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Sensory Analysis of a New Yogurt Formulation with Date Syrup from the Semi-Soft 'Hmira' Variety

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Abstract. Date palms (*Phoenix dactylifera* L.) hold significant ecological, socio-economic, and nutritional value for populations in the Saharan region. To optimize the use of common date varieties, particularly those produced in large quantities in southern Algeria, technological valorization is essential. Date syrup, known as Robb, derived from the Hmira variety and produced locally through traditional methods, can be used to enhance industrial-scale yogurt production. Microbiological analysis of Robb was conducted following Algerian standards before the production of Robb-flavored yogurt. A trial production of a yogurt-Robb mixture was carried out at laboratory scale (POSL). The resulting products underwent sensory analysis, evaluated through a preference test by a panel of 70 participants, who provided tasting notes. The microbiological results showed that the date syrup was free from pathogenic and bacterial contaminants and met national requirements. The sensory evaluation determined the level of acceptability of the products with increasing date syrup concentrations among the tasters. The yogurt-Robb mixture containing a 7% date syrup concentration was the most preferred. The main descriptors influencing the tasters' choice were acidity, sweetness, and texture, while aroma and color had less influence. This study emphasizes the potential to add value to low-market-quality date by-products, specifically Robb, by utilizing them as a sweetener in the dairy industry. This approach can lead to the production of naturally flavored dairy products with significant nutritional and health benefits.

Keywords. Date syrup (Robb), Flavored yogurt, Hmira variety, Sensory analysis, Valorization.

1. Introduction

Dates have long been a vital component of the diet for populations living in the Sahara. As one of the few plants that can withstand the harsh desert climate —extremely hot days and cold nights— the date palm is a crucial resource for nomadic communities [1]. These nutrient-dense fruits provide a concentrated source of energy [2].

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Algeria has moved from fourth place in 2023 to third in 2024 as the third-largest producer of dates in the world, after Egypt and Saudi Arabia. It plays a significant role in the global date industry. In 2024, its production exceeded 1.24 million tons, according to FAO data [3], solidifying its position as one of the top exporters of dates [1, 4].

Interestingly, around 60,000 tons of the total production consist of by-products from palm groves. The bulk of this—90%—is transformed into date paste using the 'Ghers' variety, while the remaining 10% is repurposed as cattle feed to address nutritional deficiencies [5]. Dates are well known for their rich nutritional profile [6], packed with dietary fiber, minerals, and bioactive compounds that offer health benefits, such as antioxidant, antimicrobial, anti-inflammatory, anticancer, and anti-infertility properties [4, 7-12].

Among the many by-products derived from dates, date syrup—locally known as 'Robb'—made from the semi-soft 'Hmira' variety, has gained popularity. Traditionally produced through a time-honored process, this syrup has recently seen increased adoption by small regional industries [4]. However, despite its nutritional value and cultural significance, Robb remains underutilized in modern food applications, particularly in the dairy sector. There is limited research on its potential as a functional sweetener in dairy products such as yogurt.

This gap presents a problem, especially in the context of growing consumer demand for natural, healthier alternatives to refined sugar in food products. The focus of this study is to explore the potential of Robb as a natural sweetener in the dairy industry, specifically by preparing a yogurt-Robb mixture. The organoleptic properties of this new combination are assessed through taste tests, aiming to highlight the viability of date syrup as a healthy and sustainable alternative to conventional sweeteners.

2. Material and Methods

2.1. Preparation of Date Syrup

The date syrup was made from a widely cultivated variety of semi-soft dates in the southwestern region of Algeria, specifically the 'Hmira' variety. The dates were harvested at full maturity from the palm groves of Taghit (Bechar, southwestern Algeria). They were sorted, cleaned, and stored at +6°C. Once washed (without removing the pits), the dates were combined with water in a ratio of 1kg of dates to 2 liters of water. The mixture was then heated at 85°C for 1.5 hours. The syrup was subsequently obtained after filtration [4, 7].

2.2. Microbiological Analyses of Robb

The microbiological analysis of Robb (date syrup) was carried out according to national standards as described by Benyagoub *et al.* [13, 14], using a 0.1% peptone salt solution to prepare decimal dilutions. Various microbiological parameters were assessed using different techniques, culture media, and incubation conditions:

- Total Aerobic Mesophilic Flora (TAMF): Isolated on PCA agar at 30°C for 72 hours [15].
- Fungal Flora: Isolated on Sabouraud 4% Chloramphenicol Dextrose agar at 25°C for 3–5 days [16].
- Total and Fecal Coliforms (TC and FC): Isolated on MacConkey agar at 30°C and 44°C, respectively, for 24 hours [17].
- Spores of Sulfite-reducing *Clostridia* (SRC): Isolated anaerobically on Meat-Liver agar at 46°C for 24 hours [18].
- Coagulase-Positive Staphylococci (CoPS): Isolated on Baird-Parker agar at 37°C for 24 hours [19].
- *Salmonella* spp.: Detected using selective enrichment broths, Rappaport-Vassiliadis Broth (RVB) and Selenite Cystine Broth (SCB) media, followed by isolation on Hektoen and SS agar at 37°C [20].
- Fecal streptococci: Isolated using Azide Dextrose Broth (AD) at 37°C for 48 hours. AD broth tubes that showed positive results were subsequently transferred to Ethyl Violet Azide Broth (EVA), then streaked onto Bile Esculin Azide (BEA) medium, and incubated again at 37°C [21].

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The microbiological quality of the Robb was assessed based on the microbiological criteria for foodstuffs outlined in the national standards (JORA) [22, 23].

2.3. Manufacture of Yogurt-Date Syrup

Yogurt preparation was carried out in the Phytochemistry and Organic Synthesis Laboratory (POSL) following a standard yogurt manufacturing process (partially skimmed milk yogurt), with modifications regarding the addition of date syrup at varying concentrations (1%, 3%, 5%, 7%, and 9%), compared to the control sample, which did not contain date syrup. The date syrup was added prior to the heat treatment (pasteurization step), as shown in Figure 1.

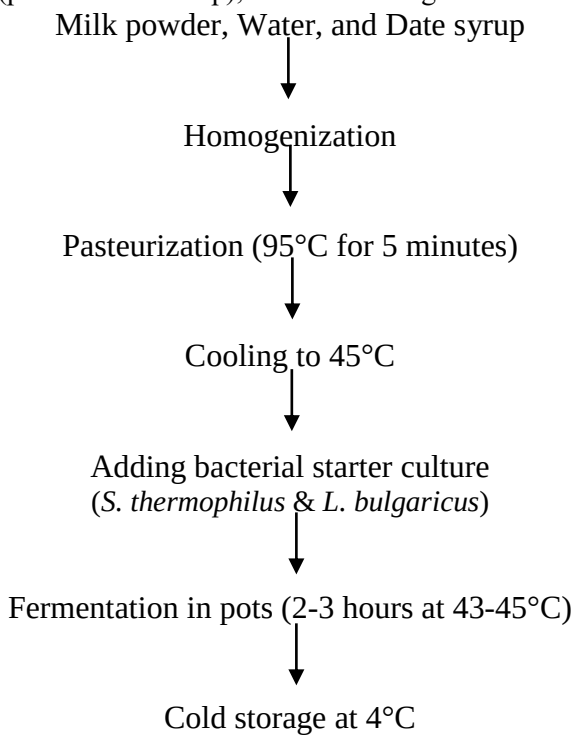

Figure 1. Yogurt-date syrup manufacturing process [24].

2.4. Sensory Analysis of Robb-Flavored Yogurt

According to the International Organization for Standardization [25], the organoleptic quality of food refers to the properties of a product that are perceivable by the senses.

Sensory analysis is a crucial method for assessing the quality of a food product. It is closely linked to the characterization of its physicochemical properties and serves as an essential tool for controlling the quality and formulation of processed products. In this study, preference analysis was used to evaluate the organoleptic quality of the new formulation of yogurt with date syrup [26].

2.4.1. Yogurt Samples

Each taster evaluated six samples in total: Robb-flavored yogurts containing varying concentrations of date syrup, along with a natural yogurt sample without date syrup (serving as the control). The samples were: [a] 0 ml/L (0%, control), [b] 10 ml/L (1%), [c] 30 ml/L (3%), [d] 50 ml/L (5%), [e] 70 ml/L (7%), and [f] 90 ml/L (9%), with alphabetical codes assigned to each sample.

2.4.2. Training of Tasters

After selecting the sensory descriptors and rating scale, tasters were trained in their use. The training included establishing tasting protocols, defining the terms, and developing a clear lexicon for each term. Concrete external references may also be provided to the tasters to form associated sensory concepts [27].

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2.4.3. Preference Test

Acceptability is defined as the degree to which a product is favorably received by an individual or specific population based on its organoleptic properties [28]. This study focuses on the following sensory descriptors: flavor, aroma, color and texture.

The tasting took place in the morning, within a temperature range of 20 to 25°C, and water for mouth rinsing was provided to the tasters.

2.4.4. Hedonic Scale

A simplified five-level hedonic scale, based on the nine-point scale proposed by NF V 09-015 [29], AFNOR [30], and Hernandez and Lawless [31] was used in this study. It is believed that a five-point scale simplifies decision-making for non-expert tasters.

Responses were recorded using a questionnaire with two parts: The first part employed the five-level hedonic scale to assess the descriptors established earlier (Figure 2). The second part included a table for classifying the six samples tasted.

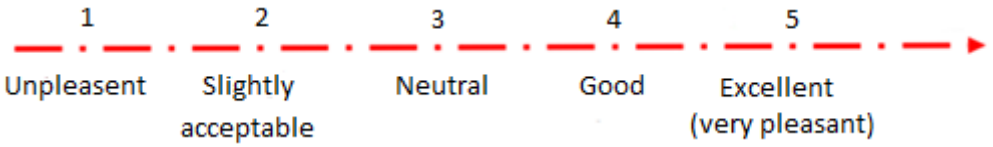

Figure 2. Scale of preference.

2.5. Statistical Analysis

Statistical analysis of the results was conducted using SigmaStat software (v.3.5). The analysis was performed in two stages, following the recommendations of Aguado *et al.* [32]. The first step involved an overall analysis of the data by calculating the tasting score-to-taster ratio. The second step focused on analysis of variance (ANOVA) to identify differences in personal preferences between the six products, with results expressed as preference averages ± SEM. The graphical presentations were plotted using Origin 2018 software.

3. Results

3.1. Microbiological Analyses of Robb

The results of the microbiological quality of Robb are shown in Table 1.

Table 1. Microbiological analysis of Robb (Source: Own study).

Microbial parameters	Microbial load
Total aerobic mesophilic flora	1.2×10^2 CFU/mL
Fungal flora	1.4 × 10 CFU/mL
Total coliforms	< 1 CFU/mL
Fecal coliforms	< 1 CFU/mL
Salmonella spp	< 1 CFU/25mL
Sulfite-reducing *Clostridia* (SRC)	< 1 spore SRC/20mL
Fecal streptococci	< 1 CFU/mL
Staphylococci	< 1 CFU/mL

The microbiological results showed that the date syrup was free from pathogenic and bacterial contaminants, including total and fecal coliforms, *Salmonella* spp., sulfite-reducing *Clostridia*, fecal streptococci, and staphylococci. However, the sample exhibited a fungal flora load within the limits set by the national standard [22, 23].

These microbiological properties make date syrup a safe ingredient for use in the production of dairy products and other food items (Figure 3).

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Figure 3. Date syrup (Original) – Photo by E. Benyagoub.

3.2. Taster Participants

The tasting panel consisted of 70 participants, including 37 women and 33 men, aged between 18 and 50 years. The total number of participants, categorized by gender, is shown in Figure 4.

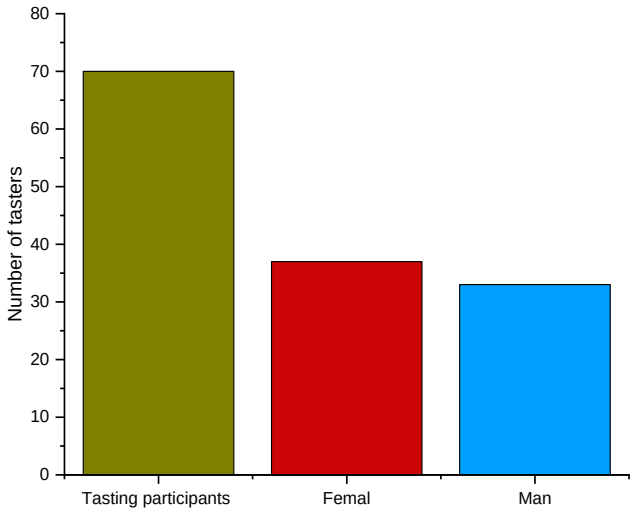

Figure 4. Distribution of the number of tasters by gender (Source: Own elaboration).

3.3. Sensory Analysis

3.3.1. Acidity Descriptor

The analysis revealed a highly significant difference in the preference for samples (e) and (d), with p-values of $p < 0.001$ and $p < 0.01$, respectively. The high concentration of date syrup in sample (f) resulted in a stronger acidity sensation for tasters compared to the other samples (Figure 5).

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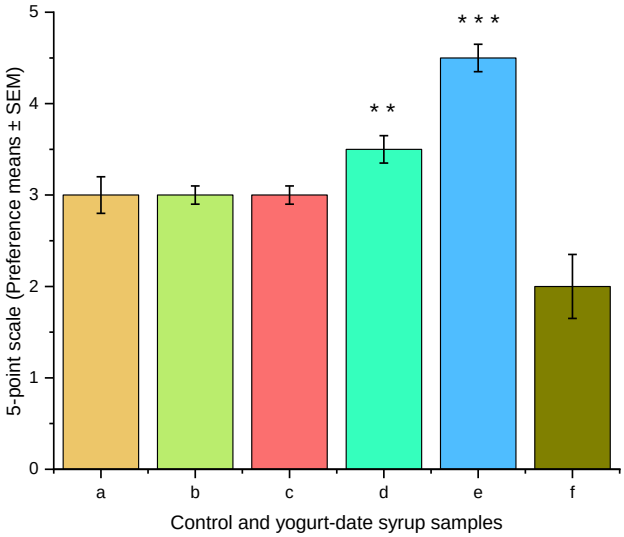

Figure 5. Preference of tasters for the acidity descriptor (Source: Own elaboration).

(*) Significant, (**) Highly significant, (***) Very highly significant.

Additionally, tasters observed an increase in sweetness flavor with higher concentrations of date syrup, which can be attributed to the presence of natural sugars like glucose and fructose that enhance the perception of sweetness.

3.3.2. Texture Descriptor

The analysis revealed highly significant differences in the preference for samples (a) and (b) compared to the other samples (Figure 6).

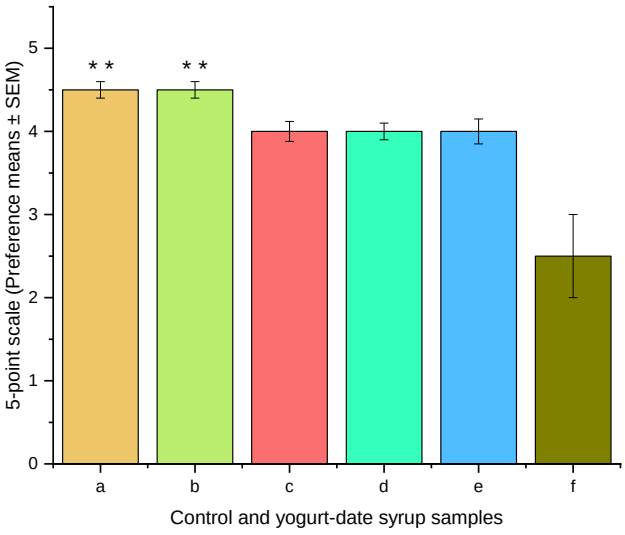

Figure 6. Preference of tasters for the texture descriptor (Source: Own elaboration).

(*) Significant, (**) Highly significant, (***) Very highly significant.

According to tasters, all the samples exhibited a firm texture, except for sample (f), which had a less firm, more liquid texture. Tasters suggested that sample (f) would be better prepared as stirred yogurt or drinking yogurt.

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3.3.3. Aroma Descriptor

The tasters' perceptions of aroma varied based on the concentration of date syrup, as shown in Figure 7.

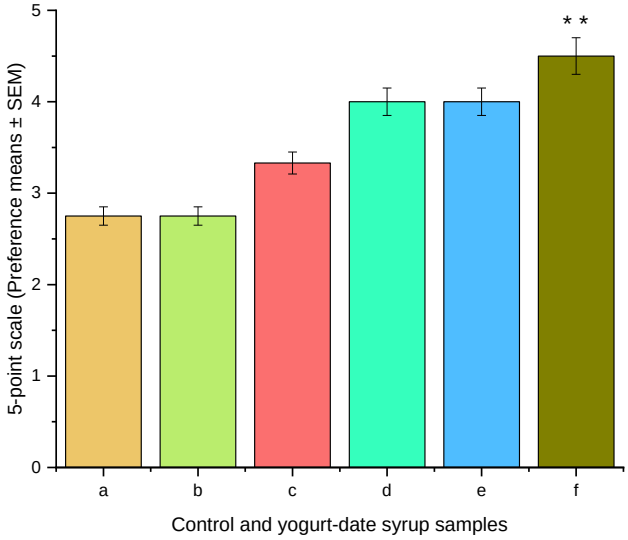

Figure 7. Preference of tasters for the aroma descriptor (Source: Own elaboration).

(*) Significant, (**) Highly significant, (***) Very highly significant.

For the control sample (a), the yogurt retained a distinctly milky flavor, as expected from the fermentation process. However, with increasing concentrations of date syrup (samples b, c, d, e, and f), the aroma shifted from a milky flavor to a more pronounced fruity note.

3.3.4. Color Descriptor

The tasters' preference for the yogurt–date syrup color is shown in Figure 8.

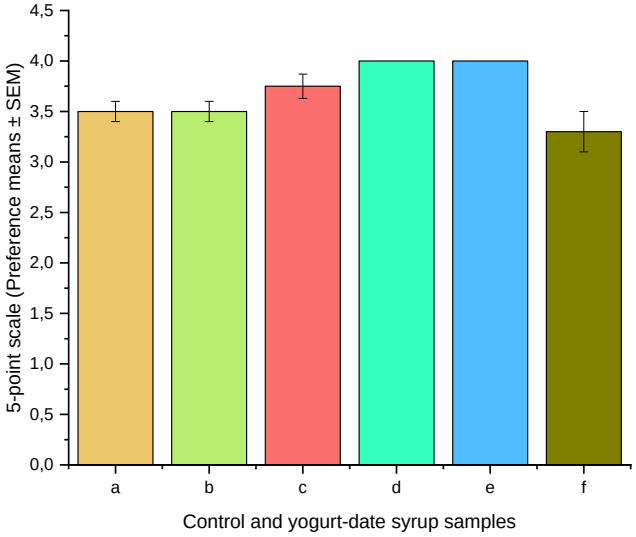

Figure 8. Preference of tasters for the color descriptor (Source: Own elaboration).

The preference means indicate that the set of samples showed less variation compared to other sensory descriptors, with average scores ranging from 3 to 4 on a five-point hedonic scale. Samples (d) and (e)

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were the most appreciated by the tasters. No significant differences were observed in color preference among the yogurt–date syrup samples. However, the color of the yogurt was affected by the concentration of added date syrup. An increase in date syrup concentration resulted in a more intense yogurt color.

3.4. Sample Classification and Tasters' Overall Preference

The sensory evaluation of the yogurt-date syrup mixture indicated that tasters' preferences were primarily influenced by the concentration of date syrup. Sample (e) received the highest ranking (Figure 9).

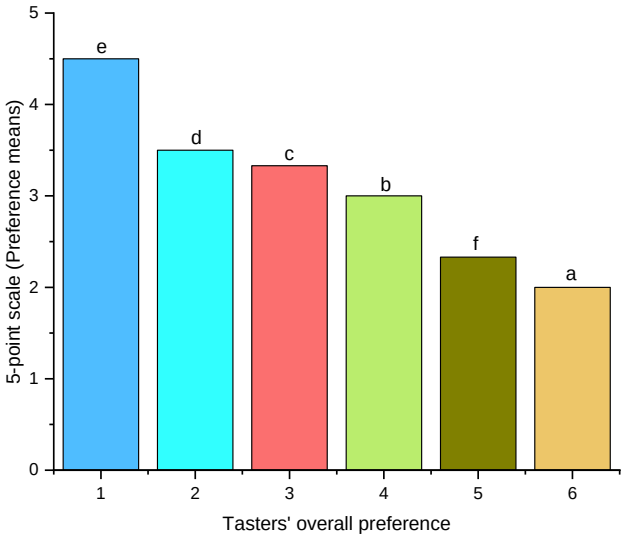

Figure 9. Ranking of yogurt-date syrup samples from most to least preferred (Source: Own elaboration).

However, sample (f), which contained a higher concentration of date syrup and exhibited a more pronounced acidity, as well as the control sample (a), which had no sweet flavor, were ranked less favorably compared to the other samples.

It is also worth noting that the yogurt-date syrup mixture showed a noticeable color change with increasing date syrup concentration (Figure 10).

Figure 10. Yogurt-date syrup samples (Original) – Photo by E. Benyagoub.

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4. Discussion

Date syrup demonstrates good microbiological quality that meets the Algerian standards, which is consistent with our previous findings [24, 33]. This microbiological safety is largely due to the syrup's production process, which includes thermal treatment. This heat treatment is sufficient to inactivate most vegetative microbial cells and many spores. Additionally, the syrup's low water activity (due to high sugar concentration) and its natural acidity create an inhospitable environment for microbial growth, thereby extending shelf life and enhancing safety [4, 6, 7, 24]. These properties make Robb suitable for direct consumption and incorporation into value-added products such as dairy formulations.

Through sensory analysis, the panelists observed a strong acidity in sample (f), which contained a higher concentration of date syrup. This finding aligns with the studies of Ghafoor et al. [2] and Moustafa et al. [34], who noted that the presence of Robb in yogurt could lead to increased acidity. Mechanistically, this may be attributed to the higher concentrations of fermentable sugars (e.g., glucose and fructose) present in Robb, which serve as key substrates for lactic acid bacteria (LAB) during fermentation. The increased availability of these sugars can enhance LAB metabolic activity, leading to elevated lactic acid production and a consequent decrease in pH. Additionally, Robb contains essential micronutrients such as potassium, magnesium, and B vitamins, which may further promote the growth of starter cultures, improve fermentation efficiency, and enhance their survival during cold storage [35, 36]. Together, these factors contribute to Robb's enhanced probiotic potential [11, 37].

Several studies, including those by Ghafoor et al. [2], Alhamdan et al. [12], Moustafa et al. [34], Hemmati et al. [35], and Amerinasab et al. [38], have reported that adding date syrup to yogurt enhances its nutritional and functional properties by increasing the total phenolic content, improving DPPH antiradical activity, and raising viscosity, total solids, and ash content. At the same time, it can reduce both the total bacterial count and the total yeast and mold count [12].

The observed changes in the yogurt's viscosity can be explained by the interaction between yogurt proteins and the phenolic compounds in the date syrup, which helps form a firmer, three-dimensional network, increasing the gel viscosity [2].

Furthermore, date syrup enriches the yogurt with essential nutrients, such as vitamins, polyphenols, and amino acids, as noted by Amellal [39]. These findings highlight the nutritional benefits of incorporating date syrup into dairy products, suggesting that it not only improves the sensory characteristics of yogurt but also enhances its health-promoting properties, as confirmed by Nikpour and Mosavian [40]. However, higher concentrations (above 8%) can lead to excessive acidity and whey separation, resulting in lower sensory scores, as reported by Moustafa et al. [34].

Importantly, Robb-enriched yogurts were more favorably received than the control sample, supporting the use of Robb as both a natural sweetener and functional ingredient. Unlike refined sugars, Robb provides sweetness along with fiber, polyphenols, and essential nutrients, which together support better metabolic outcomes and overall consumer health. Furthermore, it promotes cleaner labeling by reducing the need for artificial additives, preservatives, or colorants, making it suitable for health-conscious and clean-label product formulations [12, 41, 42].

The microbiological and biochemical properties of date syrup contribute to the enhanced sensory qualities of yogurt, making it a safe and nutritious flavoring ingredient for developing flavored dairy products [12]. The optimal Robb concentration for yogurt formulation was found to be 7%, as this level yielded the highest panelist scores in flavor, aroma, firmness, viscosity, low syneresis, and overall acceptability. This suggests a threshold beyond which the balance between acidity, sweetness, and texture is compromised. These findings agree with Amerinasab et al. [38] and Moustafa et al. [34], who also found the 6–8% range to be ideal for yogurt enrichment using date-based products.

All samples scored at least 2 on the 5-point hedonic scale, suggesting an overall favorable perception. The consistent acceptability across formulations highlights the robustness of Robb as a yogurt fortifier and its potential for commercial application in health-focused dairy products.

Conclusion

Tasters' preferences were influenced by the balance between sweetness, acidity, and texture. The formulation containing 7% date syrup received the highest ranking. Incorporating date syrup at this

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optimal concentration not only enhanced the perceived sweetness, moderate acidity, color, and firm texture but also contributed to the overall quality of the Robb-flavored yogurt. Furthermore, it provides a strong alternative to artificial sweeteners. These results highlight the promising potential of date syrup, derived from widely available varieties of common dates, in enhancing dairy products and open up exciting possibilities for future product development and increased consumer satisfaction.

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Compliance with Ethical Standards
Conflict of interest : The authors declare that they have no conflict of interest.
Ethical approval : Informed consent was obtained from all taster participants prior to their involvement in the study, and their anonymity was respected.

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