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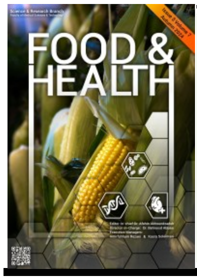

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Journal

Impact of Nepeta crispa (Moffarrah) Powder on Sponge Cake: A Comprehensive Study of Physicochemical, Microbial and Sensory Attributes

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A B S T R A C T

This study aimed to investigate the use of Moffarrah powder (MP) as a natural alternative to synthetic cake preservatives. To achieve this MP was added at concentrations of 0%, 5%, 10%, and 15% (w/w) as partial substitutes for wheat flour in the formulation of cake, while control samples were prepared with potassium sorbate as a preservative and without any preservatives. The evaluated parameters included moisture, protein, ash, gluten, and pH for flour; Acid-soluble ash, moisture, and pH for MP; specific gravity for dough; and moisture, acidity, pH, peroxide value, mold/yeast count, water activity, and sensory attributes for cake samples. The results demonstrated that the addition of MP reduced the dough's specific gravity. Compared to the control samples, cakes treated with MP exhibited a significant increase in ash content and water activity. Additionally, higher concentrations of MP resulted in a significant reduction in mold and yeast growth, along with an increase in acidity and a decrease in pH. Significant differences in sensory attributes were observed between the treated and control samples, with the cake sample containing 5% MP receiving the highest overall acceptance. However, as the concentration of MP increased to 15%, overall sensory desirability significantly declined.

1. Introduction

Presently, consumers are increasingly drawn to healthier food products. As a result, emerging food trends emphasize the mindful use of compounds, prioritizing the reduction of synthetic preservatives and favoring their replacement with natural alternatives (1). The Lamiaceae family encompasses around 220 genera and 3,300 species that are widely utilized for a variety of purposes worldwide. Plants in the Lamiaceae family are mostly rich in polyphenolic compounds, and a great number of them are widely recognized for their antioxidant capabilities. The genus Nepeta (Lamiaceae) comprises annual plants native to Asia, Europe, and parts of Africa. It includes over 250 species, among them, 67 species have been found in Iran, 53 of which are endemic. Nepeta crispa Willd's natural habitat is Alvand Mountain in the Hamadan Province. The locals call this species "Moffarrah," a name that translates to "that which uplifts and enlivens," reflecting its strong and pleasant fragrance (2). Species of the Nepeta genus are widely utilized in traditional medicine for their diverse therapeutic properties, including antispasmodic, expectorant, antiseptic, antitussive, diuretic, anti-asthmatic, and febrifuge effects. The species of the Nepeta genus are generally characterized by their chemical constituents, including 1,8-cineole and nepetalactone derivatives. Among these, 1,8-cineole is the predominant compound in *N. crispa*. However, nepetalactone derivatives are also present in notable quantities in this species (2, 3). The main challenges for the cake industry are chemical and microbial spoilage, which significantly reduces product shelf life (4). Among these, chemical spoilage primarily involves the oxidation of fats, leading to rancidity, off-flavors, and a decline in product quality (4, 5). One approach to addressing spoilage in bakery products is the use of chemical preservatives. Due to the identified health risks of chemical preservatives for consumers, extensive research in recent years has been devoted to exploring natural preservatives (6). The use of antioxidants is one of the most effective strategies for preventing oxidation and extending the shelf life of food products. Synthetic antioxidants, such as BHA, BHT, and TBHQ, are widely used in the food industry to prevent rancidity and maintain product quality. With the growing

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global demand for healthier foods, there is a greater need for natural alternatives that can stabilize high-fat flour products during storage while also providing nutritional value. Herbs, in particular, are emerging as a promising source of natural antioxidants due to their rich chemical composition (7). Natural antioxidants have the potential to prevent lipid peroxidation in foods, thereby enhancing their quality, stability, and safety. These compounds play a crucial role in maintaining the sensory and nutritional attributes of food products while extending their shelf life (5). Studies aim to identify safe and effective alternatives that preserve food quality and minimize potential health risks (6). Therefore, developing a novel cake formulation incorporating *N. crispa* could be highly beneficial. This study aimed to produce sponge cakes by incorporating 0%, 5%, 10%, and 15% *N. crispa* powder as a flour replacement in the cake formulation. The objectives were to assess the impact of *N. crispa* on the physicochemical, microbial, and sensory attributes of sponge cakes.

2. Materials and Methods

2.1. Flour mixtures

The raw materials used in preparing flour mixtures included wheat flour (WF) and Moffarrah, which were obtained from the high-altitude regions of Al-Shatar city. The Moffarrah was milled using an electric mill, and the resulting powder was sieved through a mesh with a size of 50.

2.2. Flour Analysis

The moisture content of the flour blends was analyzed following the procedure outlined in Iran National Standard No. 2705 (8). The ash content was measured by incinerating the samples at 525 ± 25°C, as specified in Iran National Standard No. 2706 (9). The total nitrogen (N) and crude protein content were determined using the Macro Kjeldahl Method, with a conversion factor of N×6.25, in accordance with Iran National Standard No. 19052 (10). Additionally, the pH of the flour sample was determined following Iran National Standard No. 37, and the gluten content was determined according to the Iran National Standards No. 9639-1 for wheat and wheat flour (11, 12).

2.3. Moffarrah powder analysis

The MP analysis, including moisture, acid-soluble ash, and pH, was determined according to Iran National Standard No. 183 (13).

2.4. Preparation and Formulation of Cake Samples

The cake samples were prepared following the standard formula of the Zarin Zafar Cake Factory adapted for laboratory-scale production. The preparation process began by mixing eggs, vanilla, and sugar with a grade 3 mixer for 3 minutes. Subsequently, water, salt, inverted syrup, and powdered milk were blended using a level 6 blender for an additional 3 minutes. Oil, cocoa powder, and chocolate essence were then incorporated into the mixture. Flour and baking powder were pre-mixed, sieved for aeration, and added in two stages. Initially, half of the flour mixture was combined with the batter and mixed for 1 minute at level 2 or 3. The remaining flour, including substituted flour in experimental samples, was then added and mixed for another minute at level 2. The prepared batter was evenly portioned into molds and baked in an electric oven at 180°C for 50 minutes. After baking, the cakes were cooled at room temperature for 1 hour to prevent moisture condensation during packaging.

Table 1 presents the experimental sample formulation. Two control samples were also prepared: one using the standard formulation without MP or potassium sorbate (P0) and another using potassium sorbate as a synthetic preservative (P4) for comparative analysis.

Table.1. Coding of experimental samples (per 100 g).

Compositions / Treatment	Treatment codes	Wheat flour	Moffarrah powder	Sugar	Soybean oil	egg	Baking powder	Vanilla powder	Milk	Cardamom extract	Potassium sorbate (ppm)
Control sample (without preservative)	P0	33.7	0	14.68	5.32	29.8	0.5	0	16	0	0
Cake with 5 % Moffarrah	P1	28	5	14.68	5.32	29.8	0.5	0.2	16	0.2	0
Cake with 10 % Moffarrah	P2	23	10	14.68	5.32	29.8	0.5	0.2	16	0.2	0
Cake with 15 % Moffarrah	P3	18	15	14.68	5.32	29.8	0.5	0.2	16	0.2	0
Control sample (with potassium sorbate	P4	33.7	0	14.68	5.32	29.8	0.5	0	16	0	500

2.5. Physicochemical Analysis of samples

The specific Gravity of the cake dough - to determine this parameter, equal volumes of cake batter and double-distilled water were weighed at the same temperature. The specific gravity of the cake batter was then calculated by dividing the weight of the cake batter by the weight of the double-distilled water (14).

The moisture content, water activity, ash content, peroxide value, and acidity of the cake samples were analyzed following the Iran National Standard Nos. 3493, 4179, and 103, respectively (15-17). The cake's specific volume was determined using the rape seed displacement method according to SR 91:2007, AACC 2000 (18, 19). Initially, the weight and density of a specific volume of rapeseed were determined. The cake sample and rapeseed were then placed together in a container of known dimensions and weighed. The cake volume was calculated using Equation 2.1, and the specific volume was obtained by dividing the cake volume by its weight.

Equation 2.1

Specific Volume = (Density of Rapeseed /((Weight of Container + Cake) - (Weight of Container + Rapeseed + Cake) - Weight of Full Rapeseed Container))

2.6. Sensory Analysis

Sensory evaluation (taste, odor, texture, and overall acceptance) was performed by a 5-point hedonic test. Five levels (excellent, good, average, poor, and very poor) were considered. Eight untrained panelists evaluated the samples. For evaluating each characteristic, score 5 was assigned to an excellent sample, and score 1 was assigned to a very poor sample (3).

To minimize bias, the samples were coded with three random letters to prevent any influence on panelists' perceptions. The sensory data were recorded and expressed as mean scores for each attribute. Panelists were selected based on specific criteria, including being in good health and being non-smokers, to ensure the reliability and accuracy of the sensory evaluations.

2.7. Microbial analysis

The counts of fungi were conducted using Sabouraud Dextrose Agar, which was prepared with 20% glucose, 10% neopeptone, 17% agar, and 1000 mL of distilled water. To prevent bacterial growth, chloramphenicol antibiotic was added to the culture medium. The samples were then inoculated onto the prepared agar plates, incubated at 25-30°C for 3-5 days, and the molds and yeasts were counted.

2.8. Statistical Analysis

To evaluate the parametric characteristics of different samples, one-way ANOVA and Duncan's post hoc test were applied. To assess significant changes in the parametric attributes of each sample over time, Repeated Measures ANOVA was employed. The significant level of $p < 0.05$ was considered for data comparison.

3. Results and Discussion

3.1. Characteristics of flour

The characteristics of the wheat flour used are presented in Table 2.

Table 2. Characteristics of the wheat flour.

Characteristic	Results
Moisture (%)	13.24
Protein (%)	8.28
Ash (%)	0.44
pH	6.13
Gluten	24

3.2. Characteristics of Moffarrah powder

The characteristics of the Moffarrah powder used are presented in Table 3.

Table 3. Characteristics of the Moffarrah powder.

Characteristic	Results
Moisture (%)	10
pH	8.81
Acid-soluble ash (%)	1

3.3. The specific Gravity of the cake dough

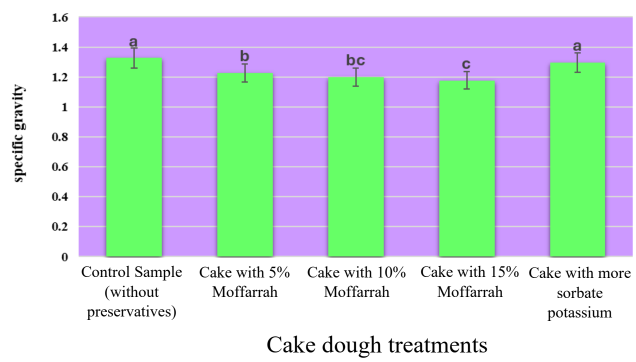

Figure 1. The specific weight of the cake dough. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

According to Fig. 1, no significant differences were observed in the average specific weight between the control cake (without preservatives) and the standard cake containing potassium sorbate at the 95% confidence level ($p \leq 0.05$). However, the inclusion of MP significantly reduced the specific gravity of cake dough treatments. Specifically, there were no significant differences between the specific Gravity of dough prepared with 5% and 10% MP ($p > 0.05$); however, increasing the concentration to 15% led to a significant reduction in specific gravity (p 0.05). A lower specific gravity, which reflects higher air incorporation and improved aeration, is desirable for cakes with high volume and porosity. Specific gravity was measured to evaluate the incorporation and retention of air bubbles during mixing, as a higher specific gravity corresponds to fewer air bubbles and reduced aeration (20). The addition of MP enhanced the dough's capacity to incorporate and retain gas, leading to consistently lower specific weights across all treatments compared to the control sample. The use of 5% MP significantly reduced specific weight, while 10% and 15% concentrations further improved aeration and air retention. In contrast, potassium sorbate resulted in only a slight reduction in specific weight, maintaining values similar to the control. These results highlight the potential of MP as an effective additive for improving dough aeration and gas retention, contributing to enhanced cake characteristics such as reduced specific weight, higher volume, and greater porosity.

3.4. Physicochemical analysis of cake samples

3.4.1. Ash

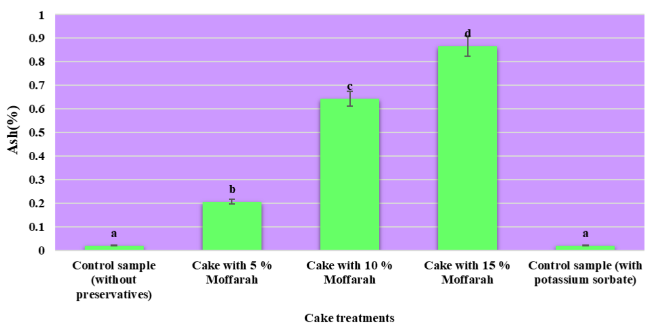

Figure 2. Ash of the cakes. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

As illustrated in Fig. 2, significant differences were observed in the ash content between the control and standard cake treatments compared to those containing MP ($p \leq 0.05$). Increasing the concentration of MP in the formulations resulted in a significant rise in ash content across the treatments ($p \leq 0.05$). The highest ash content was observed in the treatment containing 15% MP, while the lowest was recorded in the treatment with 5% MP. Control and standard treatments exhibited intermediate ash content levels, with no significant differences between them ($p \leq 0.05$). Given the high mineral and fiber content of MP, this trend was anticipated.

The ash content analysis highlighted clear distinctions among the treatments. The control sample without preservatives exhibited an ash content of approximately 0.1, the lowest among all treatments, which was identical to that of the control sample containing potassium sorbate. The cake with 5% MP had an ash content of ~0.3, representing a threefold increase compared to the control samples. The ash content in the cake with 10% MP increased further to ~0.6, doubling the content observed in the 5% Muffrah treatment and showing a sixfold increase relative to the controls. The highest ash content, ~0.9, was observed in the cake with 15% MP, marking a threefold increase over the 5% Muffrah sample and a ninefold increase compared to the controls.

These results demonstrate a clear trend of increasing ash content with higher concentrations of MP, ranging from 5% to 15%. In contrast, the control samples, whether treated with potassium sorbate or left without preservatives, consistently exhibited the lowest ash content. This finding underscores the direct and significant influence of MP on the ash content of cake treatments.

3.4.2. Acidity

As depicted in Fig. 3, significant differences were observed in the acidity levels of the control cake treatment compared to cakes prepared with MP and the standard treatment with potassium sorbate ($p \leq 0.05$). The inclusion of MP notably increased the acidity of the cake treatments, with the 5% concentration resulting in a 10% increase compared to the control sample, while the 10% and 15% treatments further increased acidity by 20% and 33%, respectively. Despite the progressive increase in acidity with higher concentrations of MP, no statistically significant differences were found between the 10% and 15% treatments ($p \leq 0.05$). The control samples exhibited the lowest acidity level, which was 25% lower than the cake with 15% MP and also significantly lower than the standard treatment with potassium sorbate. Furthermore, the 15% Moffarrah treatment demonstrated a 25% higher acidity than the 5% treatment, underscoring its pronounced effect. These findings highlight the efficacy of MP in enhancing the acidity of cakes, with higher concentrations delivering the most substantial impact, while potassium sorbate exhibited minimal influence.

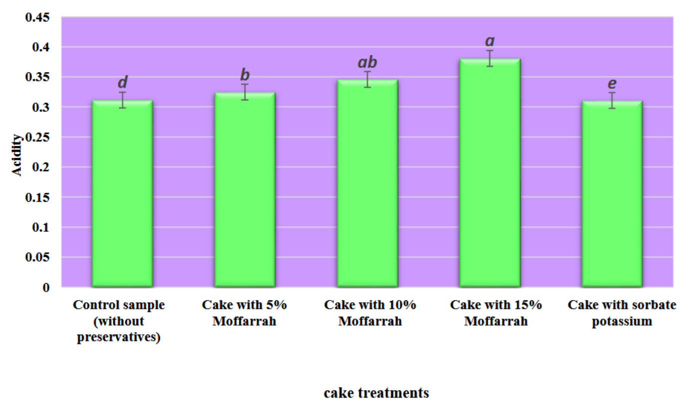

Figure 3. The acidity of the cakes. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

3.4.3. Water activity

Fig. 4 illustrates substantial differences in the average water activity among control treatments, standard cake formulations, and those enriched with MP ($p \leq 0.05$). The inclusion of MP consistently increases water activity in cake formulations, with the 15% treatment demonstrating the most pronounced enhancement, underscoring its effectiveness in improving moisture retention. Cakes containing MP outperform control samples (both with and without potassium sorbate), showcasing its superior capacity to retain moisture, unlike potassium sorbate, which has minimal impact on water activity, even lower concentrations of MP (e.g., 5%) result in significant improvements, highlighting its potential to maintain moisture and prolong product freshness during storage.

The increase in water activity with higher concentrations of MP is attributed to its fibrous structure, which effectively traps water within the dough, reduces glutenin and gliadin interactions, and weakens dough formation. Furthermore, the insoluble fibrous and cellulose components in Moffarrah act as barriers between water molecules, enhancing the availability of free water and thereby increasing water activity (21).

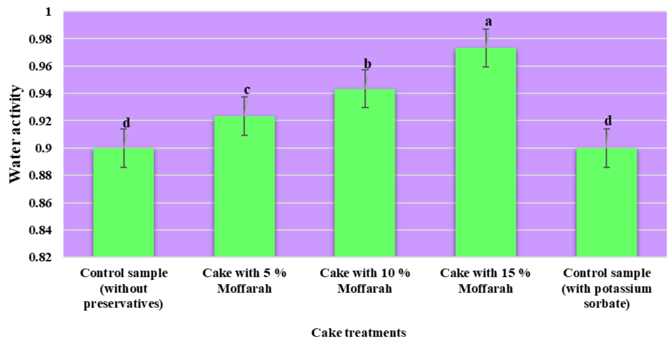

Figure 4. Water activity of the cakes. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

3.4.4. Moisture content

As presented in Fig. 5, significant differences were observed in the moisture content percentages between the control sample and each of the cake treatments ($p \leq 0.05$). Notably, the moisture content increased significantly with higher inclusion levels of MP, with the highest percentage recorded in the cake treatment containing 15% MP ($p \leq 0.05$). This trend was further supported by Fig. 5, which demonstrated that the moisture content of the control treatment was significantly lower than all other treatments ($p \leq 0.05$).

As the concentration of MP increased, the moisture content of the cakes also rose, with the 15% Moffarrah treatment exhibiting the highest moisture content (19.8%, $p \leq 0.05$). This increase can be attributed to the high concentration of hydroxyl groups in MP, which enhances its water-binding capacity by absorbing and retaining moisture during the baking process.

In this study, the addition of 5% MP increased the moisture content by approximately 1% compared to the control without preservatives. Similarly, 10% MP increased the moisture content by approximately 2%, while 15% MP increased by approximately 3% relative to the control. Overall, the progressive increase in moisture content with higher Moffarrah concentrations underscores its potential to improve the water-retention properties of cakes, with the 15% Moffarrah treatment yielding the highest moisture content at 19.8%.

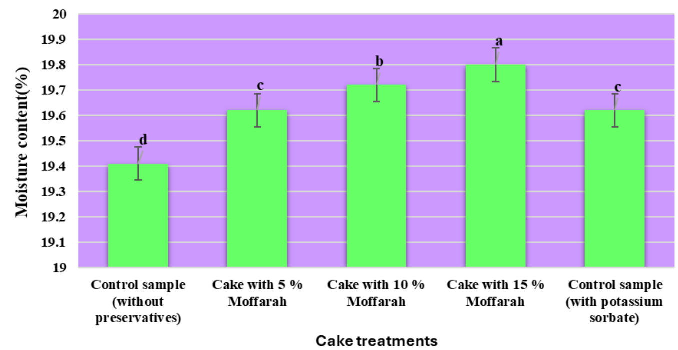

Figure 5. The moisture content of the cake dough. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

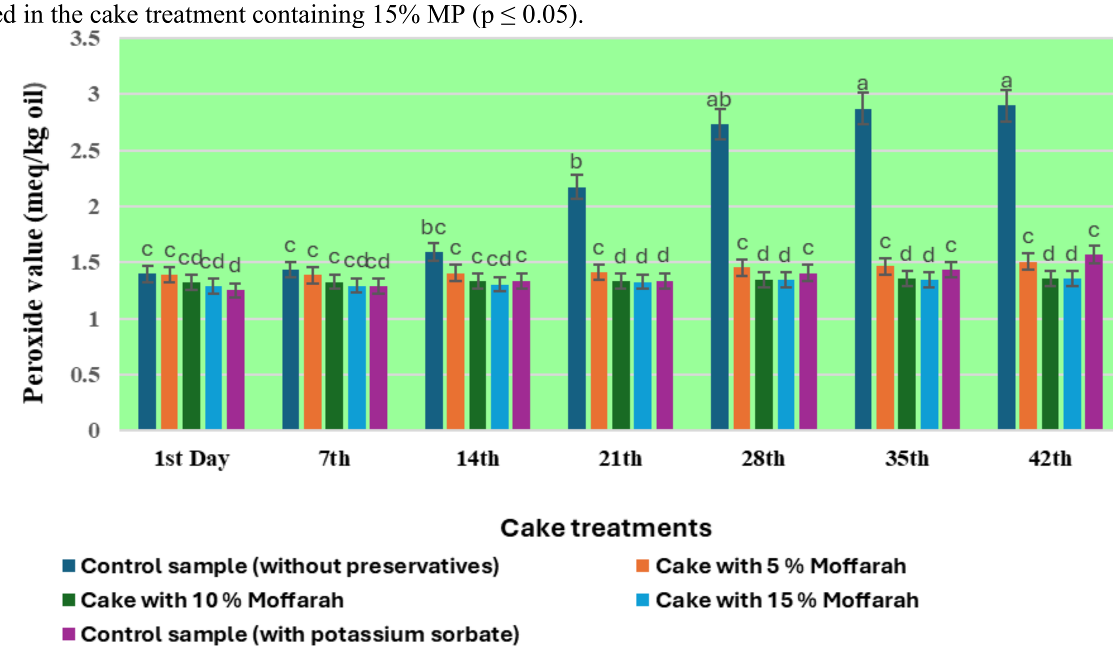

Figure 6. Peroxide value of the cake doughs. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

3.4.5. Peroxide value

The data presented in Fig. 6 illustrate significant differences in peroxide values between the control cake and the treatments containing MP, as well as the standard treatment with potassium sorbate ($p \leq 0.05$). On the first day, all treatments exhibited similar peroxide values. However, during the storage period, the peroxide values increased significantly for all samples ($p \leq 0.05$). The control treatment without preservatives displayed the most rapid and substantial increase, reaching the highest peroxide value by day 42. Conversely, the inclusion of MP effectively mitigated the rise in peroxide values, with higher concentrations (e.g., 15%) demonstrating stronger antioxidant effects and the slowest rate of peroxide formation. Among the treatments, the control sample consistently exhibited the highest peroxide values across the storage period, followed by the treatment containing potassium sorbate ($p \leq 0.05$). The cakes with 5% MP showed a similar trend to the potassium sorbate treatment, but both were less effective at suppressing peroxide formation compared to treatments with 10% and 15% MP. Notably, the treatment with 15% MP consistently demonstrated the lowest peroxide values throughout the storage period, underscoring its superior antioxidant properties. A significant reduction in peroxide values was observed with increasing concentrations of MP in the cake formulations. By day 42, the peroxide value in the 15% Mofarrah treatment was approximately 50% lower than in the control. These findings confirm that MP effectively reduces peroxide values in cakes due to its robust antioxidant properties. The treatment containing 15% MP was the most effective in minimizing peroxide formation, highlighting its potential to enhance oxidative stability and extend the shelf life of baked goods. This study underscores the functional benefits of incorporating natural antioxidants, such as MP, in food formulations to reduce lipid oxidation and maintain product quality during storage.

3.4.6. Specific volume

The data in Fig. 7 reveals notable differences in the specific volume of cake treatments based on the type and concentration of additives ($p \leq 0.05$). The control sample without preservatives had the lowest specific volume (61.8467 N/cm³), approximately 11.5% lower than the cake containing 15% MP, highlighting the positive impact of Moffarrah on a specific volume. The specific volume increased progressively with higher Moffarrah concentrations, from 67.31 N/cm³ with 5% Moffarrah (8.8% higher than the control) to 68.2433 N/cm³ with 10% Moffarrah (10.4% higher than the control) and peaked at 69.7967 N/cm³ with 15% Moffarrah (12.9% higher than the control). The control with potassium sorbate showed a moderate improvement (64.5133 N/cm³, 4.3% higher than the untreated control) but was less effective than Moffarrah treatments. These findings demonstrate a clear trend of increasing specific volume with higher Moffarrah concentrations, with the 15% treatment showing the best results. Supporting studies, such as Yanpi et al. (2016) and Babazadeh and Seydin Ardabili (2019), reported similar improvements in specific volume when functional powders like white corn flour or cranberry powder were incorporated into baked goods. This study underscores the significant potential of MP to enhance the specific volume, textural quality, and functionality of cakes, supporting its broader application as a natural ingredient in bakery formulations.

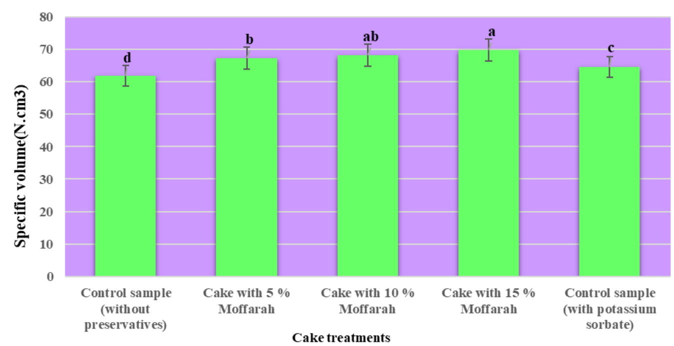

Figure 7. The specific volume of the cake dough. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

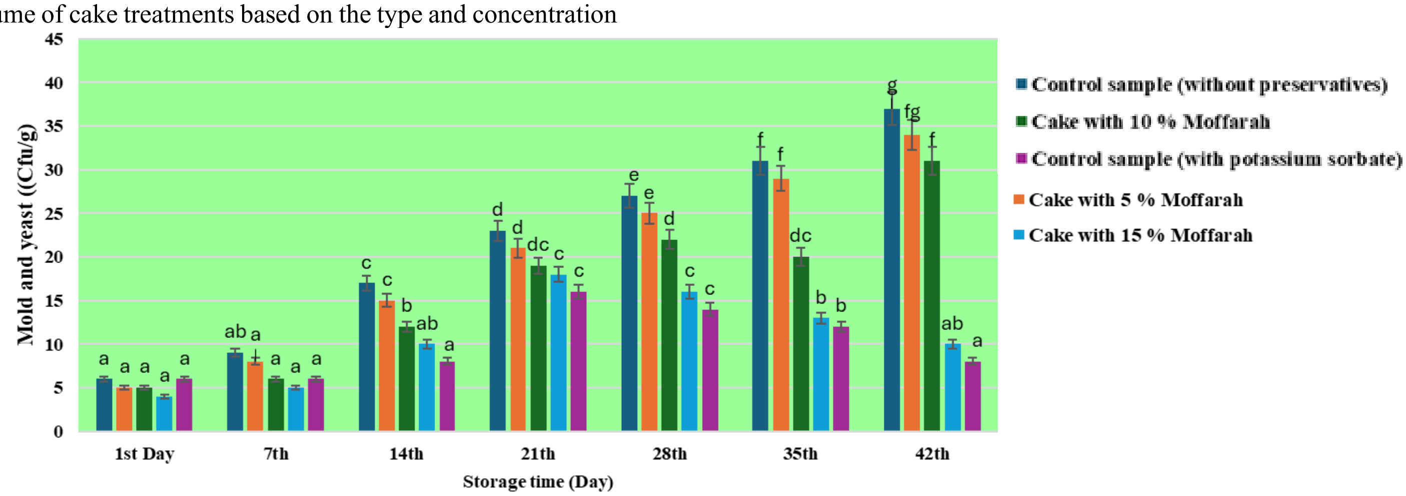

Figure 8. Mold and yeast of the cake dough. Bars represent mean (n=3) ± SD. Different letters on the bars indicate significant differences among samples ($p < 0.05$).

3.5. Microbial characteristics

The graph illustrates the mold and yeast growth (CFU/g) over a 42-day storage period for cakes treated with different preservatives: a control sample without preservatives, a control sample with potassium sorbate, and cakes containing 5%, 10%, and 15% MP. Mold and yeast growth consistently increased in all treatments over time, but the rate of growth was notably slower in cakes with preservatives. The untreated control exhibited the highest mold and yeast levels, reaching approximately 40 CFU/g by the 42nd day, demonstrating no preservation effect. The control with potassium sorbate reduced mold and yeast counts by about 20% compared to the untreated control by day 42, showing moderate preservative effectiveness. Cakes with 5% MP exhibited a 15% reduction in mold and yeast growth compared to the untreated control, particularly during the first 21 days, though its effect was less pronounced than higher concentrations. Cakes with 10% MP performed better, reducing mold and yeast counts by approximately 25% compared to the untreated control, highlighting improved efficacy. The 15% MP treatment demonstrated the greatest inhibition of mold and yeast growth, reducing levels by 30–35% compared to the untreated control and outperforming all other treatments, including potassium sorbate. Overall, MP exhibited a dose-dependent effect, with higher concentrations (10% and 15%) being more effective at reducing mold and yeast growth and extending the cakes' shelf life. The results suggest that MP, particularly at 15%, is a highly effective natural preservative, offering superior mold and yeast inhibition compared to synthetic potassium sorbate.

3.6. Sensory evaluation

According to Figure 9, significant differences were observed in the sensory desirability of taste among the various cake treatments ($p \leq 0.05$). The sensory desirability of taste in cakes prepared with 5% MP was comparable to that of the standard and control cakes. However, as the concentration of MP increased, the sensory desirability of taste decreased significantly, with the lowest desirability observed in the treatment containing 15% MP ($p \leq 0.05$). At a 5% concentration, MP imparted a mild and pleasant flavor, making it favorable among evaluators. In contrast, higher concentrations of 10% and 15% resulted in a decline in sensory acceptability. Then, while incorporating 5% MP enhances the sensory desirability of taste in cakes, higher concentrations negatively affect the flavor balance, making the cakes less favorable from a sensory perspective.

The results of Figure 9 indicate significant differences in the sensory desirability of appearance color among the various cake treatments ($p \leq 0.05$). Cakes prepared with 5% MP exhibited sensory desirability for appearance color comparable to that of the standard and control cake treatments. However, as the concentration of MP increased, sensory desirability for appearance color decreased significantly, with the lowest desirability observed in the treatment containing 15% MP ($p \leq 0.05$). At a 5% concentration, MP did not result in significant differences compared to the control treatment, maintaining an appealing appearance. However, at concentrations of 10% and 15%, the sensory desirability for appearance color declined. This reduction can be attributed to increased acidity and alterations in the Maillard reaction, which adversely affected the visual appeal of the cakes, as perceived by the evaluators.

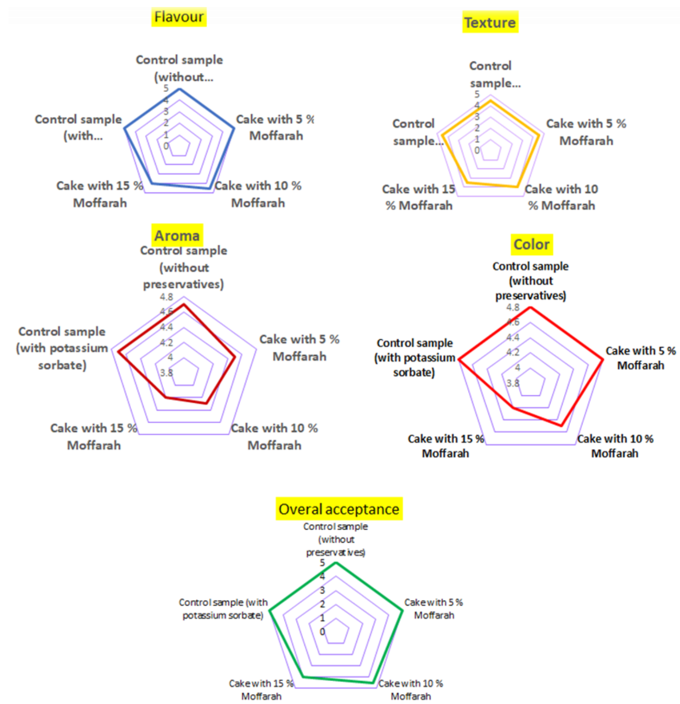

Figure 9. The sensory evaluation of the cake dough.

The texture evaluation revealed significant differences in texture desirability among the cake treatments ($p \leq 0.05$), as shown in Fig. 9. The sensory desirability of texture in the cake containing 5% MP was comparable to that of the standard and control cake treatments. However, with increasing concentrations of MP, the sensory desirability of texture declined significantly, reaching its lowest value at 15% MP ($p \leq 0.05$). The decrease in texture desirability at higher concentrations of MP is attributed to a reduction in wheat gluten content, which weakens the gluten network of the dough ($p \leq 0.05$). A well-desired cake texture is characterized by uniformity and thin walls, which were best achieved in samples containing 5% MP and the control sample. In contrast, the samples with 10% and 15% MP showed a decline in texture desirability. This can be associated with increased water retention caused by the addition of mP, which affects the firmness of the cake texture. The texture firmness is largely influenced by the dough's ability to bind water and the rate of water loss during the storage period (22). Additionally, interactions between MP and starch components may contribute to starch retrogradation, further affecting tissue firmness. Overall, the results indicated that while low concentrations of MP (5%) maintained favorable texture characteristics, higher concentrations (10% and 15%)

negatively impacted the sensory desirability of the cake texture.

According to Fig. 9, significant differences were observed in the sensory desirability of overall acceptance among the cake treatments ($p \leq 0.05$). The overall acceptance of the cake treatment prepared with 5% MP was comparable to that of the standard cake and the control cake treatments. However, as the concentration of MP increased, the sensory desirability of overall acceptance decreased significantly. The lowest level of overall acceptance was recorded in the treatment containing 15% MP ($p \leq 0.05$). Based on the results from various sensory evaluations, the cake treatment containing 5% MP was identified as the optimal formulation due to its balance of favorable sensory attributes. This conclusion is supported by the observation that the overall acceptance of the 5% MP treatment was comparable to that of the standard and control cake treatments, while the treatments containing 10% and 15% MP were deemed less desirable, with the latter being the least favorable according to the evaluators. These findings suggest that while the inclusion of MP at lower concentrations can enhance the sensory profile of cakes, higher concentrations negatively impact overall acceptance.

4. Conclusion

The technological and nutritional aspects of food products have garnered significant attention from researchers in the food industry. As a result, there is a growing emphasis on developing products that not only exhibit high technological quality but also possess enhanced nutritional value. In this study, the incorporation of MP into sponge cake formulations was found to positively influence sensory attributes. Specifically, an increase in MP content led to a statistically significant improvement in taste and flavor scores. Additionally, the sensory evaluation of aroma also showed a notable enhancement with higher concentrations of the extract. The findings highlight the beneficial role of MP in improving the chemical, physical, and sensory properties of sponge cake. Among the tested formulations, the sample containing 10% MP demonstrated the most favorable results. This concentration not only optimized the sensory attributes but also significantly enhanced the cake's resistance to microbial contamination. Based on these findings, MP emerges as a natural and cost-effective alternative to synthetic preservatives. Its application in the food industry could contribute to extending shelf life, improving product quality, and increasing the overall value of sponge cake formulations.

References

1. *Salehi S, Khodadadi I, Akbari-Adergani B, Shekarchi M, Karami Z. Surveillance of sodium benzoate and potassium sorbate preservatives in dairy products produced in Hamedan province, northwest of Iran. International Food Research Journal. 2017;24(3):1056.*
2. *Ranjbaran P, Moradkhani S. Iron Chelating Activity of Nepeta Crispa Willd., an Endemic Plant in the West of Iran. Avicenna Journal of Medical Biochemistry. 2022;10(1):65-70.*
3. *Haseli A, Ahmadi R, Mortazavi SA, Pirouzifard M, Hosseini H. Application of nanoencapsulated Mofarrah (Nepeta crispa) essential oil as a natural preservative in yogurt drink (doogh). LWT - Food Science and Technology. 2023;186:115256.*
4. *Hitendra J, Kumar A, Kumar M, Bhatia SK. Role of lactic acid bacteria (LAB) in food preservation. International Journal of Current Microbiology and Applied Sciences. 2016;5:255-256.*
5. *Lu TM, Lee CC, Mau JL, Lin SD. Quality and antioxidant property of green tea sponge cake. Food Chemistry. 2010;119(3):1090-1095.*
6. *Imran M, Sajid M, Ahmad I, Khan MR, Hassan S. Antimicrobial activity of different plants extracts against Staphylococcus aureus and Escherichia coli. Polymers in Medicine. 2021;51(2):69-75.*
7. *Iorgachova K, Makarova O, Khvostenko K. Herbs as a source of natural preservatives against rancidity in the low-moisture bakery products. Food Science and Technology. 2019;13(4):99-105.*
8. *Institute of Standards and Industrial Research of Iran. Cereal and cereal products-Determination of moisture content-Reference method. Tehran: ISIRI; 2011. Standard No. 2705.*
9. *Institute of Standards and Industrial Research of Iran. Cereals, pulses and by products-Determination of ash yield by incineration. Tehran: ISIRI; 2009. Standard No. 2706.*
10. *Iranian National Standardization Organization. Cereals and pulses – Determination of the nitrogen content and calculation of the crude protein content – Kjeldahl method. Tehran: ISIRI; 2015. Standard No. 19052.*
11. *Iranian National Standardization Organization. Biscuit- Specifications and test methods. 9th Revision. Tehran: ISIRI; 2024. Standard No. 37.*
12. *Institute of Standards and Industrial Research of Iran. Wheat and wheat flour – Gluten content – Part 1: Determination of wet gluten by a manual method. Tehran: ISIRI; 2010. Standard No. 9639-1.*
13. *Iranian National Standardization Organization. Coriander whole or ground(powdered)- Specification. Tehran: ISIRI; 2008. Standard No. 183.*
14. *Afsharian Torghabeh S, Sheikholeslami Z, Ataye Salehi E. Effect of xanthan and guar gums on qualitative properties of gluten-free sponge cake. Journal of Food Science and Technology (Iran). 2016;13(50):133-143.*
15. *Iranian National Standardization Organization. Cookies and Pastry - Specifications and test methods. 2nd Revision. Tehran: ISIRI; 2017. Standard No. 3493.*
16. *Iranian National Standardization Organization. Animal and vegetable fats and oils - Determination of peroxide value - Iodometric (visual) endpoint determination. 2nd Revision. Tehran: ISIRI; 2018. Standard No. 4179.*
17. *Iranian National Standardization Organization. Wheat flour – Specifications and test methods. 7th Revision. Tehran: ISIRI; 2023. Standard No. 103.*
18. *Oprea OB, Apostol L, Berca L, Nicului M, Bordei D. Research on the potential use of grape seed flour in the bakery industry. Foods. 2022;11(11):1589.*
19. *American Association of Cereal Chemists. Approved methods of the American association of cereal chemists. Vol. 1. St. Paul: AACC; 2000.*
20. *Gómez M, Ronda F, Caballero PA, Blanco CA, Rosell CM. Functionality of different hydrocolloids on the quality and shelf-life of yellow layer cakes. Food Hydrocolloids. 2007;21(2):167-173.*
21. *Goldstein A, Ashrafi L, Seetharaman K. Effects of cellulosic fibre on physical and rheological properties of starch, gluten and wheat flour. International Journal of Food Science and Technology. 2010;45(8):1641-1646.*
22. *Korus J, Witczak M, Ziobro R, Juszczak L. The impact of resistant starch on characteristics of gluten-free dough and bread. Food Hydrocolloids. 2009;23(3):988-995.*