularly in staple foods like wheat flour, where harmful substances are often added to increase weight or alter appearance. Wheat flour, one of the most widely consumed food items, is vulnerable to adulteration practices driven by profit motives. This study focuses on wheat flour adulteration in Gorakhpur city, Uttar Pradesh, a region experiencing rapid urbanization and increased food demand. The study evaluates the degree of contamination present in wheat flour and its possible ramifications on health. A total of 160 wheat flour samples were collected from various local markets, grocery stores, and mills across Gorakhpur and analyzed in laboratories for common adulterants such as chalk powder, soapstone, starch, and artificial colorants using standard detection methods, including iodine and hydrochloric acid tests. The findings revealed that 50 (31.25% of the samples tested positive for one or more adulterants with starch being the most prevalent, followed by chalk powder and starch. The health risks associated with these adulterants are significant, including gastrointestinal distress, respiratory issues, skin irritation and long-term effects such as kidney damage and chronic health conditions. The study also highlights the lack of public awareness and inadequate regulatory enforcement as key factors contributing to the widespread issue. The study emphasizes the need for enhanced public awareness, stricter regulations, and improved food safety testing to combat adulteration. It calls for coordinated efforts from government bodies, local authorities, and consumers to ensure food safety and mitigate health risks associated with wheat flour adulteration.

### Introduction

Food adulteration is a widespread issue affecting the quality and safety of food consumed by millions of people worldwide. The problem is particularly prevalent in India due to the rapidly increasing population, economic challenges, and the lack of stringent enforcement of food safety regulations. Adulteration refers to intentionally adding inferior, harmful, or unauthorized substances to food products to increase profit margins or increase food quantity. Among the various food products vulnerable to adulteration, wheat, a staple food and a major ingredient in many culinary preparations, has been a significant target for adulteration. Wheat flour adulteration threatens food security and poses severe health risks to consumers, ranging from gastrointestinal problems to more chronic conditions, including cancer (Yadav et al., 2019).

Adulteration of wheat in India has led to significant health crises, notably due to ergot contamination. In 1975, an outbreak of convulsive ergotism in India affected 78 individuals, causing symptoms such as nausea, vomiting, drowsiness, and convulsions; however, no fatalities were reported (Singh and Kumari, 2022). Wheat is an essential crop in India and holds cultural, nutritional, and economic significance. As reported by the Food and Agriculture Organization (FAO), India is the second-most prolific wheat flour producer globally, with an approximate output of 108 million metric tons (FAO, 2020). Under systems like the United States Grain Standards Act, grades are often defined by minimum thresholds, incentivizing manipulation to deliver wheat just above the minimum permissible standard (Alsberg, 1931). It is a primary source of carbohydrates for millions of people, particularly in northern and central India, where it is used in various forms, such as wheat flour (atta), bread, and other food products. However, due to the increasing demand and price sensitivity, wheat flour and its

derivatives have become prime targets for adulteration. Common adulterants in wheat flour include starch, chalk powder, soapstone, artificial colors, and other chemicals (Patel et al., 2020). These substances are used to either increase the volume of the wheat flour or alter its appearance to make it look fresher or of better quality. Adulteration in wheat significantly reduces its nutritional and economic value, posing health risks and emphasizing the urgent need for stricter regulatory oversight and public awareness initiatives (Hussen, 2012).

In Gorakhpur, a city in the eastern part of Uttar Pradesh, wheat flour adulteration has become a growing concern. Gorakhpur is one of the largest cities in the region, with a rapidly growing population of approximately 675,000 people as per the 2011 census (Census of India, 2011). The city is a major agricultural hub in Uttar Pradesh, and wheat is a critical crop for both consumption and trade. However, with the increasing urbanization and commercial activities, the issue of food adulteration, particularly in wheat flour, has escalated. This problem is compounded by limited consumer awareness, insufficient regulatory enforcement, and the lack of accessible food safety testing facilities.

While adulteration in wheat flour has been extensively studied in other parts of India, limited research has been focused on specific cities like Gorakhpur. Given the rapid urbanization and growing market demand, it is essential to assess the scope of wheat flour adulteration in this city to understand its prevalence, identify the most common adulterants, and evaluate their health implications. This study aims to fill this gap by investigating the extent of adulteration in wheat flour in Gorakhpur and analyzing the potential health risks associated with the consumption of adulterated wheat flour. The primary objective of this study is to identify the types of adulterants present in wheat flour sold in Gorakhpur, assess their frequency, and evaluate their potential impact on public health. The study also aims to contribute to the growing body of literature on food safety and adulteration in India, highlighting the need for stronger regulations and better consumer awareness programs. It is hoped that the findings from this study will inform policy and regulatory measures aimed at reducing wheat flour adulteration and improving food safety in Gorakhpur and other similar urban centers.

## **Methodology**

This study aimed to investigate the extent of wheat flour adulteration in Gorakhpur city, Uttar Pradesh, focusing on identifying the types of adulterants present and assessing their potential health risks. A cross-sectional research design was employed and 160 wheat flour samples were randomly collected from various sources within the city, including local retail markets, wholesale suppliers, and wheat flour mills, over a three-month period from June to August 2022. The sample size was chosen to ensure a diverse representation of the wheat flour available in Gorakhpur's market.

The collected wheat flour samples weighing approximately 1 kilogram were subjected to laboratory analysis to detect common adulterants such as chalk powder, soapstone, starch, artificial colorants, and bleaching agents. The adulterants were identified using standard testing methods: chalk powder was detected using a hydrochloric acid test to observe gas release; soapstone was identified through visual inspection and microscopic analysis; starch was detected with an iodine solution that changes color in its presence; artificial colorants were examined using a solubility test and chemical reagents; and bleaching agents were identified through a spot test with acetone for any changes in the texture or appearance of the wheat flour. The wheat flour samples were also tested for moisture content to assess their overall quality. The potential health risks associated with consuming adulterated wheat flour were estimated based on the types of adulterants identified and their known effects on human health. Ethical considerations were carefully observed throughout the study. The research adhered to ethical guidelines to ensure integrity and reliability.

## **Results:**

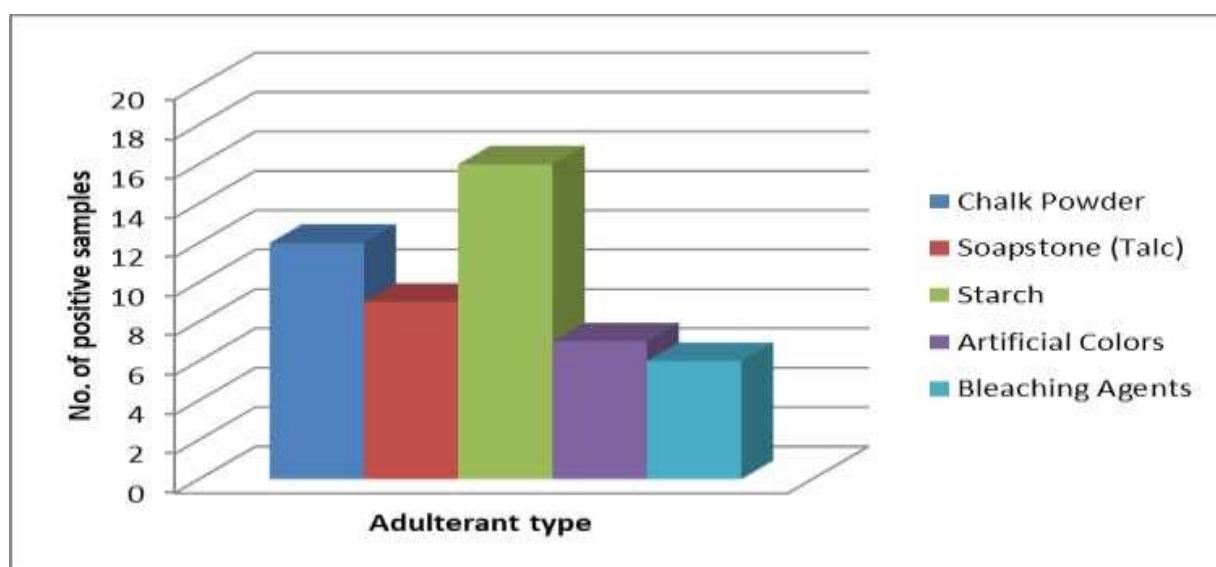
### **Prevalence of Adulteration in wheat flour Samples**

The laboratory analysis of the 160 wheat flour samples collected from various markets, wholesalers, and mills in Gorakhpur city revealed a high incidence of adulteration. The results showed that 50 (31.25%) samples tested positive for one or more adulterants. The most common adulterants

detected were starch, chalk powder, soapstone, and artificial colorants, with starch being the most prevalent. Below is a breakdown of the findings in table format:

**Table 1: Prevalence of Adulterants in Wheat Flour Samples and Associated Health Risks**

S. No.	Adulterant	Positive Samples (Out of 160)	Percentage of Samples Affected	Health Risks
1.	Chalk Powder	12	7.5%	Can cause gastrointestinal issues, kidney stones, and long- term kidney damage due to excessive calcium intake.
2.	Soapstone (Talc)	09	5.6%	Causes respiratory problems, skin irritation, and has been linked to lung disease and cancer with prolonged exposure.
3.	Starch	16	10%	Reduces the nutritional value of wheat flour, leading to potential malnutrition and weakened immunity, especially in vulnerable populations.
4.	Artificial Colors	07	4.4%	Linked to allergies, gastrointestinal issues, and an increased risk of cancer. Prolonged exposure may cause hyperactivity, particularly in children.
5.	Bleaching Agents	06	3.8%	Skin and eye irritation, with potential carcinogenic effects when consumed over long periods.
<b>Total</b>		<b>50</b>	<b>31.25%</b>	



**Figure 1: Graphical representation of prevalence of various Adulterants in Wheat Flour Samples**

### Wheat flour Samples Quality:

In conjunction with the adulteration assessment, the quality of the wheat flour specimens was further evaluated through analyses of moisture content, as these parameters directly impact the flour's functional applicability and longevity in storage. One of the key quality indicators evaluated was moisture content, as high moisture levels can promote spoilage, mold growth, and bacterial contamination. The recommended moisture content for wheat flour is generally between 12-14%, as this range ensures optimal freshness and minimizes the risk of microbial growth. However, the results of this study revealed that 104 (65%) of the wheat samples exceeded the moisture content limit, indicating a significant quality issue. Flour with elevated moisture content is more prone to degradation, reducing its shelf life and making it unsuitable for long-term storage. High moisture levels also contribute to the growth of mold and fungi, which can lead to off-flavors and potential health risks for consumers. This finding highlights the importance of proper storage and handling practices in maintaining the quality of wheat flour and suggests the need for stricter quality control measures at both the supplier and retail levels in Gorakhpur.

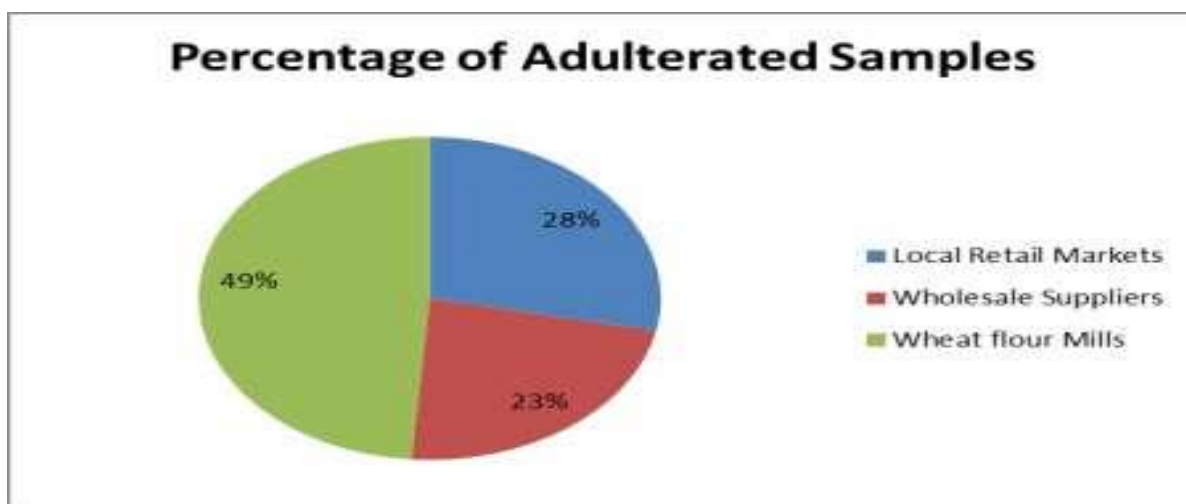
Moreover, the findings regarding the quality of wheat flour in Gorakhpur city suggest that adulteration and poor handling and milling practices contribute to the compromised quality of the wheat products available in the market. These quality issues can affect wheat flour's safety and usability, further emphasizing the need for improved regulation and quality control in the local food supply chain.

### Analysis of Adulteration by Source:

The examination elucidated a noteworthy correlation between the origin of wheat flour (local retail establishments, wholesale distributors, and wheat flour production facilities) and the propensity for adulteration. The table below shows the distribution of adulteration across the different sources of wheat flour:

**Table 2: Distribution of Wheat Flour Adulteration across Different Sources in Gorakhpur**

S. No.	Source of wheat flour	Number of Samples Tested	Number of Adulterated Samples	Percentage of Adulterated Samples
1.	Local Retail Markets	80	22	27.50%
2.	Wholesale Suppliers	40	9	22.50%
3.	Wheat flour Mills	40	19	47.50%



**Figure 2: Pie Chart representation of the percentage of adulterate samples of various sources**

The data clearly indicate that the source plays a crucial role in determining the quality and safety of the wheat flour. The study tested a total of 160 wheat flour samples, distributed across three different sources: local retail markets, wholesale suppliers, and wheat flour mills. The findings suggest that wheat flour obtained from wheat flour mills exhibited the highest rate of adulteration, with 47.5% of the samples being adulterated. This is a notable finding, as mills are responsible for processing raw wheat into flour and may have greater control over production, yet still showed a relatively high incidence of adulteration. This could point to possible cost-cutting measures, where adulterants are added to increase the weight of the flour, or poor quality control during milling.

In comparison, local retail markets showed a 27.5% adulteration rate, while wholesale suppliers had the lowest rate of adulteration at 22.5%. These figures suggest that while adulteration is prevalent across all sources, wheat flour from wholesale suppliers is slightly less likely to be adulterated, potentially due to wholesale distribution's larger-scale, more regulated nature, which may involve stricter oversight and longer supply chains. Retail markets, however, tend to deal with smaller quantities and may face more challenges in ensuring the authenticity of the wheat flour, leading to a higher likelihood of adulteration.

These findings emphasize the need for targeted interventions depending on the source of wheat flour. While adulteration is a concern across all market segments, the higher prevalence of adulterated samples from wheat flour mills and local retail markets suggests that regulatory efforts should be strengthened in these areas. Improved quality control, regular testing, and stricter regulations on the milling process could help reduce the incidence of adulteration in these sectors, thereby enhancing the safety and quality of wheat flour available to consumers in Gorakhpur.

### Health Risk Estimation Based on Adulterants

The prospective health hazards linked to the prolonged intake of contaminated wheat flour are encapsulated in the table presented below. This estimation is based on the types of adulterants found in the wheat flour samples and their known effects on human health:

**Table 3: Short and long time health risk associated with various adulterants**

S. No.	Adulterant	Short term Health Risks	Long term Health Risks
1.	Chalk Powder	Gastrointestinal distress, nausea, and abdominal pain.	Kidney damage, kidney stones and hypercalcemia.
2.	Soapstone (Talc)	Skin irritation and eye irritation.	Respiratory problems, lung disease, and cancer (mesothelioma).
3.	Starch	Indigestion and bloating.	Potential malnutrition due to reduced nutritional value.
4.	Artificial Colors	Allergic reactions, nausea, and dizziness.	Cancer, hyperactivity (especially in children).
5.	Bleaching Agents	Skin irritation and eye irritation.	Carcinogenic effects with prolonged consumption.

### Discussion:

The analysis of the wheat samples collected from various markets, grocery stores, and mills in Gorakhpur city revealed that 31.25% of the samples tested positive for adulteration. The most prevalent adulterants detected were chalk powder, soapstone, starch, and artificial colorants, all of which pose varying health risks to consumers. Chalk powder, which was found in 7.5% of the samples, is commonly added to wheat to increase its weight and give it a finer, whiter appearance. While chalk powder may not pose an immediate danger in small quantities, its prolonged consumption can lead to gastrointestinal issues, such as abdominal pain and constipation, as well as more serious long-term health concerns like kidney stones and hypercalcemia (Noori et al., 2021). This is due to the elevated calcium levels in the body, which can lead to kidney damage if consumed over extended periods. Given the high prevalence of chalk powder in the samples, raising awareness of these risks

and implementing stronger food safety regulations to prevent such adulteration is essential. A previous analysis by Singh et al. (2021a) reveals that common adulterants in wheat flour, such as chalk powder, soapstone, starch, and artificial colorants, are driven by economic incentives but pose substantial health risks to consumers.

Another common adulterant identified in the samples was soapstone (or talc), which was found in 5.6% of the wheat flour samples. Talc is used to enhance the appearance of wheat flour, making it look whiter and fresher. However, talc is not safe for human consumption and can cause respiratory problems when inhaled or ingested. It has also been linked to lung disease and, in severe cases, cancer (Shi et al., 2023). The widespread use of soapstone in wheat flour in Gorakhpur poses significant long-term health risks and highlights the need for improved regulatory oversight and monitoring in local markets. Starch, found in 10% of the samples, is another adulterant commonly added to wheat to increase volume and improve texture. While starch is not harmful in small amounts, its presence in wheat flour dilutes its nutritional value, particularly its protein content. This adulteration can lead to digestive discomfort, such as bloating and indigestion, especially in individuals with sensitive stomachs. More importantly, the use of starch in wheat flour reduces the overall nutritional quality, which could contribute to malnutrition, particularly among vulnerable groups like children, the elderly, and those with weakened immune systems.

Finally, artificial colorants were found in 4.4% of the wheat samples. These synthetic dyes are used to make the flour appear brighter and more visually appealing. However, artificial colorants such as metanil yellow and yellow sudan dye are not intended for consumption and can cause a range of health problems. Consumers exposed to these dyes may experience allergic reactions, including skin rashes and itching. Long-term consumption of foods containing artificial colorants has been associated with gastrointestinal issues, hyperactivity, particularly in children, and even an increased risk of cancer (Yadav et al., 2019; Bhatnagar et al., 2022). The use of artificial colorants in wheat flour is a serious health concern and a violation of food safety standards, emphasizing the need for greater regulation and consumer education.

The consumption of wheat flour products containing additives such as chalk, starch, soapstone, and artificial color poses several potential health risks, primarily due to contamination with heavy metals and microbial pathogens. In chalk powder, heavy metals have been detected in wheat flour, often exceeding safety limits, which can lead to chronic exposure and adverse health effects, including carcinogenic risks, particularly from Cd (Wahab & Jamil, 2023; Noori et al., 2021; Ghanati et al., 2019; Lei et al., 2015). The presence of these metals is often linked to environmental contamination from industrial activities, such as lead smelting, which significantly increases the concentration of these metals in wheat flour (Li et al., 2021). Due to high moisture content, microbial contamination with pathogens like *Salmonella* and *Escherichia coli* has been identified in wheat flour, posing risks of foodborne illnesses (Prakash et al., 2024; Feng & Archila-Godínez, 2021). These substances can lead to severe health outcomes, including gastrointestinal disorders, malnutrition, and exposure to toxic compounds like mycotoxins from ergot (Singh et al., 2021b). While not directly addressed in the previous studies, the use of additives like chalk and artificial colors could potentially exacerbate these risks by introducing additional contaminants or by masking the presence of harmful substances, making detection and regulation more challenging (Xin et al., 2017). Therefore, it is crucial to implement stringent monitoring and regulatory measures to control the contamination of wheat flour with heavy metals and pathogens, and to educate consumers on safe handling practices to mitigate these health risks (Feng & Archila-Godínez, 2021; Xin et al., 2017).

The findings of this study highlight the alarming prevalence of wheat adulteration in Gorakhpur, with substances that range from relatively benign to highly toxic. The adulterants identified in this study are consistent with those found in other regions of India, as reported in previous research (Patel & Kapoor, 2020; Yadav et al., 2019). However, the high incidence of adulteration in Gorakhpur city indicates a more widespread issue that poses significant public health risks. The lack of consumer awareness and inadequate regulatory enforcement exacerbate the problem, leading to adulterated wheat flour's continued sale and consumption. The results of this study underscore the urgent need for stricter enforcement of food safety laws, routine monitoring, and improved testing mechanisms. Consumer

education is also critical to ensuring that the public is aware of the potential dangers of adulterated wheat flour. We can only reduce the prevalence of food adulteration and mitigate its impact on public health through coordinated efforts from government bodies, local authorities, and consumers.

### **Summary and Conclusion:**

This study investigated the prevalence of adulteration in wheat flour and its associated health risks in Gorakhpur city, Uttar Pradesh, India. A total of 160 wheat flour samples were randomly collected from various local markets, wholesale suppliers, and wheat flour mills in the city. The laboratory analysis revealed that 31.25% of the wheat flour samples tested positive for adulteration. The most common adulterants detected were chalk powder, soapstone, starch, and artificial colorants, with chalk powder being the most prevalent. The adulterants were found to pose significant health risks, including gastrointestinal issues, kidney damage, respiratory problems, and potential carcinogenic effects. Additionally, a higher incidence of adulteration was observed in wheat flour samples collected from local retail markets compared to those obtained from wholesale suppliers or wheat flour mills. The investigation further evaluated the quality parameters of the wheat flour, revealing that numerous samples exhibited elevated moisture levels, which could compromise both the product's nutritional integrity and safety. Quantitative analysis substantiated a substantial correlation between the origin of the wheat flour and the propensity for adulteration, underscoring the imperative for focused regulatory interventions within particular market segments.

Moreover, adulteration of wheat flour is a prevalent issue in Gorakhpur and has serious implications for public health. The findings underscore the urgent need for improved food safety regulations, enhanced public awareness, and better enforcement of existing laws. The consumption of adulterated wheat flour not only compromises the quality of food but also poses long-term health risks to the population.

### **Future Scope of the Study:**

While this study yields significant insights regarding the prevalence and ramifications of wheat flour adulteration in Gorakhpur, numerous domains exist where additional inquiry may prove advantageous. Initially, augmenting the sample size and geographic parameters to encompass alternative urban centers and rural regions would facilitate a more holistic comprehension of the magnitude of wheat flour adulteration throughout Uttar Pradesh or India as a collective entity. Furthermore, subsequent research endeavors could concentrate on the economic repercussions of adulteration for both consumers and suppliers, encompassing the financial strain imposed by health complications attributable to adulterated food products. Another area of future research is the development of advanced detection methods for adulterants. While the laboratory tests used in this study effectively identified common adulterants, more sophisticated techniques, such as spectroscopy or chromatography, could be explored for the rapid and non-invasive detection of adulterants in wheat flour. This could lead to the establishment of better monitoring and testing systems in markets and at points of sale. Lastly, intervention-based studies are needed to evaluate the effectiveness of public awareness campaigns and regulatory enforcement. Investigating how consumer education and stricter regulations impact the prevalence of adulteration could provide practical insights for policymakers and regulatory bodies in their efforts to combat food adulteration. Moreover, this study opens the door for continued research into the issue of wheat flour adulteration, offering potential avenues for both scientific and public health interventions that can improve food safety in India.

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