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Ancient wheat unveiled: Exploring the physical properties and nutritional value of Sonamoti wheat (*Triticum aestivum* L. ssp. *sphaerococcum*)

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Abstract
Sonamoti wheat (*Triticum sphaerococcum)*, an ancient wheat variety rediscovered in rural Punjab, is of interest due to its potential nutritional benefits and sustainability. This study aims to evaluate its physical characteristics, proximate composition, gluten content, and folic acid levels to validate its nutritional advantages. Samples were collected from Pratapgarh District, Rajasthan, and standard methods were employed for analysis. The physical properties of Sonamoti wheat revealed a thousand kernel weight of 30.04±2.04 g, a thousand kernel volume of 22.66±0.57 ml, and a bulk density of 0.76±0.04 g/ml. It demonstrated a swelling capacity of 0.096±0.007 ml, a swelling index of 0.43±0.03, a hydration capacity of 0.506±0.03 g, and a hydration index of 1.6±0.1. The proximate composition showed a moisture content of 6.18±0.15 g per 100 g, crude protein content of 16.6±0.55 g per 100 g, crude fat of 0.83±0.11 g per 100 g, ash content of 2.78±0.36 g per 100 g, crude fiber of 0.51±0.11 g per 100 g, carbohydrate content of 73.102±0.84 g per 100 g, and energy content of 366.33±2.35 Kcal per 100 g. The gluten content was significant, with wet gluten at 58.39±1.52 g per 100 g and dry gluten at 18.05±0.84 g per 100 g. However, the folic acid content was low, measured at 0.014±0.00 mg per kg (0.14 µg per 100 g). Sonamoti wheat demonstrates high nutritional properties, including high protein and mineral content and significant gluten levels. However, its low folic acid content necessitates further enhancement through biofortification. Sonamoti wheat holds promise for sustainable agriculture and improved dietary intake.

Keywords: Ancient wheat, Sonamoti, folic acid, proximate, gluten

Introduction

Background

Cereals, derived from the Latin phrase "cerealis" meaning 'grain,' are botanically classed as caryopses and belong to the Poaceae or Gramineae family, distinguished by their tall, slender stalks. Important cereal crops with starchy grains, such as wheat, rice, corn, sorghum, millet, barley and rye, are vital parts of human nutrition (Sarwar *et al*., 2013) [1].

Importance of wheat

Due to its substantial contribution to daily protein and caloric needs, wheat is crucial for maintaining global food security (Shiferaw *et al*., 2013) [2]. Wheat is a rich source of vital amino acids, phytochemicals, minerals, vitamins, and dietary fibre in addition to calories. Its multipurpose utilisation in a range of culinary products highlights its necessity, especially in baking and cooking applications (Uthayakumaran and Wrigley, 2017) [3].

Nutritional Challenges and Ancient wheat varieities

Considering wheat's major global yield, current high-yield varieties frequently lack key minerals, increasing deficiencies in nutrition (Debnath *et al*., 2023) [4]. As a result, demand for ancient wheat varieties has increased again because it is believed that they have better nutritional profiles and are more sustainable (Szczepanek *et al*., 2022) [5]. The possible health benefits of ancient wheat species, such Einkorn, Emmer, and Spelt, have drawn attention. One such benefit is that they may reduce risk factors linked to chronic diseases (Jirillo *et al*., 2019; Fujita *et al*., 2020) [6, 7].

Historical Significance of Ancient wheat

Being among the first cultivated crops, ancient wheat types have great historical value. These grains were essential to the nutritional and financial frameworks of ancient civilizations, making a significant contribution to their socioeconomic stability and daily survival. The recognized resilience and nutritional richness of these grains played pivotal roles in sustaining the health and longevity of early human societies. Presently, the revaluations of ancient grains not only reconnect us with our agricultural heritage but also offers viable solutions to contemporary nutritional challenges.

Triticum sphaerococcum (AABBDD, 2n = 6x = 42), commonly referred to as Indian dwarf wheat or emmer, is a wheat landrace renowned for its compact size, unique grain structure, and resilience to environmental challenges. Originating from South Asia, this ancient variety offers potential nutritional benefits due to its hemispherical grains and elevated protein content compared to modern wheat strains. Despite its advantageous traits, Indian dwarf wheat has received limited research attention. Also known by various local names such as Sona Moti, Sugar-Free, Gundu, and Bol Gahu in India, it likely originated from Bread Wheat (*Triticum aestivum*) (Matsuoka, 2011) [8].

Rediscovery of sonamoti wheat

Of all the ancient varieties, sonamoti wheat stands out as one of the most notable variety. It was rediscovered in rural Punjab by the Art of Living Foundation. Sonamoti wheat is a viable candidate for further investigation due to its claimed elevated folic acid content and potential health advantages (Williamson and Leonelli, 2023) [9]. This research aims to thoroughly assess the sonamoti wheat's physical characteristics, proximate composition, gluten content, and folic acid levels in order to validate its nutritional benefits and support its reintroduction into sustainable farming practices and to reintroduce it as a nutritious alternative to modern varieties.

Materials and Methods

Sample procurement

Sonamoti wheat samples were collected from a local source in Pratapgarh District, Rajasthan, adhering to standard collection procedures.

Physical properties estimation

The physical properties assessment encompassed several steps. Thousand kernel weight was determined by manually counting and weighing 100 kernels using an electronic balance, following the method outlined by Williams *et al.* (1983) [10]. Thousand kernel volume was measured using the water displacement method, as described by Williams *et al.* (1983). Bulk density was determined by compacting 50 grams of wheat kernels in a graduated cylinder and calculating the ratio of weight to volume according to the formula: Bulk Density = Weight of kernels (g)/ Final volume of kernels (ml), based on the procedure recommended by Okaka and Potter (1977) [11]. Swelling capacity and swelling index were evaluated after a 24-hour soaking period, following the methodology outlined by Dhingra *et al.* (1992) [12] and Kantha *et al.* (1986) [13], respectively. Hydration capacity and hydration index were determined by measuring the change in weight of the kernels before and after soaking, with calculations performed using formulas provided by Bishnoi and Khetarpal (1993) [14] and Kantha *et al.* (1986) [15].

Proximate composition estimation

The proximate composition analysis involved a series of steps. Moisture content was determined by weighing the sample before and after placing it in a humidity chamber, following AOAC guidelines (2000) [15]. Crude protein was measured using the Micro Kjeldahl method, as outlined by NIN (2003) [16]. Crude fat content was determined using the Soxhlet technique described in AOAC guidelines (2000) [15]. Ash content was assessed by combusting the sample and measuring the residual inorganic matter, following AOAC protocols (2000) [15]. Crude fiber was quantified using the procedure standardized by AOAC (2000) [15]. Carbohydrate content was calculated by deducting the sum of moisture, crude protein, crude fat, crude fiber, and ash from 100, following NIN guidelines (2003) [16]. Energy content was estimated using physiological fuel values, as per NIN guidelines (2003) [16].

Gluten content estimation

The estimation of gluten content in Sonamoti wheat flour involved several steps. Wheat flour was mixed with water to form dough, which was then kneaded and washed to extract crude gluten, following the method described by Jain and Mogra (2006) [17]. Wet and dry gluten content were determined by weighing the gluten before and after drying.

Folic acid estimation

The estimation of folic acid content in Sonamoti wheat samples was conducted using High-Performance Liquid Chromatography with Ultraviolet Detection (HPLC-UV). Sample preparation involved enzymatic extraction and cleanup using immunoaffinity solid-phase extraction cartridges, as per the method described by Mahato *et al.* (2020) [18]. Analysis was performed using an HPLC-UV system, with calibration and validation procedures ensuring accurate quantification of folic acid levels.

Results

Physical Properties

The physical properties analysis of Sonamoti wheat revealed several key attributes. The average thousand kernel weight was measured at 30.04±2.04 g, indicating the weight of 1000 kernels, while the corresponding volume occupied by these kernels averaged 22.66±0.57 ml. The bulk density of Sonamoti wheat was found to be 0.76±0.04 g/ml, indicative of its kernel density and integrity. Additionally, the wheat demonstrated a swelling capacity of 0.096±0.007 ml and a swelling index of 0.43±0.03, illustrating its ability to absorb and expand upon hydration. The hydration capacity measured 0.506±0.03 g, with a hydration index of 1.6±0.1, further highlighting its water absorption characteristics. These findings collectively underscore the physical resilience and hydration potential of Sonamoti wheat, suggesting its versatility for various food applications and processing methods.

Proximate Analysis

The proximate analysis of Sonamoti wheat indicated several significant nutritional properties. The moisture content, measured at 6.18±0.15 g per 100 g, suggested enhanced storage stability and a reduced risk of microbial growth. The crude protein content was high, at 16.6±0.55 g per 100 g, highlighting its potential as a valuable protein source. With a low crude fat content of 0.83±0.11 g per 100 g, Sonamoti wheat signifies itself well-suited for low-fat dietary formulations. The ash content, recorded at 2.78±0.36 g per 100 g, indicated a richer mineral profile. The crude fiber content was noted as 0.51±0.11 g per 100 g. The carbohydrate content stood at 73.102±0.84 g per 100 g, making it a significant energy source. The energy content of 366.33±2.35 kcal per 100 g further underscored its capacity to meet daily caloric requirements. Collectively, these attributes suggested that Sonamoti wheat possessed a balanced nutritional profile with high protein and carbohydrate content, moderate energy value, and low fat content, making it an ideal ingredient for the development of nutritious food products.

Gluten Content
Sonamoti wheat displayed significant gluten content, with wet gluten measured at 58.39±1.52 g per 100 g and dry gluten at 18.05±0.84 g per 100 g. These findings indicate that Sonamoti wheat possesses strong gluten characteristics, which are important for various culinary applications requiring robust dough elasticity and baking performance

Folic Acid Content
The folic acid content was found to be very low, measuring 0.014±0.00 mg/kg (equivalent to 0.14 µg per 100 g). This suggests that Sonamoti wheat may benefit from future efforts in breeding or fortification to enhance its nutritional value, particularly in terms of folic acid content.

Overall, while the low folic acid content presents an area for potential improvement, the high gluten content underscores Sonamoti wheat's suitability for diverse food processing and product development purposes, highlighting the need for further investigation into enhancing folic acid levels in Sonamoti wheat for improved nutritional value.

Table 1: Physical properties of Sonamoti wheat

S. No	Physical Properties	Mean±SD
1	Thousand kernel weight (g)	30.04±2.04
2	Thousand kernel volume (ml)	22.66±0.57
3	Bulk density (g/ml)	0.76±0.04
4	Swelling Capacity (ml)	0.096±0.007
5	Swelling Index	0.43±0.03
6	Hydration Capacity (gm)	0.506±0.03
7	Hydration Index (g)	1.6±0.1

All values are (Mean±SD) of three observations

Table 2: Proximate of the sonamoti wheat

S. No.	Nutrients	Mean±SD
1	Moisture (g)	6.18±0.15
2	Crude Protein (g)	16.6±0.55
3	Crude Fat (g)	0.83±0.11
4	Ash (g)	2.78±0.36
5	Crude Fibre (g)	0.51±0.11
6	Carbohydrate (g)	73.102±0.84
7	Energy (Kcal)	366.33±2.35

All values are (Mean±SD) of three observations

Table 3: Folic acid and gluten content of the sonamoti wheat

S. No	Nutrient		Mean±SD
1	Folic acid (mg/kg)		00.014±0.00
2	Gluten (g/100g)	Wet Gluten	58.39±1.52
		Dry Gluten	18.05±0.84

All values are (Mean±SD) of three observations

Summary
This research investigates the physical characteristics, proximate composition, gluten content, and folic acid levels of Sonamoti wheat (*Triticum sphaerococcum*), an ancient variety rediscovered in rural Punjab. The study aims to validate the nutritional benefits of Sonamoti wheat and support its reintroduction into sustainable farming practices. Samples were collected from Pratapgarh District, Rajasthan, and analyzed using established methodologies.

The physical properties evaluation of Sonamoti wheat revealed significant characteristics impacting its suitability for various applications. The mean thousand kernel weight and volume were found to be 30.04±2.04 g and 22.66±0.57 ml, respectively aligning with previous findings by Adhikari *et al*. (2023) [19]. Additionally, the bulk density was calculated as 0.76±0.04 g/ml, indicating the density and integrity of the kernels, consistent with observations in wheat quality studies (Dziki *et al*., 2012) [20]. Sonamoti wheat demonstrated higher swelling capacity and swelling index compared to common wheat varieties. (Chaudhary *et al*., 2018) [21], suggesting potential differences in kernel characteristics.

The proximate composition analysis of Sonamoti wheat has provided insightful findings into its nutritional profile. The moisture content noted as 6.18±0.15 g per 100 g, indicating potential variability influenced by environmental factors. Sonamoti wheat exhibited a higher crude protein content of 16.6±0.55 g per 100 g compared to common wheat varieties (Kaur *et al*., 2023; Golea *et al*., 2023) [22] [23], suggesting superior nutritional value due to its enhanced protein content. The average crude fat content in Sonamoti wheat was notably lower at 0.83±0.11 g per 100 g, contrasting with the higher ranges observed in indigenous wheat varieties (Parvez *et al*., 2018) [24]. Furthermore, the ash content in Sonamoti wheat measured as 2.78±0.36 g per 100 g, exceeds the ranges reported for other wheat varieties (Parvez *et al*., 2018) [24], indicating a richer mineral profile. In contrast, the crude fiber content was 0.51±0.11 g per 100 g, falling below the reported ranges in other varieties (Parvez *et al*., 2018) [24], potentially influencing its dietary fiber contribution. The carbohydrate content averaged 73.102±0.84 g per 100 g, falled within reported ranges (Parvez *et al*., 2018) [24].

The average energy content of Sonamoti wheat was measured at 366.33±2.35 kcal per 100 g, highlighting its capacity to provide significant caloric value in diets. These proximate composition findings underscore Sonamoti wheat as a nutritious ingredient for food product development, particularly due to its high protein content, moderate carbohydrates, and substantial energy value. The lower fat content suggests healthier formulation options, while the elevated mineral content enhances its overall nutritional value, making it suitable for developing high-nutrition food products.

The gluten content findings are consistent with studies on *T. sphaerococcum*, supporting its utility in culinary applications that require strong gluten networks (Adhikari *et al*., 2023; Bodor *et al*., 2024) [19] [25]. However, the low folic acid content contrasts with Araujo *et al*. (2012) [26], who reported higher levels in fortified commercial wheat flours, indicating a need for targeted nutritional enhancement.

The results have several implications for agriculture, nutrition, and health. Agriculturally, Sonamoti wheat's resilience and nutritional profile make it a promising candidate for sustainable farming practices. Nutritionally, its high protein and mineral content can contribute to improved dietary intake, particularly in regions where wheat is a staple food. The significant gluten content suggests potential for diverse culinary applications, enhancing the variety of wheat-based products available to consumers. However, the low folic acid content underscores the necessity for further research to improve this aspect, potentially through biofortification or selective breeding practices. Overall, reintroducing Sonamoti wheat could address contemporary nutritional challenges and support global food security.

Conclusion

This study has demonstrated that Sonamoti wheat possesses notable physical properties, high protein content, and substantial gluten levels, positioning it as a nutritionally superior and versatile grain compared to common wheat varieties. However, its low folic acid content indicates a need for further nutritional enhancement.

Future research should focus on exploring methods to enhance the folic acid content of Sonamoti wheat, such as fortification. Additionally, comprehensive studies on the environmental resilience of Sonamoti wheat could support its widespread agricultural adoption. Investigating its health benefits, particularly in relation to chronic disease risk factors, would further validate its reintroduction into modern diets. Finally, consumer acceptance studies could help gauge the market potential of Sonamoti wheat products, ensuring successful integration into contemporary food systems.

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