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Effect of Different Sowing Dates on Productivity and Quality Characteristics of Two Egyptian Bread Wheat Cultivars

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ABSTRACT

Two field investigations were conducted during the 2018–2019 and 2019–2020 wheat growing seasons at the Sids Agricultural Research Station to evaluate the impact of different sowing dates—November 5 (D1), November 20 (D2) and December 5 (D3)-on the yield and quality traits of two spring wheat cultivars, Misr1 and Sids14. The findings revealed that both the number of spikes per square meter and the number of kernels per spike increased with the second sowing date (D2) in both seasons. Sids14 produced a higher number of spikes per square meter compared to Misr1, while Misr1 recorded a greater 1,000-kernel weight on D2 in both seasons (60.73 and 64.93g, respectively). Among the six samples analyzed, Sids14 exhibited the highest number of kernels per spike and spikes per square meter on D2. The highest grain yield per plot was recorded on D1 across both seasons (6.00 and 6.75kg, respectively). Regarding color and milling characteristics, the optimal sowing date for Misr1 was D2, while the best performance for Sids14 was observed on D3. Protein content was the only chemical component that showed significant variation across sowing dates, with no notable differences in the mean values of other chemical components for either cultivar. Similarly, no significant differences were found in the mineral content among the samples. For sensory evaluation, pan bread made from the flour (72% extraction) of the wheat samples showed no significant differences in sensory parameters. Texture profile analysis revealed that pan bread from Sids14 (D3) and Misr1 (D1) exhibited higher hardness values, while cohesiveness remained consistent across samples. Notably, pan bread from Misr1 (D1) and Sids14 (D1 and D3) demonstrated higher gumminess and chewiness ratings. Significant differences in physical properties were identified between the control and other pan bread loaves. In terms of chemical composition, pan bread samples made from Misr1 and Sids14 grown on D2 exhibited higher protein content (11.59% and 11.92%, respectively), while no significant changes were observed in the mean values of other components. In conclusion, the ideal sowing date for Misr1 was November 20 (D2), while November 5 (D1) was optimal for Sids14, as these dates maximized their qualitative and quantitative traits.

1. Introduction

Wheat is a vital crop for feeding the world's growing population due to its high protein content and its richness in essential minerals, vitamins and phytochemicals (Nadew, 2018). Like in many other regions worldwide, bread and other wheat-based products are staple foods consumed daily in various forms for breakfast, lunch and dinner because of their availability and convenience (Amiri et al., 2015).

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Wheat (Triticum aestivum L.) is one of the most widely cultivated crops globally and serves as a principal food grain (DES, 2020). Timely sowing is a critical agronomic practice for winter wheat to ensure proper germination, robust seedling establishment and optimal yield development (Liu et al., 2021). An ideal planting date enhances wheat's grain production and baking quality by allowing the crop to synchronize its physiological, phenological and environmental adaptations. It also ensures efficient utilization of water, temperature and solar radiation during growth (Silva et al., 2014). Controlling planting dates, along with selecting appropriate cultivars and managing environmental conditions, can increase wheat grain yield by 10–80% (Coventry et al., 2011). Sowing wheat at the right time is considered the most effective strategy to enhance grain development, yield and quality traits. Jalota et al. (2010) reported that wheat sown in early November achieved the highest grain yield compared to other sowing dates. Similarly, Seleiman et al. (2011) found that sowing wheat on November 15 resulted in superior growth, yield components and grain quality traits. Additionally, Ahmed and Hassan (2011) noted that appropriate sowing dates could mitigate reduced germination and vegetative growth caused by metabolic imbalances due to low temperatures during the growing season. Abdel-Nour and Hayam (2011) reported that the optimum planting date significantly outperformed both early and late planting dates across all analyzed traits, including days to heading and maturity, plant height, number of spikes per square meter, number of kernels per spike, 1,000-kernel weight, biological yield and grain yield. Wheat tends to grow more rapidly at temperatures exceeding the optimal range. The genotypic response of wheat to planting dates varies due to differences in genetic potential, which influence yield-contributing traits. The importance of bread-making quality has become more prominent in recent years. As a result, plant breeders prioritize developing high-yielding wheat varieties that produce high-quality bread and respond effectively to modern agricultural techniques. Evaluating the quality of wheat for baking involves several tests, such as protein concentration, gluten index, hardness index, water absorption, sedimentation value and falling number (Kurt-Polat and Yagdi, 2017; Doneva et al., 2018). Among these, protein content plays a central role in determining the bread-making quality of wheat (Laidig et al., 2017). Numerous studies have highlighted the critical role of protein, which is considered the most important component of the wheat kernel. Kernel protein concentration varies widely among wheat cultivars, typically ranging from 8% to 17%, depending on genotype and environmental conditions (Koppel and Ingver, 2010). Therefore, the current study aims to determine how three sowing dates and their interactions influence the productivity and quantitative and qualitative traits of the wheat varieties Misr1 and Sids14 over two consecutive crop cycles. Additionally, the study seeks to assess how these traits impact the characteristics of pan bread made from each variety.

2. Materials and Methods

Experimental Design

Two field investigations were conducted during the 2018–2019 and 2019–2020 wheat growing seasons at Sids Agricultural Research Station (28.904348 Latitude, 30.947167 Longitude and an altitude of 12±71.78m with an accuracy of 8.5m) to evaluate the effects of three sowing dates—November 5 (D1), November 20 (D2) and December 5 (D3)—on the yield and quality traits of two spring wheat varieties (Misr1 and Sids14). A split-plot design with three replicates was employed, with wheat varieties assigned to the subplots and sowing dates to the main plots. Each plot consisted of six rows, spaced 20cm apart and measuring 3 m in length.

Yield and Yield Components

The following yield and yield component traits were measured:

- Number of spikes per square meter
- Number of kernels per spike
- 1,000-kernel weight (calculated by weighing 100 grains in triplicate and extrapolating to 1,000 grains, following ISTA, 1996)

Physical Characteristics of Wheat Grains

Prior to analysis, wheat grains were physically cleaned to remove foreign matter, broken grains, and immature grains. The following physical parameters were then assessed:

- 1,000-kernel weight: Determined as described above (ISTA, 1996).

- Hectoliter weight: Measured using standard methods from the AACC (2005). Kernel length and width were recorded according to Alami et al. (2007).

Color attributes

Grain color for both Misr1 and Sids14 was assessed using a hand-held chromameter (CR-400, Konica Minolta, Japan) in accordance with McGuire (1992). The results were expressed in terms of L* (lightness), a* (redness-greenness) and b* (yellowness-blueness).

Milling of Wheat Grains

Wheat grains were cleaned and adjusted to a moisture content of approximately 14%. Milling was performed using the Quadrumat Senior Laboratory Mill, producing wheat flour with a 72% extraction rate, as described by AACC (2005). The resulting flour was used to prepare pan bread for further analysis.

Chemical Analysis

Whole wheat meals and pan bread samples from the various treatments were analyzed for the following: Crude protein, Crude fat, Ash. Crude fiber These analyses were performed according to AOAC (2010) procedures. Total hydrolysable carbohydrates were calculated by difference.

Mineral Content

The mineral composition of the wheat samples was assessed using a PerkinElmer atomic absorption spectrophotometer (Agilent Technologies 4210 MP-AES), following AOAC (2010) guidelines. The measured minerals included:

- Micro-elements: Iron (Fe) and zinc (Zn)
- Macro-elements: Calcium (Ca), potassium (K), sodium (Na), phosphorus (P) and magnesium (Mg)

Gluten Quality

The wet gluten, dry gluten and gluten index of the investigated wheat flours were determined using Glutomatic Perten instruments (AB model 2200 No. 005092, Huddinge, Sweden), following the methods outlined by AACC (2008).

Preparation of Pan Bread

A straight-dough bread-making process was carried out according to AACC (2002). The basic dough formula included: Wheat flour (100g, 72% extraction), Salt (1g), Dry yeast (4g), Sugar (4g), Bread improver (0.1g), Olive oil (10g).

Medicinal and aromatic plants were incorporated at a level of 2%. The dough was divided into 125g portions and placed in a fermentation cabinet at 37°C and 80–85% relative humidity for 20 minutes. Following this, the dough underwent an additional 30 minutes of fermentation in a controlled environment. Baking was performed in an electric oven at 240°C for 20 minutes. The baked loaves were removed from their pans and allowed to cool at room temperature.

Physical Measurements of Pan Bread

After 1 hour of cooling, the weight (g) and volume (cm^3) of bread loaves were measured using the rapeseed displacement method, as recommended by AACC (2002). The specific volume (cm^3/g) was calculated by dividing the volume by the weight. Bread density (g/cm^3) was determined by dividing the weight by the volume.

Pan Bread Texture Profile Analysis (TPA)

Texture profile analysis was performed using a universal testing device (Conetech, B type, Taiwan) equipped with appropriate software, as described by Bourne (2003). A TPA double-compression test was conducted using a cylindrical aluminum probe (25 mm diameter) to compress the bread samples to 50% of their depth at a speed of 1mm/s. Parameters measured included: Hardness (N), Adhesiveness (mJ), Resilience, Cohesiveness, Springiness (mm), Gumminess (N), Chewiness (mJ).

Sensory Evaluation of Pan Bread

Sensory evaluation of the pan bread was conducted by a panel of ten trained evaluators from the Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. The samples were evaluated based on the following attributes:

- Crust color (10 points)
- Crumb color (20 points)
- Taste (15 points)
- Odor (15 points)
- Texture (20 points)

General appearance (20 points) The overall acceptability score for each sample was calculated by summing the individual scores, following the method described by Yousif et al. (2020).

Statistical analysis

All data were presented as means±standard deviation, with each sample analyzed in triplicate. Statistical analysis was conducted using the Statistical Analysis System (SAS) software for Windows (Statistical Analysis System, 2008). Analysis of variance (ANOVA) was used to evaluate differences among mean values, with the least significant difference (LSD) test applied at a significance threshold of $p \leq 0.05$.

3. Results and Discussion

In the two successive seasons, 2018–2019 and 2019–2020, the wheat varieties Misr1 and Sids14 were cultivated under three distinct sowing dates: 5/11 (D1), 20/11 (D2) and 5/12 (D3). The results in Tables 1 and 2 illustrate the impact of these sowing dates on grain yield and yield components, including the number of spikes per square meter (spikes/m²), number of kernels per spike (kernels/spike), 1000-kernel weight and grain yield per plot.

Number of Spikes per Square Meter

Table 1 demonstrates that the second sowing date (D2) produced significantly higher spike counts compared to D1 and D3 in both seasons. The values recorded were 401spikes/m² and 425spikes/m² for D2 in the first and second seasons, respectively. Similarly, Table 2 confirms that Misr1 and Sids14 under D2 produced 395spikes/m² and 407 spikes/m², respectively, in the first season. In the second season, D2 values increased to 420spikes/m² for Misr1 and 430spikes/m² for Sids14. Across varieties, Sids14 consistently showed significantly higher spike counts compared to Misr1 under all sowing dates (D1, D2 and D3) in both seasons, as shown in Table 1.

Number of Kernels per Spike

For the number of kernels per spike, Table 1 shows that D2 consistently resulted in significantly higher values compared to D1 and D3. The recorded values were 72.73kernels/spike in the first season and 77.20kernels/spike in the second season. However, the investigation across varieties revealed no significant differences between Misr1 and Sids14. Furthermore, the interaction between variety and sowing date reduced the significance of differences between treatments, particularly between D1 and D2, as presented in Table 2.

1000-Kernel Weight

Table 1 indicates significant differences in 1000-kernel weight across sowing dates, with D1 yielding the highest values of 56.89g and 61.15g in the first and second seasons, respectively. Across varieties, Misr1 demonstrated significantly higher kernel weights compared to Sids14 in both seasons. Misr1 achieved 56.97g and 60.43g in the first and second seasons, respectively, compared to 48.58g and 52.99g for Sids14 in the same periods. The interaction between variety and sowing date also influenced 1000-kernel weight. Misr1 exhibited the highest 1000-kernel weight under D2, recording 60.73g in the first season and 64.93g in the second season, as shown in Table 2.

Many studies have demonstrated the interaction between wheat varieties and sowing dates on yield measurements. Due to differing genetic potentials, the genotypic response of wheat to sowing dates varies significantly for yield-contributing traits (Wahid et al., 2017). Recording 60.73g in the first season and 64.93g in the second season, as shown in Table 2. Many studies have demonstrated the interaction between wheat varieties and sowing dates on yield measurements. Due to differing genetic potentials, the genotypic response of wheat to sowing dates varies significantly for yield-contributing traits (Wahid et al., 2017).

Table 1. Mean values of the number of spike/m^2, number of kernel/spikes, 1000-kernel weight (g) and grain yield/plot (kg), for each of Misr1 and Sids14 variety, as affected by different sowing dates

Characters Treatments	Number of spike/m^2		Number of kernel/ spikes		1000- Kernel weight (g)		grain yield/plot (kg)	
	2018-2019	2019-2020	2018-2019	2019-2020	2018-2019	2019-2020	2018-2019	2019-2020
Sowing date (D)								
D1	383^b±0.50	412^b±2.78	69.83^b±1.06	74.10^b±1.98	56.89^a±1.33	61.15^a±1.55	5.70^a±0.41	6.45^a±0.43
D2	401^a±2.78	425^a±2..78	72.73^a±0.46	77.20^a±0.56	53.09^b±1.24	57.29^b±1.41	5.68^a±0.44	6.40^a±0.51
D3	384^b±2.29	406^c±1.32	59.63^c±1.60	64.27^c±1.53	48.36^c±0.39	51.69^c±1.64	5.01^a±0.38	5.65^a±0.43
LSD(0.05%)	4.198	4.791	2.279	2.961	2.144	3.071	0.815	0.912
Varieties								
Misr1	384^a±2.65	409^b±1	68.38^a±0.51	72.53^a±1.28	56.97^a±0.60	60.43^a±1.67	5.48^a±0.51	6.23^a±0.35
Sids14	394^b±0.58	419^a±0.67	66.42^a±1.54	71.18^a±0.56	48.58^b±1.46	52.99^b±1.42	5.44^a±0.34	6.10^a±0.55
LSD (0.05%)	4.341	1.93	2.59	2.241	2.53	3.51	0.97	1.096

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12).

Table 2. Impact of interactions between each of Misr1 and Sids14 variety and different sowing dates on the number of spike/m^2, number of kernel/spikes, 1000-kernel weight (g) and grain yield/plot (kg)

Characters Treatments		Number of spike/m^2		Number of kernel/ spikes		1000- Kernel weight (g)		grain yield/plot (kg)	
		2018-2019	2019-2020	2018-2019	2019-2020	2018-2019	2019-2020	2018-2019	2019-2020
D1	Misr1	380^e±2.00	405^c±2.65	67.33^c±1.27	71.87^{cd}±1.61	55.09^b±2.01	58.81^b±1.41	5.39^a±0.51	6.14^a±0.41
	Sids14	385^d±3.00	419^b±3.00	72.33^{ab}±1.11	76.33^{ab}±3.29	58.68^a±1.28	63.49^a±2.12	6.00^a±0.20	6.75^a±0.48
D2	Misr1	395^b±3.61	420^b±2.65	70.73^b±0.81	74.87^{bc}±1.62	60.73^a±0.81	64.93^a±1.55	5.58^a±0.62	6.33^a±0.49
	Sids14	407^a±2,00	430^a±3.00	74.73^a±1.46	79.53^a±1.76	45.44^c±1.75	49.64^c±1.17	5.77^a±0.40	6.47^a±0.67
D3	Misr1	378^e±2.65	403^c±3.00	67.07^c±1.19	70.87^d±1.59	55.08^b±1.07	57.54^b±2.12	5.46^a±0.35	6.21^a±0.52
	Sids14	390^c±2.65	408^c±2.00	52.20^d±2.05	57.67^e±1.57	41.63^d±1.89	45.83^d±1.31	4.56^b±0.41	5.09^b±0.70
LSD (0.05%)		4.82	4.87	2.43	3.57	2.73	2.95	0.77	0.99

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12).

Grain Yield per Plot

Regarding grain yield per plot, D2 sowing date produced slightly higher values for Misr1 in both cultivation seasons, though the differences were not statistically significant. Misr1 recorded 5.58kg and 6.33kg in the first and second seasons, respectively. Conversely, for Sids14, D1 sowing date showed marginally higher values compared to D2 and D3, with yields of 6.00kg and 6.75kg in the first and second seasons, respectively. Overall, Sids14 exhibited a slight, though statistically insignificant, advantage over Misr1 in terms of yield per plot for D1 and D2 sowing dates across both seasons.

Supporting Studies on Sowing Dates

Bachhao et al. (2018) examined the effects of sowing dates on various wheat varieties and found that sowing during the first week of December optimized growth, yield and yield characteristics for the Tapowan variety, which achieved the highest grain yield among the tested varieties. Similarly, Verma (2015) observed that wheat sown on November 11th had superior spike length, grains per spike and grain test weight compared to those sown on December 6th.

Regional and Climatic Impacts

Research indicates that applying the ideal sowing date enhances crop output and mitigates adverse weather impacts. In North Egypt, the optimal sowing window is between November 15th and 30th, whereas in South Egypt, sowing is generally conducted in the first two weeks of November. However, the most favorable period across Egypt is November 5th to 25th. Deviating from these dates can result in yield losses due to high temperatures in South Egypt and moderate temperatures in North Egypt (Hassanein et al., 2012).

Impact of Sowing Dates on Grain Quality and Heat Stress

Singh et al. (2018) emphasized that sowing time and variety selection are critical determinants of wheat productivity. Late-sown wheat is exposed to high temperatures during reproductive development, which negatively affects macro- and microsporogenesis, ultimately reducing grain yield. Torbica and Mastilović (2008) highlighted that extreme temperatures (35–40°C) during grain filling significantly hinder dry matter and protein accumulation in the plant. These high temperatures impair the formation of protein aggregates necessary for positive dough mixing properties. However, heat shock occurring late in the grain-filling stage may not significantly affect grain yield or protein concentration.

Physical and Milling Properties of Wheat Grains

Table 3 presents the physical and milling characteristics of wheat grains across the investigated sowing dates. Results indicate that Misr1 (D2) and Sids14 (D1) recorded the highest hectoliter weights, with values of 82.76kg/hl and 84.00kg/hl, respectively. Hectoliter weight is a primary determinant of wheat grain quality and a key predictor of potential flour yield, as recognized by the milling industry (Mut et al., 2010). These findings suggest that the optimal sowing dates for hectoliter weight are D2 for Misr1 and D1 for Sids14. Regarding grain dimensions, the length-to-width (L/W) ratio was highest for Misr1 (D2) at 2.20, while Sids14 (D3) achieved a maximum value of 1.73.

Color Attributes

The color parameter (L*, lightness) reached its peak for Misr1 (D2) and Sids14 (D3), with values of 59.02 and 62.25, respectively. Additionally, Misr1 (D2) showed the highest values for redness (a*, 8.19) and yellowness (b*, 31.13), indicating superior visual quality compared to other treatments.

Table 3. Physical properties of each of Misr1 and Sids14 variety, for the different investigated sowing dates

Sample	Hectoliter weight (kg/hl)	L/W ratio	Color of wheat grain			Milling properties		
			L*	a*	b*	Wheat flour (%)	Shorts (%)	Bran (%)
Misr1								
D1	81.27^{c}±0.306	2.11^{a}±0.185	57.59^{b}±1.735	7.55^{a} ±0.212	29.96^{a}±0.180	62.40^{d}±0.475	25.52^{bc} ±0.347	10.14^{ab}±0.605
D2	82.76^{b}±0.318	2.20^{a}±0.265	59.02^{ab}±1.270	8.19^{a} ±0.689	31.13^{a}±0.040	63.40^{cd}±0.458	25.82^{b}±0.249	9.92^{b}±0.528
D3	80.49^{d}±0.196	1.93^{ab}±0.112	58.11^{b}±0.555	7.32^{a} ±0.499	30.26^{a}±0.806	60.64^{c}±0.668	28.08^{a}±0.741	11.02^{a}±0.758
Sids14								
D1	84.00^{a}±0.200	1.41^{d}±0.793	59.75^{ab}±2.686	7.99^{a}±0.563	30.38^{a}±1.122	67.78^{a}±0.625	24.68^{cd}±0.485	7.50^{d}±0.448
D2	82.99^{b}±0.185	1.60^{cd}±0.100	60.54^{ab}±2.854	7.56^{a}±0.603	29.57^{a}±1.327	64.58^{b}±0.558	23.88^{d}±0.679	8.84^{c}±0.471
D3	80.87^{cd}±0.200	1.73^{bc}±0.113	62.25^{a}±2.333	7.11^{a}±0.112	29.71^{a}±1.163	64.00^{bc}±0.859	24.84^{c}±0.225	8.40^{cd}±0.502
LSD (at 0.05)	0.428	0.2775	3.6840	1.1960	1.6330	1.1070	0.8830	0.9995

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12)

Milling Yield

Flour yield (72% extraction) was also maximized for Misr1 (D2) and Sids14 (D1), achieving values of 63.40% and 67.78%, respectively. These results underscore the importance of sowing date in optimizing milling quality, with D2 being ideal for Misr1 and D1 for Sids14. Sohrabi et al. (2010) highlighted that wheat production and grain quality are heavily influenced by both genetic inheritance and agronomic practices, particularly sowing date. This study's findings align with this perspective, emphasizing the critical role of optimized sowing dates in achieving superior physical and milling properties for different wheat varieties.

Chemical composition of the investigated wheat grains

The chemical compositions of Misr1 and Sids14 wheat grains, for the different investigated sowing dates, are presented in Table 4. No significant differences were found in the mean values of moisture, fat, fiber, ash, and hydrolysable carbohydrate content for whole meals of both varieties. Misr1 exhibited ranges of 1.68-1.79% for fat, 2.46-2.73% for fiber, 1.95-2.08% for ash, and 74.15-74.66% for hydrolysable carbohydrates. Sids14, on the other hand, showed ranges of 1.68-1.73% for fat, 2.04-

-2.19% for fiber, 1.79-2.04% for ash, and 74.21-74.64% for hydrolysable carbohydrates. Regarding protein levels, Misr1 (D2) and Sids14 (D3) displayed higher values (11.13% and 11.35%, respectively) compared to other sowing dates. These findings align with those of Jabran et al. (2020), who reported that grains typically contain 60-80% carbohydrates, 8-15% protein, 1.5-2.0% fat, and 1.5-2.0% inorganic ions and vitamins B-complex and E. Wheat's high protein, starch, and gluten content make it a versatile ingredient in various food industries. However, adverse weather conditions can significantly impact wheat crop quality. Several ecological factors, such as growing zone and environmental parameters, can substantially influence grain protein content and other quality attributes (Saeed et al., 2014). Wheat flour typically comprises 72% carbohydrates, 8-13% protein, 12-13% moisture, 1.5% fat, 2-3% fiber, and 1-2% ash (Verem et al., 2021).

Table 4. Chemical contents of each of Misr1 and Sids14 variety, for the different investigated sowing dates (%)

Sample	Moisture	Protein	Fat	Fiber	Ash	Hydrolysable carbohydrate
Misr1						
D1	8.69^{a}±0.115	10.40^{b}±0.315	1.71^{a}±0.236	2.46 ^{a}±0.135	2.08^{a}±0.192	74.66^{a}±0.219
D2	8.53^{a}±0.295	11.13^{a}±0.556	1.68^{a}±0.285	2.56 ^{a}±0.175	1.95^{a}±0.204	74.15^{a}±0.482
D3	8.44^{a}±0.335	10.44^{b}±0.180	1.79^{a}±0.128	2.73 ^{a}±0.335	1.96^{a}±0.135	74.64^{a}±0.902
Sids14						
D1	8.78^{a}±0.593	10.91^{ab}±0.115	1.69^{a}±0.223	2.19 ^{a}±0.076	1.79^{a}±0.130	74.64^{a}±0.745
D2	8.57^{a}±0.534	11.25^{a}±0.275	1.73^{a}±0.252	2.15 ^{a}±0.110	2.01^{a}±0.131	74.29^{a}±1069.
D3	8.68^{a}±0.388	11.35^{a}±0.085	1.68^{a}±0.221	2.04 ^{a}±1.031	2.04^{a}±0.239	74.21^{a}±0.865
LSD (at 0.05)	0.726	0.533	0.408	0.8096	0.315	1.367

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12).

Mineral content investigation

Table 5 presents the mineral content of Misr1 and Sids14 wheat grain samples for different sowing dates. Compared to other sowing dates, Misr1 (D3) and Sids14 (D2) exhibited higher Ca and Fe concentrations. However, Misr1 displayed greater K, Mg, and P concentrations on D2 and higher Mn content on D1. Additionally, Sids14 (D1) showed higher K, Mn, Na, and P levels compared to other sowing dates.

Gluten quality investigation

It is well-known that gluten quantity and quality are crucial factors determining wheat's baking quality and flour strength. In industrial applications, both protein concentration and gluten quality significantly impact bread baking quality (Ferrari et al., 2014). Sivam et al. (2010) reported that the gluten index, ranging from 75 to 95%, is a key indicator of flour quality and is associated with ideal bread baking quality for Central European cultivars. Table 6 presents the effects of different sowing dates on gluten quality parameters (wet gluten, dry gluten, and gluten index) of 72% extraction rate wheat flour for both Misr1 and Sids14 varieties. Wet gluten levels for all sowing date samples ranged from 27.52 to 34.67%. Misr1 exhibited the highest dry gluten level on D2 (12.83%), followed by D1 and D3 (11.31 and 10.30%, respectively). Sids14, on the other hand, showed the highest gluten index on D1 (87.21%), followed by D3 and D2 (84.60 and 81.72%, respectively). Misr 1 (D1) recorded the highest gluten index (98.32%), followed by D2 and D3 (97.10 and 96.93%, respectively). Late-sown crops, with higher protein content, wet gluten, and dry gluten, tend to have increased water uptake and dough stability time (Ali et al., 2020 and Atique-ur-Rehman et al. 2020). This trend is consistent with both common wheat and durum wheat genotypes, where wet gluten, dry gluten, and gluten index tend to increase (Sissons et al., 2018).

One potential reason for this is an increase in the production of gliadin-like heat shock components, which can lower the glutenin to gliadin ratio and consequently reduce the gluten index (Li et al., 2018).

Table 5. Mineral contents of each of Misr1 and Sids14 variety, for the different investigated sowing dates (mg/100g)

Samples	Zn	K	Mg	Mn	Na	Ca	P	Fe
				Misr1				
D1	3.89	349.56	156.15	3.51	17.91	66.27	140.96	4.64
D2	4.25	379.18	170.99	3.18	10.97	69.13	152.15	4.44
D3	5.71	357.53	138.37	3.06	29.22	95.46	146.94	5.03
				Sids14				
D1	3.91	368.32	210.25	3.35	26.15	92.04	173.91	4.69
D2	4.38	329.57	139.66	3.18	20.49	98.91	160.65	4.97
D3	4.70	336.91	129.41	3.14	11.73	80.29	145.94	4.75

D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12).

Table 6. Wet gluten, dry gluten and gluten index (%), for wheat flours (72% extraction) of each of Misr1 and Sids14 variety, for the different investigated sowing dates (%)

Sample	Wet gluten(%)	Dry gluten(%)	Gluten index(%)
		Misr1	
D1	$32.96^{b}\pm0.951$	$11.31^{abc}\pm0.789$	$98.32^{a}\pm1.489$
D2	$34.67^{a}\pm0.520$	$12.83^{a}\pm0.639$	$97.10^{a}\pm0.926$
D3	$30.48^{c}\pm0.496$	$10.30^{bc}\pm1.370$	$96.93^{a}\pm0.719$
		Sids14	
D1	$34.29^{ab}\pm0.626$	$12.25^{ab}\pm0.557$	$87.21^{b}\pm1.473$
D2	$31.50^{c}\pm0.644$	$11.22^{abc}\pm1.572$	$81.72^{d}\pm0.653$
D3	$27.52^{d}\pm1.213$	$10.11^{c}\pm1.029$	$84.60^{c}\pm1.093$
LSD (at 0.05)	1.396	1.887	1.973

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12).

Sensory evaluation of the investigated pan bread samples

Table 7 presents the sensory evaluation results for pan bread samples made from 72% extraction wheat flours of Misr1 and Sids14 varieties for different sowing dates. Sensory evaluation is a crucial test to assess consumer acceptability based on organoleptic attributes such as texture, crumb color, crust color, odor, taste, appearance, and overall acceptability. The control pan bread sample scored the highest among all samples. While odor and taste are key factors for both manufacturers and consumers, volume, texture, and appearance are also critical bread quality characteristics (Hussien et al., 2022). No significant differences were observed in bread appearance, crust color, odor, and taste among the different pan bread samples. For Misr1, the highest crumb color value was recorded for D2 (18.43). Sids14, on the other hand, showed significantly higher crumb color values for D1 and D2 (18.64 and 18.07, respectively). Sids14 (D2) also exhibited the lowest crust color value (8.64). No significant differences were observed in taste and odor parameters for all pan bread samples compared to the control sample. Misr1 (D2) scored the highest for taste (14.00).

In terms of overall acceptability, Misr1 (D2) and Sids14 (D2) scored 93.00 and 90.78, respectively, compared to the control pan bread sample (97.00). Wheat flours of Misr1 and Sids14, on D2 sowing date could be recommended for producing pan breads of high overall acceptability to consumer.

Texture Profile Analysis

In terms of hardness, springiness, cohesiveness and chewiness, bread crumbs' texture profile can be summed up. Hardness is a critical element of texture profile, since it is closely tied to how people perceive the freshness of their bread (Onyango et al., 2010). The amylose and amylopectin matrix, which affect the texture of the bread overall, are primarily responsible for its hardness (Schiraldi and Fessas, 2000). Furthermore, Gomez et al. (2003) noted that interactions between gluten and fibrous substances contributed to the hardness of bread. The findings of the Texture Profile Analysis (TPA) in Table 8. showed that sowing date had a substantial impact on the textural characteristics of the produced pan bread loaves, as samples of Misr1 (D1) and Sids14 (D1) recorded the highest hardness values (16.48 and 17.79N, respectively). According to Feili et al. (2013), the combination of gluten and fiber components is what makes bread hard. Elasticity can be used to gauge how much breadcrumbs decompress after being compressed. It is the elastic quality of breadcrumbs. The flexibility of the bread can also be used to gauge how stale it is (Tian et al., 2009). Moreover, there were no significant differences, for cohesiveness among pan bread samples. The maximum gumminess values were found for Misr1 (D1) and Sids14 (D3), (11.21 and 9.24N, respectively). Pan bread samples from Misr1 and Sids14 cultivated on the D1 sowing date exhibited higher chewiness ratings, measured at 58.70mJ and 51.00mJ, respectively.

Chewiness, a key textural property closely associated with sensory analysis (Gomez et al., 2007), is determined by the interaction between gelatinized starch and gluten within the dough. This interaction is essential for imparting elasticity and forming the sponge-like structure characteristic of bread during baking (Hoseney, 1994). However, a reduction in elasticity may occur when gluten is diluted, resulting in a decreased capacity for gas retention in the bread. The physical properties of bread are critical as they significantly influence consumer perceptions of freshness and eating satisfaction. A high loaf-specific volume (bread volume per gram of bread) is widely regarded as a hallmark of good-quality bread (Sahi et al., 2014). Table 9 outlines the physical characteristics of the pan bread samples, including loaf weight, loaf volume, loaf-specific volume, and density. The findings revealed significant differences in loaf weight among the samples, with values ranging from 146.5 to 170.17g. Notably, loaf volume was highest in pan bread samples made from Misr1 (D2) and Sids14 (D1), reaching 350cm³ and 320cm³, respectively, when compared to samples from other sowing dates for each variety. In terms of specific volume, the control sample and Misr1 (D2) pan bread demonstrated the highest values, at 2.32cm³/g and 2.06cm³/g, respectively, outperforming the other samples. Conversely, the density values of the pan bread samples were higher than that of the control sample (0.43g/cm³). Among the investigated samples, Misr1 (D2) pan bread had the lowest density value (0.485g/cm³), while Sids14 (D3) exhibited the highest density value (0.545g/cm³). The relationship between specific volume and density is inverse, as a lower specific volume corresponds to denser crumbs and impacts bread texture.

This trend was evident in the data, with all samples showing smaller loaf-specific volumes compared to the control. This pattern aligns with previous studies (Mannonmani et al., 2014; Bhol and Bosco, 2014). These results emphasize the interplay between sowing dates, variety, and bread quality parameters, underscoring the importance of selecting optimal conditions for achieving desirable physical properties in pan bread.

Table 7. Sensory evaluation of pan bread samples made from wheat flours (72% extraction) of each of Mirs1 and Sids14 variety, for the different investigated sowing dates

Samples	Texture(20)	Crumb color (20)	Crust color (10)	Odor(15)	Taste(15)	Appearance (20)	Overall acceptability (100)
Control	19.43^{a}±0.787	19.57^{a}±0.787	9.71^{a}±0.480	14.43^{a}±0.78	14.43^{a}±0.787	19.43^{a}±0.787	97.00^{a}±3.790
Misr1							
D1	18.14^{a}±1.464	17.79^{b}±1.630	8.79^{a}±1.075	13.86^{a}±0.899	13.43^{a}±0.976	18.50^{a}±1.440	90.50^{a}±5.937
D2	18.57^{a}±1.134	18.43^{ab}±1.134	9.14^{a}±0.899	14.14^{a}±0.899	14.00^{a}±1.528	18.86^{a}±1.069	93.00^{a}±5.033
D3	17.70^{a}±1.799	17.79^{b}±1.520	9.07^{a}±0.732	14.00^{a}±0.817	13.71^{a}±1.380	18.14^{a}±1.215	90.42^{a}±5.680
Sids14							
D1	17.71^{a}±1.889	18.64^{ab}±0.940	8.79^{a}±1.075	13.71^{a}±1.110	13.57^{a}±1.512	18.36^{a}±1.750	90.70^{a}±8.546
D2	17.86^{a}±2.120	18.07^{ab}±1.430	8.64^{a}±1.110	14.29^{a}±0.951	13.71^{a}±0.756	18.36^{a}±1.180	90.78^{a}±6.695
D3	17.86^{a}±2.152	17.57^{b}±1.510	8.86^{a}±0.899	13.86^{a}±1.070	13.57^{a}±1.272	18.36^{a}±1.180	89.85^{a}±5.872
LSD (at 0.05)	1.821	1.418	0.9927	1.014	1.308	1.362	6.567

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11),

Table 8. Texture Profile Analysis (TPA) of pan bread samples, made from wheat flours (72% extraction) of each of Misr1 and Sids14 variety, for the different investigated sowing dates

Sample	Hardness cycle 1(N)	Adhesiveness (mJ)	Resilience	Hardness cycle 2(N)	Cohesiveness	Springiness (mm)	Gumminess (N)	Chewiness (mJ)
Control	18.53^{a}±0.380	0.20^{c}±0.027	0.18^{a}±0.046	15.62^{a}±0.490	0.51^{a}±0.233	5.35^{a}±0.498	9.42^{b}±0.439	50.40^{b}±0.540
Misr1								
D1	16.48^{c} ±0.432	0.20^{c} ±0.046	0.27^{a} ±0.030	14.62^{b} ±0.342	0.68^{a} ±0.115	5.23^{a} ±0.565	11.21^{a} ±0.646	58.70^{a} ±0.737
D2	15.75^{c} ±0.439	0.10^{cd} ±0.052	0.22^{a} ±0.061	13.58^{c} ±0.416	0.55^{a} ±0.089	4.75^{a} ±0.399	8.70^{cd} ±0.557	41.30^{c} ±1.369
D3	13.85^{d} ±0.544	0.04^{d} ±0.490	0.25^{a} ±0.044	11.75^{d} ±0.466	0.58^{a} ±0.110^{a}	4.85^{a} ±0.641	7.89^{cd} ±0.678	38.70^{d} ±0.973
Sids14								
D1	17.79^{ab} ±0.688	0.40^{b} ±0.061	0.21^{a} ±0.052	14.91^{ab} ±0.498	0.51^{a} ±0.040	5.66^{a} ±0.594	9.01^{bc} ±0.406	51.00^{b} ±0.976
D2	14.16^{d} ±0.692	0.50^{a} ±0.610	0.21^{a} ±0.061	11.91^{d} ±0.703	0.53^{a} ±0.111	4.66^{a} ±0.477	7.45^{d} ±1.306	34.70^{e} ±1.124
D3	17.52^{d} ±0.449	0.10^{cd} ±0.790	0.22 ^{a}±0.091	15.15^{ab} ±0.528	0.53^{a} ±0.122	5.46^{a} ±0.459	9.24^{bc} ±0.614	50.50^{b} ±1.209
LSD (at 0.05)	0.930	0.097	0.091	0.880	0.229	0.919	1.260	1.792

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by

Table 9. Physical properties of pan bread samples, made from wheat flours (72%extraction) of each of Misr1 and Sids14 variety, for the different investigated sowing dates

Samples	Loaf weight (g)	Loaf volume (cm^3)	Loaf-specific volume (cm^3/g)	Density (g/cm^3)
Control	146.50^{d}±1.280	340.00^{ab}±10.000	2.32^{a}±0.057	0.431^{c}±0.010
Misr1				
D1	165.67^{c}±1.420	310.00^{c}±10.000	1.87^{c}±0.072	0.534^{a}±0.210
D2	169.90^{ab}±1.350	350.00^{a}±10.000	2.06^{b}±0.061	0.485^{b}±0.015
D3	170.17^{a}±2.050	316.67^{bc}±11.550	1.86^{c}±0.093	0.537^{a}±0.023
Sids14				
D1	166.13^{c}±1.520	320.00^{bc}±10.000	1.93^{bc}±0.076	0.519^{ab}±0.020
D2	165.27^{bc}±1.640	306.67^{c}±20.820	1.86^{c}±0.127	0.539^{a}±0.035
D3	165.23^{c}±1.320	303.33^{c}±15.280	1.84^{c}±0.107	0.545^{a}±0.310
LSD (at 0.05)	2.6820	22.9290	0.1539	0.0412

Chemical composition of the investigated pan bread samples

Table 10 presents the proximate chemical composition of pan bread samples prepared from wheat grown on different sowing dates. The results revealed variations in the chemical composition, particularly in protein, fiber and carbohydrate content. The protein content was higher in pan bread samples made from Misr1 (D2) and Sids14 (D2), with values of 11.59% and 11.92%, respectively. Protein content is a critical factor influencing bread quality, as high protein levels are associated with improved bread-making properties (Horvat et al., 2015). The mean values for fat and ash did not show significant differences across the samples. However, fiber content was higher in pan bread samples from Misr1 (D2) and Sids14 (D1), with values of 0.59% and 0.57%, respectively. Increased fiber content in bread is beneficial for nutritional value and consumer health. Additionally, pan bread samples from Misr1 (D1) and Sids14 (D3) had higher levels of hydrolyzable carbohydrates, measured at 76.87% and 77.62%, respectively. Hydrolyzable carbohydrates contribute significantly to the caloric value and texture of bread, influencing its consumer acceptability. Bread, as one of the most widely consumed food items globally, holds cultural and nutritional significance. The art of bread-making represents one of the earliest known food technologies and remains a cornerstone of many nations' diets (Selomulyo and Zhou, 2007). Protein content, in particular, continues to be a critical marker of bread -making quality, as demonstrated in this study. These findings highlight the impact of sowing dates on the chemical composition of wheat-based pan bread and underscore the importance of selecting optimal agricultural practices to enhance bread quality.

Table 10. Chemical composition of pan bread samples, made from wheat flours (72% extraction) of each of Misr1 and Sids14 variety, for the different investigated sowing dates (%)

Samples	Moisture	Protein	Fat	Fiber	Ash	Hydrolysable Carbohydrate
Control	$6.27^{c} \pm 0.462$	$9.83^{d} \pm 0.469$	$4.23^{a} \pm 0.468$	$0.63^{a} \pm 0.026$	$1.43^{a} \pm 0.175$	$77.61^{a} \pm 0.658$
Misr 1						
D1	$7.13^{ab} \pm 0.262$	$10.06^{cd} \pm 0.424$	$4.04^{a} \pm 0,637$	$0.46^{c} \pm 0.035$	$1.44^{a} \pm 0.165$	$76.87^{ab} \pm 1.552$
D2	$6.30^{c} \pm 0.265$	$11.59^{a} \pm 0.408$	$4.17^{a} \pm 0.389$	$0.59^{ab} \pm 0.072$	1.53a ±0.090	$75.82^{ab} \pm 0.803$
D3	$7.39^{a} \pm 0.372$	$10.69^{bc} \pm 0.420$	$4.06^{a} \pm 0.390$	$0.55^{ab} \pm 0.026$	$1.54^{a} \pm 0.131$	$75.77^{ab} \pm 1.549$
Sids14						
D1	$6.59^{bc} \pm 0.310$	$11.33^{ab} \pm 0.340$	$4.15^{a} \pm 0.282$	$0.57^{ab} \pm 0.040$	$1.32^{a} \pm 0.121$	$76.04^{ab} \pm 1.128$
D2	$7.25^{a} \pm 0.322$	$11.92^{a} \pm 0.448$	$4.06^{a} \pm 0.313$	$0.54^{b} \pm 0.036$	$1.46^{a} \pm 0.173$	$74.77^{b} \pm 1.025$
D3	$6.20^{c} \pm 0.361$	$10.28^{cd} \pm 0.420$	$4.07^{a} \pm 0.382$	$0.51^{bc} \pm 0.044$	$1.32^{a} \pm 0.139$	$77.62^{a} \pm 0.827$
LSD (at 0.05)	0.599	0.736	0.741	0.074	0.253	1.974

Values are means followed by ±SD, number in the same column followed by the same letter are not significantly different, while followed by different letters are significantly different, D1 = first sowing date (5/11), D2 = second sowing date (20/11), D3 = third sowing date (5/12)

4. Conclusion

The experiment's findings demonstrated that the D2 sowing date (20th of November) yielded the best results for the Misr1 variety, while the D1 sowing date (5th of November) was optimal for the Sids14 variety. Therefore, it is recommended to plant Misr1 on the D2 sowing date and Sids14 on the D1 sowing date, as the majority of quality indicators for each variety showed highly significant positive correlations with these respective sowing dates. Additionally, the results for the D2 sowing date for Sids14 showed a high-quality performance in terms of grain yield per plot, protein content in wheat grains, and the quality of the pan bread produced. Notably, these quality indicators were not significantly different from those observed for the D1 sowing date. For Sids14, no significant differences were found between the results of D1 and D2 for key pan bread parameters such as overall organoleptic acceptability and loaf-specific volume. These findings underscore the importance of selecting the appropriate sowing date to optimize the quality and quantity of wheat cultivars. By aligning sowing dates with the specific requirements of each variety, it is possible to enhance both the agricultural and quality outcomes of wheat production.

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