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Using hydroxypropyl methylcellulose as a fat substitute in making of healthy sweet while keeping sensory value

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SUMMARY

Introduction: Sweet foods are among the greatest broadly consumed food products in the Middle East and the world. Traditional Middle Eastern sweets such as Maamoul and Barazek are consumed in great amounts during social festivals. However, these sweets hold a high percentage of fat, reaching around 35%, which offers them necessary sensory properties for consumers.

Objective: In this research, hydroxypropyl methylcellulose (HPMC) was used as a fat substitute in sweet products such as Barazek and Maamoul, due to their low fat content, without affecting the desirable sensory possessions of consumers.

Methods: The study prepared Maamoul and Barazek by replacing ghee with hydroxypropyl methylcellulose at ratios of 10–30%, and evaluated their chemical properties in three replicates using AOAC (2011), with statistical data analysis via ANOVA, Duncan's and t-tests in SPSS (2025).

Results: The research shows that substituting fat at levels of 10%–30% with HPMC result in a significant decrease in fat and energy density, while keeping protein content and a non-significant development in starches. Sensory analysis similarly show that substituting fat with these HPMC percentages conserved the overall acceptability and taste of Maamoul, while Barazek show a more positive response when substituting higher HPMC percentages.

Conclusions: This research recommends that HPMC could be used as an appropriate fat substitute in the production of healthy old-style sweets while preserving sensory quality.

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KEYWORDS

Food grade cellulose derivative, Fat reducing, Healthy formula confectionery, Sensory stability.

INTRODUCTION

Sweets are rich in food components and sensory possessions that are desirable to consumers worldwide (Guiné, 2022). In the Middle East, Barazek and Maamoul sweets are produced, which have a special consumer advantage during social and religious festivals. These sweets are made from flour, sugar, and fats ranging from 30 to 35 %. Fats contribute to determining the texture of sweets in terms of the elasticity of the dough and the mixing of elements such as starches and proteins (Obeidat et al., 2018). Significant relationships have been found between human health and food, which has contributed to increased consciousness of human food selections (Mishenin et al., 2023). Fats have been linked to health difficulties, mainly blood and heart sicknesses. This has prompt the food manufacturing to concentration on reducing the fat content of foods while maintaining value such as taste and texture (Alsaffar, 2016).

Table 1 shows that Maamoul and Barazek are two traditional Middle Eastern sweets that differ in composition and consumption. Maamoul is made with semolina or flour and filled with dates and nuts and is often consumed during special occasions, while Barazek is devoid of filling and features a thick sesame coating and a crunchy texture, making it suitable for everyday consumption (Al-Khusaibi, 2019).

Fat substitutes could be relied upon to maintain sensory properties and reduce calories, as solid fat substitutes support emulsification and durability, while preserving taste and stopping decomposition (Gao et al., 2024).

As for protein-based fatty alternatives, they contribute to improving the texture of the product. Carbohydrate-based al-

Table 1. A comparison showing the differences between locally made Maamoul and Barazek in some Middle Eastern countries

Element	Maamoul	Barazek
Basic Ingredients	Semolina or flour, butter/ghee, sugar, spices (such as mahlab)	Flour, butter/ghee, sugar
Fillings	Dates, walnuts, pistachios	No filling
Special Additions	Musk or mahlab for a special flavor	A rich layer of toasted sesame
Shape	Shaped using molds with patterns and decorations	Thin, flat discs
Texture	Soft and slightly crumbly	Crispy and crunchy
Consumption	Most commonly used for special occasions and holidays	Consume daily with tea or coffee
Nutritional Value	Higher in fat due to the fillings	High in sugar and sesame

ternatives, such as maltodextrin, inulin, and hydroxypropyl methylcellulose (HPMC), bind to water and act as a fat in improving the texture of sweets Kew et al., 2020). The use of carbohydrate-based fat substitutes such as polydextrose and hydroxypropyl methylcellulose (HPMC) increases the texture and taste of sweets, and in a variety of foodstuffs (Nikolic et al., 2024). Hongjuan et al., (2022) show that whey protein molecules could be used as fat substitutes to reduce their amount, improve their value, and meet users' demand for healthy dairy products. The resulting product outperformed untreated milk powder in terms of texture, rheological properties and consistency. Because it also has a vegetable oil, emulsion added to it, it was preferred over untreated milk powder, which improved the taste.

Recent evidences show that fat substitutes based on carbohydrate and protein food polymers are effective functional tools for reducing calories and maintaining the texture and sensory properties of food products. They play a pivotal role as emulsifiers and stabilizers that promote healthy eating patterns (Syan et al., 2024). Oil gels enriched with cellulose and proteins have proven effective in baked goods, dairy products, meats, and confectionery, while maintaining their physical and sensory properties (Silva et al., 2025). Similarly, food polymers and hydrocolloids have been shown to improve the texture and flavor of meat, dairy products, sauces, and low-fat baked goods, making them promising alternatives to traditional fats (Talins et al., 2024). In this context, Al-Tarawneh and Al-Najjar (2025) indicate that probiotic yogurt produced by traditional filtration preserves probiotic viability, enhances sensory acceptance, and meets production requirements.

The primary reason for using HPMC as a partial fat substitute in Maamoul and Barazek today is related to the growing consumer interest in health and nutrition, particularly in reducing saturated fat and calorie content without significantly compromising texture and taste. The importance lies in the possibility of producing lower-fat versions that maintain acceptable sensory characteristics, making these traditional sweets more compatible with the modern diet and meeting the growing demand for healthy products while preserving food and cultural heritage.

Based on the above, this study aims to use different proportions of hydroxypropyl methylcellulose as fat substitutes in the manufacture of Maamoul and Barazek and their effect on the structural and sensory properties.

MATERIALS AND METHODS

HPMC as a Fat Substitute for Maamoul and Barazek products

Involvement different proportions of HPMC with traditional base elements, containing flour, skimmed milk, sesame seeds, sugar, and vanilla made Maamoul and Barazek. Mahlab, anise, and food coloring were also added to the Maamoul and/or Barazek. The ghee and margarine components were replaced with HPMC at 10, 15, 25, and 30% levels as fat substitutes. The filling for all of these products consists of butter, date paste, anise, almonds, pistachios, and cinnamon. All ingredients are sourced locally in City Irbid. The elements were used in preparation of the traditional Middle Eastern sweet goods, Barazek and Maamoul, as shown in Figures 1 and 2, respectively:

In Maamoul and Barazak, portions of the margarine and ghee were replaced with fat substitutes, hydroxypropyl methylcellulose, at ratios of 10%, 15%, 25%, and 30%. Control samples were prepared using traditional fat ratios without any substitutes. Details of the compositions are shown in Table 2.

Chemical Composition

Chemical properties, including protein, fat, ash, moisture, and carbohydrates, were evaluated by relative analysis. These

Source: The authors

Figure 1. Barazek products

Source: The authors

Figure 2. Maamoul products

evaluations followed guidelines established by AOAC (2011) Standard Procedures.

Sensory Evaluation of Maamoul and Barazek

The sensory evaluation of the products was conducted using a trained tasting panel of 30 consumers to measure the overall acceptability of both Maamoul and Barazek. Samples were presented under standard conditions in terms of temperature, lighting, and presentation method, and were randomly coded to ensure the neutrality of the tasting. Participants were asked to evaluate the main sensory characteristics, including overall acceptability, softness, flavor, and color. A nine-point hedonic scale ranging from "not at all acceptable" (1) to "very acceptable" (9) was used to determine the degree of satisfaction with each characteristic (Oh, et al., 2023).

Table 2. Concentrations of fat substitutes (hydroxypropyl methylcellulose, HPMC) used in processing

Treatments(Fat replacement with HPMC levels %)	Concentrations	
	Maamoul %	Barazak %
Control group (at 0)	0.0	0.0
First group (at 10)	10.0	10.0
Second group (at 15)	15.0	15.0
Third group (at 25)	25.0	25.0
Fourth group (at 30)	30.0	30.0

Statistical Analysis

All analyses were performed in replicates, and results were expressed as mean values. To determine statistically significant differences between treatments, one-way analysis of variance (ANOVA) was used. The multiple range test of Duncan (1955) was used to compare post-experimental mean values, while independent samples t-tests were applied at a 95% confidence level. All data analyses were performed using SPSS (2025), following the methodology described by Chysirichote et al., (2011).

For sensory characteristics (overall acceptability, softness, flavor, and color), data were collected and analyzed using analysis of variance to determine significant differences for both Maamoul and Barazek at a significance level ($p<0.05$).

RESULTS

Barazek product

When hydroxypropyl methylcellulose (HPMC) is used as a fat substitute in this formulation, its proportion has been gradually increased to 0%, 10%, 15%, 25%, and 30%, as shown in Table 3.

Maamoul product

Table 4 illustrates the use of HPMC as a fat substitute in this Maamoul formulation. A gradual increase in HPMC content,

Table 3. Efficiency of edible HPMC coating on the chemical properties of Barazak

Level of HPMC%	Fat (%)	Protein (%)	Carbohydrates (%)
Control group (at 0)	25.2	9.0	62.9
First group (at 10)	23.1	9.1	63.4
Second group (at 15)	21.0	8.9	63.8
Third group (at 25)	18.3	9.3	63.6
Fourth group (at 30)	16.2	9.3	63.8

Table 4. The Efficiency of HPMC as Edible Coating on Chemical Properties of Maamoul

Level of HPMC %	Fat (%)	Protein (%)	Carbohydrates (%)
Control group (at 0)	26.8	6.1	55.7
First group (at 10)	24.3	6.1	56.5
Second group (at 15)	22.9	5.9	56.7
Third group (at 25)	21.1	6.3	56.8
Fourth group (at 30)	18.4	6.1	56.1

from 0% to 30%, results in a significant decrease in fat content (from 26.8% to 18.4%) and a corresponding decrease in energy density (from 488.4 to 414.4 kcal per 100 g). Protein levels remain constant, while carbohydrate content increases slightly. HPMC absorbs water which helps to form a dough with improved viscosity and elasticity especially when producing Maamoul and this improves the texture of the product (Dodi et al., 2007).

Figures 3 and 4 show that the calculated energy content of both Barazek and Maamoul products gradually decreased with increasing hydroxypropyl methylcellulose (HPMC) content. In Barazek, energy decreased by 76.2 kcal/100 g, while in Maamoul, it decreased by 74 kcal/100 g at the 30% level. This indicates that replacing conventional fats with HPMC significantly reduced the energy content of the products, consistent with the functional role of food polymers in reducing calories while maintaining the physical and sensory properties of the food product (Sun and Fang, 2021; Sabbaghi, 2023). This pattern confirms the effectiveness of HPMC as a fat substitute in improving the health value of conventional products without significantly affecting their structure or consumer quality (Alvarez et al., 2021; Ferdaus et al., 2024; Wang et al., 2024).

Effect of HPMC on the Sensory Properties of Maamoul and Barazek

Table 5 shows the reformulation of both Maamoul and Barazek using varying levels of hydroxypropyl methylcellulose (HPMC) as a fat substitute, and their sensory properties were evaluated. For Maamoul, overall acceptability remained statistically similar to the control group at medium HPMC levels (mean scores between 6.9 and 7.33±1.5–1.8, rated 'A' or 'AB'), but decreased significantly at the highest substitution level (5.99±1.01, rated 'B'). A similar trend was seen for softness, high acceptability at low HPMC additions (7.3 and 7.59±1.3), followed by a significant decrease at high levels (5.23 and 5.69±1.3–1.8, rated 'B'). Interestingly, flavor scores remained relatively stable across all formulations (range: 6.90–7.33, all "a"), as did color acceptability (6.93–7.97, mostly "ab"), suggesting that moderate HPMC substitution can maintain these sensory attributes. Conversely, Barazek showed a sharp decline in sensory quality with increasing HPMC: overall acceptability decreased from 8.1±1.45 ("a") in the control group to only 3.99±1.26 ("c") at the highest HPMC level. Softness, flavor, and color also showed significant deterioration, although the color changes were relatively subtle. These differences

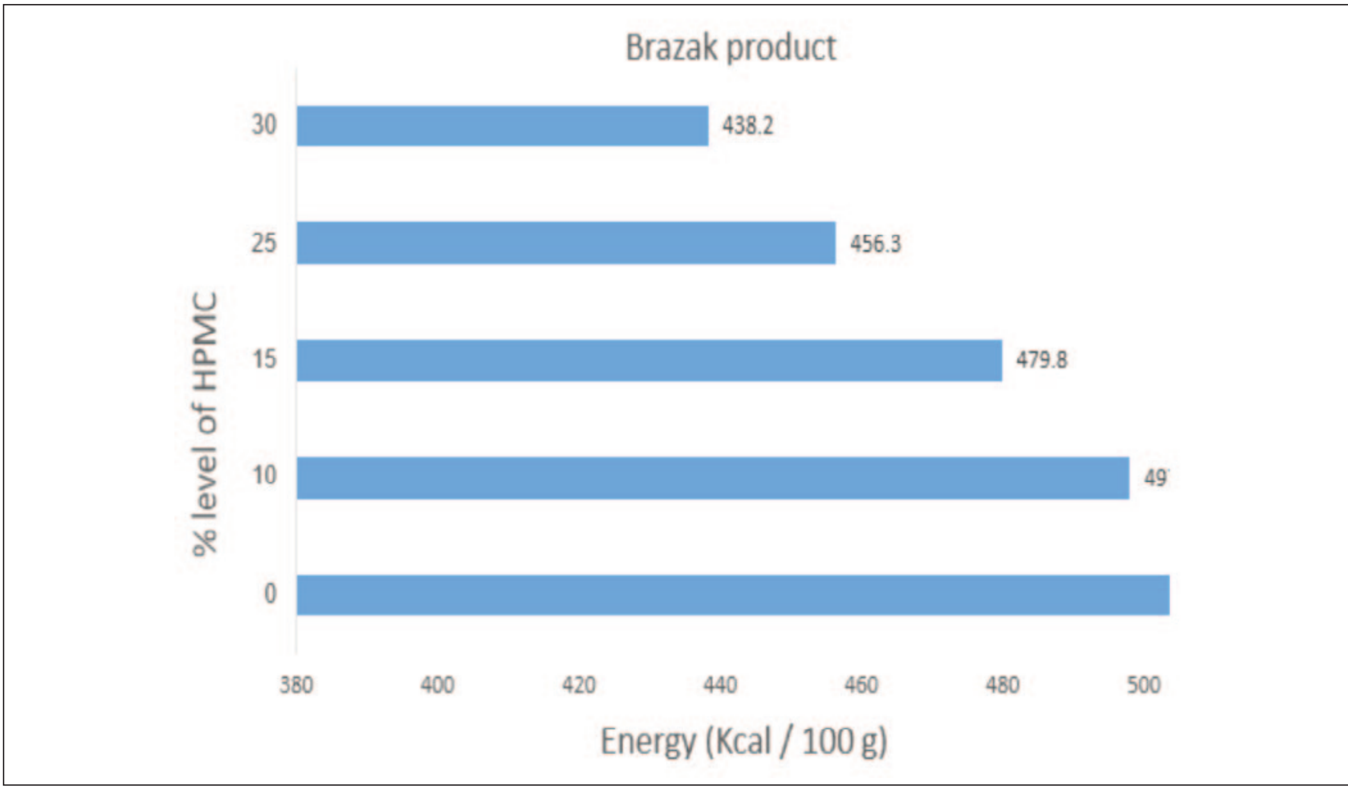

Figure 3. Calculated energy of Barazek products

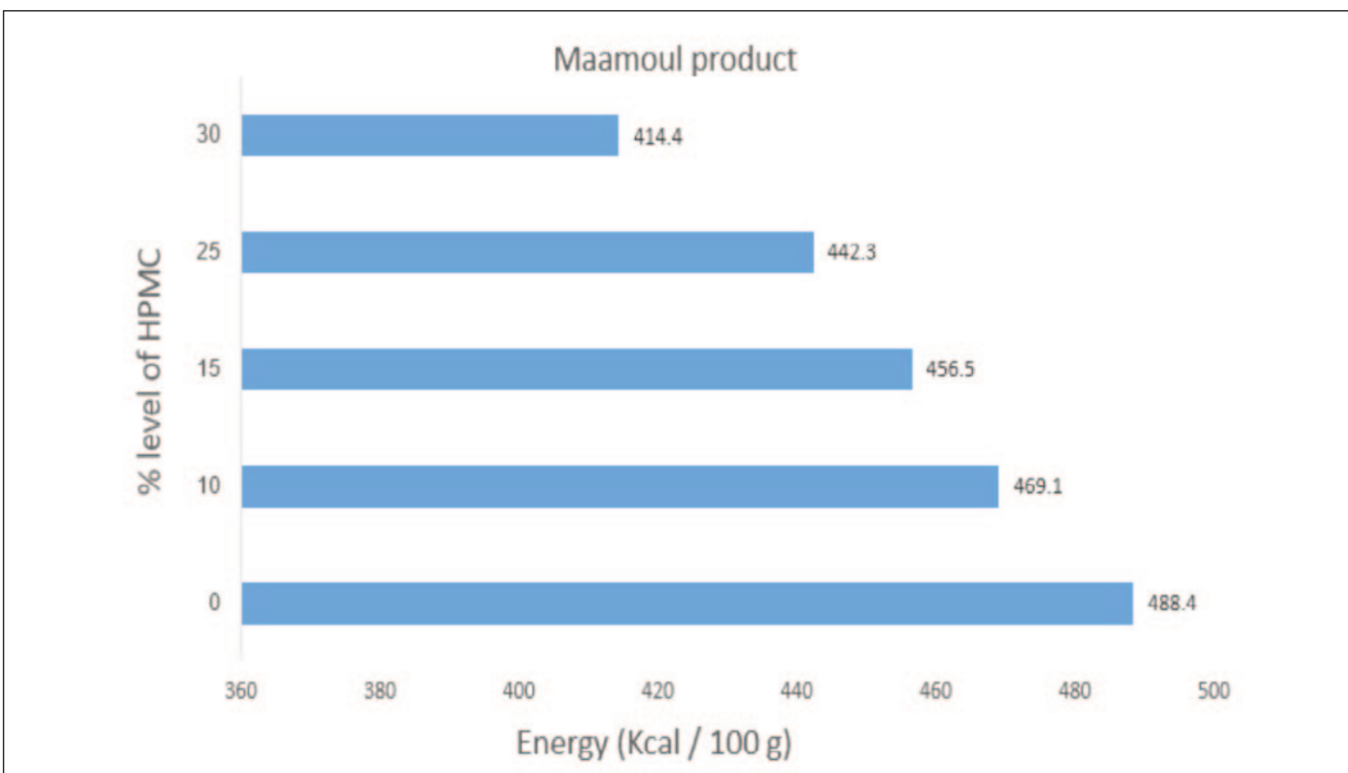

Figure 4. Calculated energy of Maamoul products

Table 5. Sensory properties (Maamoul and Barazek) made using HPMC

Product / Properties	Percent of fat replaced with HPMC				
	0	10	15	25	30
	Maamoul products				
Acceptance	7.1±1.77^{a}	6.9±1.46^{a}	6.99±1.59^{ab}	7.33±1.79^{ab}	5.99±1.01^{b}
Softness	7.3±1.40^{a}	7.59±1.36^{a}	6.77±1.34^{a}	5.23±1.34^{b}	5.69±1.83^{b}
Flavor	6.90±1.60^{a}	7.01±1.08^{a}	7.13±1.90^{a}	5.23±1.40^{a}	7.33±1.69^{a}
Color	7.13±1.70^{a}	7.96±1.23^{ab}	6.99±1.47^{ab}	6.93±1.9^{ab}	7.97±1.66^{ab}
	Barazek products				
Acceptance	8.1±1.45^{a}	6.56±1.96^{b}	6.93±1.32^{b}	5.93±1.09^{b}	3.99±1.26^{c}
Softness	6.32±1.25^{a}	6.97±1.23^{b}	5.96±1.43^{b}	6.10±1.16b^{c}	4.99±1.54^{c}
Flavor	7.99±0.93^{a}	6.98±1.72^{b}	6.01±1.57^{bc}	6.93±1.21^{bc}	6.33±1.67^{c}
Color	7.91±1.51^{a}	6.53±1.32^{ab}	6.89±1.37^{ab}	6.58±1.53^{ab}	6.89±1.38^{ab}

* Values within a row followed by a common letter are not significantly different.

suggest that the sensory properties of Maamoul are more resilient to the inclusion of moderate HPMC compared to the more intense Barazek.

DISCUSSION

The Barazak products (similar to Barazek) show a significant decrease in fat content (from 25.2% to 16.2%) and corresponding energy density (from 514.4 to 438.2 kcal per 100 g), with stable protein levels and a slight increase in carbohydrate content. These trends are closely related to the functional roles of hydroxypropyl methylcellulose during dough formation and baking. First, HPMC enhances dough viscosity, elasticity, and water-binding capacity, supporting the formation of stable and elastic doughs, as in Brazik production, and compensating for the lower fat content. This is consistent with the findings of Rosell and his colleagues 2001, who reported that HPMC-enriched dough exhibits increased water activity, moisture retention, and decreased crumb toughness (Rosell et al., 2001). Additionally, KimaCell (2025) reports that HPMC improves dough extensibility, structure, and stability, features that make it easier to shape, flatten, and even compress sesame onto its surface without cracking or breaking (KimaCell, 2025).

The baking process highlights the functional benefits of HPMC. During heating, HPMC forms thermoreversible gels and network structures that stabilize gas cells and reduce the loss of moisture and volatiles, a phenomenon that maintains dough integrity, reduces shrinkage, and maintains weight (Bárcenas & Rosell, 2005; Guarda et al., 2004). This is particularly attributable to your observations where the baked dough lost approximately 150 grams of weight; it is likely that HPMC network mitigated this loss, resulting in moisture retention and reduced fat migration compared to control groups without HPMC.

Furthermore, the slight increase in carbohydrate content may reflect a partial displacement of fat and a compensatory shift in macronutrient distribution, as HPMC binds to water and occupies volume, consistent with the broader compositional changes observed in low-fat systems. Indeed, studies of textured breads have shown that hydrocolloids such as HPMC increase crumb moisture and soften its texture, supporting the idea that HPMC-added Barazek retains a desirable mouthfeel even with reduced fat (Eduardo, 2013).

The comprehensive functionality of HPMC as a hydrocolloidal fat substitute is enhanced in this context: it enables a significant reduction in fat and energy density while maintaining or improving dough handling properties, structural stability during shaping and baking, and sensory properties such as tenderness, moisture, and overall palatability. This dual capability makes HPMC particularly suitable for Barazek formulations, where traditional methods rely on high-fat media to improve texture and mouthfeel, but health modifications are desired.

Research suggests that HPMC creates a gel network that contributes to changing the tensile properties of the dough, enhancing its stretchability, which is beneficial for dough shaping and molding (Ko, et al., 2015; Nath et al., 2022).

The use of HPMC has been associated with increased moisture retention in dough, resulting in improved texture and freshness in baked goods Where HPMC properties help retain moisture in the dough, which is crucial to maintaining the texture and quality of the product (Nammakuna al., 2016; Zhao et al., 2021).

HPMC effectively replaces fat without compromising the nutritional value of maamoul as it reduces fat and energy while maintaining protein levels. A slight increase in carbohydrate content and its binding to water leads to fat displacement and thus a compensatory shift in macronutrient distribution. This is consistent with the structural changes observed in low-fat diets (Dizlek et al., 2017).

Eduardo et al (2013) show that the addition of HPMC contributes to increased bread moisture and thus softens the texture, supporting the idea that Maamoul with HPMC added retains a desirable texture even with low fat.

Including HPMC as a fat substitute in Maamoul formulations not only reduces the fat and energy content but also enhances the properties of the dough, contributing to a product that maintains the desired texture and quality.

The results are consistent with broader studies on the use of high-density monounsaturated fatty acids (HPMC) as a fat substitute. In biscuits, replacing 15 g/100 g of fat with HPMC contributes to maintaining texture and overall acceptability, while higher levels contribute to increased firmness and thus reduced consumer desire (Laguna et al., 2014).

In gluten-free pancakes, HPMC use at levels ranging from 2% to 3% enhanced softness, elasticity, and sensory appeal, despite increased viscosity and dark color (Maghsoud et al., 2024). In barley and oat bread, the use of HPMC was effective in improving loaf size, reducing firmness, and maintaining overall quality (Kim et al., 2015).

When making Maamoul, using high-density fatty acids (HDFAs) as a fat substitute helps maintain sensory properties such as texture, taste, and color. On the other hand, Barazek was found to be more sensitive when HPMC was used as a fat substitute. These results demonstrate the importance of using fat substitutes (HPMC) in proportions of about (10-30%) that maintain sensory properties in a healthy product (Maghsoud et al., 2024).

The results indicate that reducing fat content of Maamoul and Barazek using an edible HPMC coating caused a gradual and significant decrease in fat content while maintaining relatively constant protein and carbohydrate content. Fat content of Barazek decreased from 25.2% at 0% HPMC to 16.2% at 30% HPMC, while it decreased from 26.8% to 18.4% at the same level in Maamoul. This decrease was accompanied by an improvement in overall energy distribution (Figures 3-4), underscoring importance of investigating the nutritional composition per 100 grams when studying low-fat alternatives.

From a sensory perspective, the results in Table (5) show that inclusion of HPMC at moderate levels (10-15%) did not negatively affect softness or flavor, and maintained acceptable levels of overall acceptability and color. However, higher levels (25-30%) resulted in a significant decrease in overall acceptability (from 8.1 to 3.99). Therefore, relying on data including protein, fat, carbohydrate, and calorie content, along with sensory evaluation, allows for important conclusions about the effectiveness of fat reduction. It could be argued that Maamoul and Barazek, enhanced with HPMC at moderate levels (≤ 15%), represent healthier and more balanced food alternatives while maintaining acceptable levels of sensory properties and consumer acceptance.

CONCLUSION

This research confirms that replacing 10% to 30% of the fat with Hydroxypropyl methylcellulose (HPMC) is suitable for maintaining product health while preserving its sensory characteristics, particularly in Maamoul. BARAZEK, however, is more sensitive to increased HPMC levels. Using HPMC as a fat substitute in sweets, especially Maamoul and Barazek, is also a valuable option, as it reduces fat levels without compromising sensory qualities. Further research is recommended to determine the optimal HPMC ratio for each product (Maamoul and Barazek) and to test a range of modified formulations to achieve a healthier product while maintaining its sensory value. In future studies, researchers will assess the long-term stability and consumer acceptance of these modified formulations to increase their use as healthy and delicious products in the market.

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