



## Effect of natural sweeteners on the physicochemical, nutritional, sensory, and microbiological properties of carrot-coconut gel pudding

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### ABSTRACT

The market for sugar-reduced products is expanding rapidly due to increasing health awareness among consumers and advancements in sweetener technology. Consumers are actively seeking to reduce sugar intake, making sugar the primary ingredient targeted for reduction. Consequently, products labeled as "no added sugar," "sugar-free," or "low sugar" are gaining considerable popularity. Manufacturers are therefore developing innovative formulations to overcome challenges related to taste, texture, and consumer acceptability, ensuring the commercial viability of sugar-replaced gel puddings. This study was conducted to evaluate the effects of replacing refined sugar with natural sweeteners, dates, and honey, on carrot-coconut gel pudding. Seven formulations were prepared: a sugar-based control (S), honey-based samples (H1: 90g, H2: 80g, H3: 70g), and date-based samples (D1: 90g, D2: 80g, D3: 70g). Physicochemical properties, proximate composition, energy content, sensory attributes, and microbiological quality were analyzed. The results revealed that sample D1 (90g dates) exhibited the highest levels of crude fiber ( $12.88 \pm 0.005\%$ ), vitamin A ( $30.85 \pm 0.05$  RAE/g), protein ( $4.12 \pm 0.03\%$ ), fat ( $10.20 \pm 0.00\%$ ), calcium ( $2.98 \pm 0.02$  mg/g), potassium ( $2.83 \pm 0.02$  mg/g), and sodium ( $68.90 \pm 0.02$  mg/g) among all formulations. In contrast, the sugar-based control demonstrated the highest energy value and overall sensory acceptability. No yeast or mold growth was detected in any sample during seven days of storage, while microbial load was comparatively higher in the control sample. Although sugar-based pudding exhibited higher energy content and acceptability, the date- and honey-based puddings-particularly the formulation containing 90g dates-offered significantly improved nutritional quality. These findings support the potential use of dates and honey as natural sweeteners for the development of healthier functional desserts.

**Keywords:** Natural sweeteners, Dates, Honey, Gel pudding, Nutritional evaluation, Sensory analysis, Microbiological quality

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### Introduction

Puddings and dairy desserts are semisolid foods produced by cooking, baking, or steaming a cereal, flour, or batter with milk. Common ingredients include sugar, eggs, various starches, tapioca, rice or rice flour, tapioca granules, gelatin, seaweed extracts

such as alginates, hydrocolloids like carrageenan, as well as flavors and colors (Chandan and Kilara, 2015). It is estimated that sugars, preserves, and confectionery account for 21% of free sugars in total energy, with 5% especially allocated to sugar



confectionery (Weaver *et al.*, 2014). Foods with elevated sugar levels have been demonstrated to generate substances with psychedelic properties (DiNicolantonio *et al.*, 2017). Over the past fifty years, the global consumption of sugar has tripled due to contemporary lifestyles and shifts in consumer dietary choices (Lustig *et al.*, 2012). Excessive intake of refined sugar is linked to non-communicable diseases and several health problems, including an elevated risk of dental caries, obesity, and neurodevelopmental difficulties in children (Jomaa *et al.*, 2020). As a result, the U.S. Department of Agriculture (USDA) advises that added sugar intake should comprise 6–10% of total energy consumption (Manickvasagan *et al.*, 2018). Despite the concerns about caloric content, no significant reductions in the usage of confectionery foods are expected. A potential reason might be that these foods can enhance the mood levels instantly desired by consumers (Konar *et al.*, 2022). Due to which, numerous plant-derived sources may be regarded as alternative sugar sources that provide beyond basic nutritional benefits as well. Functional foods incorporating medicinal plants are gaining popularity because they are scientifically proven, have fewer side effects, and are eco-friendly. Using natural sweeteners aligns with this approach. Moreover, all plant-based sources offer supplementary nutritional benefits (Curi *et al.*, 2017). Among naturally occurring sweeteners, date and honey appear to be the optimal selections (Shanta *et al.*, 2021). Dates are a superior source of carbohydrates, primarily consisting of glucose and fructose (Shehzad *et al.*, 2021). Likewise, honey is a naturally occurring sweetener with a complex makeup. It comprises approximately 200 components, predominantly consisting of sugars (75% are monosaccharides, 10–15% are disaccharides, with trace amounts of other sugars). Honey contains about 38% fructose and over 30% glucose (da Silva *et al.*, 2016). This study generated 3 distinct types of puddings utilizing dates and honey in varying amounts, and a comparison was conducted with a control sample composed of carrot and coconut milk with sugar. A pudding made from coconut milk and carrots, sweetened with dates and honey, has the potential to be a functional food due to the inherent health benefits of its ingredients. Coconut provides healthy fats, fiber, and minerals, while carrots offer bioactive compounds. Dates and honey offer natural sweetness and additional nutrients. It provides a nutritious, allergen-free, and ethically-sourced dessert option that meets

the increasing desire for plant-based alternatives.

The objective of this study was to formulate a functional pudding using coconut milk and carrot, incorporating date and honey as natural sweeteners to create a healthier, sugar-reduced alternative. By comparing these formulations to a sugar-based control, the study aimed to evaluate the impact of natural sweeteners on the pudding's physicochemical properties and microbial stability. Ultimately, this research seeks to develop a nutritious, consumer-friendly product that aligns with the growing demand for healthier, sustainable food options.

## Materials and Methods

### Sample collection

Fresh carrots (*Daucus carota*) were collected from Reazuddin Bazar in Chattogram, Bangladesh. The average weight of each carrot was  $210 \pm 2.5$  g. The consistency in dimensions and hue of the peel was distinctly maintained. Natural organic coconut milk powder, dates and honey were acquired from a local supermarket. All compounds employed in this study were of analytical grade.

### Sample preparation

The carrots were subsequently peeled and sliced into approximately 2–3 mm thick slices using a Panasonic MK-5086M slicer. The sliced carrot was then extracted using a Panasonic MX-AC300 Mixer Grinder. Next, the crushed pulp was strained using muslin cloth to remove any impurities. The resulting carrot juice was then carefully poured into a 500 ml hot-filling PET bottle. Coconut milk was prepared by mixing coconut milk powder with lukewarm water. For thick cream, 1/3 cup of coconut milk powder was mixed with 1 cup of warm water until a thick and creamy consistency is achieved.

### Preparation of carrot and coconut milk pudding

The pudding was manufactured according to the procedure outlined in Fellendorf *et al.* (2015), with minor formulation adjustments. To cook this carrot and coconut milk pudding, chopped carrots were boiled until tender and then mixed with a portion of coconut milk to produce a smooth purée. Simultaneously, dates were immersed in hot water to soften, and thereafter mixed into a paste. Subsequently, in a saucepan, the remaining coconut milk was combined with date paste/honey/sugar. Slowly integrated the carrot puree into the liquid, continuously

stirring over medium heat. The pudding will become denser with ongoing stirring after the addition of agar-agar. Upon achieving the proper consistency, the pan was removed from the heat. Subsequently, transfer the

heated pudding into serving dishes or a large bowl, cover the surface with plastic wrap to avert the formation of a skin, and chill for a minimum of three hours until it solidifies.

Table 1. Formulation of carrot coconut milk gel pudding.

| Ingredients  | Using Sugar | Using Honey |       |       | Using Dates |       |       |
|--------------|-------------|-------------|-------|-------|-------------|-------|-------|
|              | S (Control) | H1          | H2    | H3    | D1          | D2    | D3    |
| Coconut milk | 500ml       | 500ml       | 500ml | 500ml | 500ml       | 500ml | 500ml |
| Carrot       | 200g        | 200g        | 200g  | 200g  | 200g        | 200g  | 200g  |
| Sugar        | 100g        | 0g          | 0g    | 0g    | 0g          | 0g    | 0g    |
| Agar         | 2g          | 2g          | 2g    | 2g    | 2g          | 2g    | 2g    |
| Honey        |             | 90g         | 80g   | 70g   |             |       |       |
| Date         |             |             |       |       | 90g         | 80g   | 70g   |

### **Physicochemical analysis of gel pudding**

**pH:** The pH was measured using a pH meter (Hanna, Romania).

**Titrateable acidity:** The titrateable acidity of the sample was determined by titration with a 0.1 N sodium hydroxide solution. The findings were expressed as the concentration of citric acid per 100 mL of juice (Sadler and Murphy, 2010).

### **Proximate analysis of gel pudding**

The constituent parts of the pudding sample were evaluated using the AOAC standard method (DM Basis) (AOAC, 2023). The moisture, ash, crude protein, crude fiber, and crude fat contents were quantified using the dry ash technique, oven drying method, Kjeldahl method, gravimetric method, and Soxhlet method, respectively.

### **Vitamin and mineral analysis of gel pudding**

#### *Vitamin A quantification*

High Performance Liquid Chromatographic (HPLC) procedures are regarded as the sole appropriate techniques for obtaining precise measurements of vitamin A activity. The method outlined in Nielsen (2014) was used to ascertain the amount of Vitamin A.

The quantification of potassium (K), sodium (Na) and calcium (Ca) was performed using the Atomic Absorption Spectroscopy (AAS) method, as described by the Association of Official Analytical Chemists (AOAC, 2023).

### **Microbial analysis**

#### *Aerobic plate count (bacterial plate count)*

The shelf life of the food, as well as a potential change in its organoleptic characteristics, can both be revealed by APC. The number of microorganisms in the

prepared and stored samples was calculated using an SPC according to procedures mentioned in AOAC (2023).

#### *Fungal analysis in gel pudding*

The selective medium Sabouraud Dextrose Agar (SDA) is mostly used for the isolation of dermatophytes, different fungi, and yeasts. It can support the growth of filamentous bacteria like Nocardia (Haneuse *et al.*, 2023). The samples were checked for fungal development weekly, and they were kept for one week before being judged to be negative.

### **Sensory evaluation**

Using the 9-point Hedonic scale Armstrong *et al.* (1997), the 7 samples' sensory evaluation of the qualitative criteria (taste, appearance, color, smell, texture, sweetness, and overall approval) was conducted. A group of taste testers assessed if the developed product was acceptable to consumers. There were both teachers and students on the panel for the test, which was conducted on the grounds of CVASU.

### **Statistical analysis**

For statistical analysis, data were gathered and stored on a Microsoft Excel 2013 spreadsheet. Every sample was used three times. Descriptive statistics (mean and standard deviation) were used for the sensory investigation and evaluation of gel pudding. Data on proximate, vitamin, mineral, and sensory assessment, as well as microbiological data, were examined using one-way ANOVA techniques. ANOVA is one method used to assess the importance of variation at a 95% confidence level. Using a post hoc "Tukey" test, the variation across the sample groups was determined. The statistical analysis was performed at 5% level of significance ( $p \leq 0.05$ ).

## Results

### Physiological properties of gel pudding

pH content of gel pudding is shown in Table 2; almost all samples are significantly the same. In table 2, the highest pH found in

sample S and lowest in sample H1 and the pH values ranged from 5.01 to 7.00 for the control one. The least value ( $0.20 \pm 0.00$ ) of acidity obtained in sample S and highest value ( $0.50 \pm 0.00$ ) found in sample H1 and the values ranged from 0.20 to 0.50.

Table 2. Physiochemical properties of gel pudding.

| Sample | pH                | Acidity (%)          |
|--------|-------------------|----------------------|
| S      | $7.00 \pm 0.00^b$ | $0.20 \pm 0.00^c$    |
| H1     | $5.01 \pm 0.02^c$ | $0.50 \pm 0.00^b$    |
| H2     | $5.79 \pm 0.01^c$ | $0.44 \pm 0.00^c$    |
| H3     | $6.50 \pm 0.00^c$ | $0.26 \pm 0.05^{bc}$ |
| D1     | $5.90 \pm 0.01^d$ | $0.40 \pm 0.00^a$    |
| D2     | $6.80 \pm 0.00^c$ | $0.26 \pm 0.05^{bc}$ |
| D3     | $6.97 \pm 0.00^c$ | $0.23 \pm 0.00^b$    |

Means  $\pm$  SD and values in the same rows with the same superscripts are not statistically significant ( $P < 0.05$ )

The pH of commercial puddings is typically regulated to approximately 6.5 to 6.8 (Rapp, 1986). This range is meticulously regulated to ensure product stability, inhibit microbiological proliferation, and preserve the intended texture and flavor. A reduced pH can impede the proliferation of spoiling germs and pathogens, therefore prolonging the shelf life of pudding products (Yang et al., 2023). A reduced pH can augment gel strength, which is crucial for achieving the optimum consistency in puddings (Karimidastjerd et al., 2024). Honey possesses acidity, with a pH often between 3.2 and 4.5. Incorporating honey into

puddings may decrease the overall pH of the mixture (Khan et al., 2018). It is evident from the result that honey generally has the most significant potential to lower pH, followed by date products, while sugar has the least direct impact on pH. Additionally, all three sweeteners can increase titratable acidity, with honey and date products likely having a more pronounced effect than sugar alone.

### Proximate composition of gel pudding

Table 3 gives information of the nutritional value of gel pudding, almost all sample varied considerably.

Table 3. Proximate composition and energy content of carrot and coconut milk pudding.

| Sample | Moisture           | Crude fiber (%)    | Ash (%)            | Crude fat (%)      | Crude protein (%)  | CHO (%)            |
|--------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| S      | $61.60 \pm 0.02^e$ | $5.12 \pm 0.02^f$  | $2.17 \pm 0.005^b$ | $9.12 \pm 0.01^c$  | $3.70 \pm 0.010^a$ | $23.40 \pm 0.03^a$ |
| H1     | $65.20 \pm 0.01^c$ | $6.08 \pm 0.02^d$  | $1.74 \pm 0.45^b$  | $8.05 \pm 0.08^e$  | $3.00 \pm 0.00^b$  | $22.00 \pm 0.51^b$ |
| H2     | $65.10 \pm 0.17^a$ | $5.59 \pm 0.02^e$  | $1.94 \pm 0.01^b$  | $8.01 \pm 0.01^e$  | $2.98 \pm 0.01^b$  | $21.96 \pm 0.15^b$ |
| H3     | $64.84 \pm 0.02^d$ | $5.13 \pm 0.11^f$  | $1.87 \pm 0.005^b$ | $8.50 \pm 0.02^d$  | $2.89 \pm 0.01^b$  | $21.89 \pm 0.05^b$ |
| D1     | $60.17 \pm 0.14^b$ | $12.88 \pm 0.00^a$ | $2.93 \pm 0.01^a$  | $12.20 \pm 0.00^a$ | $4.93 \pm 0.03^a$  | $19.57 \pm 0.15^c$ |
| D2     | $59.16 \pm 0.02^b$ | $12.67 \pm 0.00^b$ | $2.94 \pm 0.07^a$  | $11.80 \pm 0.07^a$ | $4.52 \pm 0.44^a$  | $19.56 \pm 0.44^c$ |
| D3     | $58.01 \pm 0.02^d$ | $10.49 \pm 0.01^c$ | $2.95 \pm 0.13^a$  | $12.20 \pm 0.08^a$ | $4.13 \pm 0.18^a$  | $18.55 \pm 0.30^c$ |

Means  $\pm$  SD and values in the same rows with the same superscripts are not statistically significant ( $P < 0.05$ )

Sugar and honey are hygroscopic (Hasan et al., 2025), signifying their ability to attract and hold moisture. Utilizing sugar and honey as a sweetener may yield a marginally elevated moisture content in comparison to alternative sweeteners initially. From the formulated puddings, it is evident that sample H1 contains the highest moisture content (65.20%) followed by H2 (65.10%).

Crude fiber denotes the indigestible plant matter found in food. Carrots provide a substantial amount of nutritional fiber, but coconut milk contains minimal fiber. The sweeteners themselves provide different quantities of fiber. Refined sugar possesses negligible fiber content. Honey includes negligible levels of fiber; nevertheless, it is not a substantial source. Dates provide as an excellent source of dietary fiber (Afolake et al., 2023). Consequently, the highest crude

fiber level was found in puddings with dates (H1, H2, H3), followed by those with honey and sugar. There was no significant disparity observed in terms of ash content. The values ranged from 1.74 to 2.95%.

The primary source of fat and protein in this pudding is coconut milk, which is high in saturated fats and protein. Carrots contain negligible amounts of fat, while the sweeteners themselves have no significant fat or protein content except for dates. Dates contain a small amount of fat, which may marginally increase the overall fat content. Therefore, the highest fat content was observed in date incorporated puddings (D1, D2 and D3) with 12.20% being the highest. And the lowest was observed for control sample S. The Variation in protein values is rather minimal. As it ranged from 2.89 (H3) to 4.93% (D1).

Carbohydrates will provide the primary component of the pudding [Sharma and](#)

[Meghwal \(2021\)](#), sourced from coconut milk, carrots, and the incorporated sweetener. The choice of sweetener will markedly affect the overall carbohydrate composition. Dates possess a significant carbohydrate content, however slightly lower than that of sugar or honey-based desserts, owing to the inclusion of additional nutrients ([Afolake et al., 2023](#)). As a result, a comparatively lower carbohydrate content was observed for D1, D2 and D3. The highest was observed in control sample S.

In conclusion, honey-based puddings exhibited greater moisture content, marginally elevated ash and protein levels, while maintaining comparable carbohydrate content when contrasted with sugar-based puddings. Date-based puddings demonstrated elevated levels of crude fiber, ash, and protein, a marginally increased fat content, and a more varied nutritional composition overall.

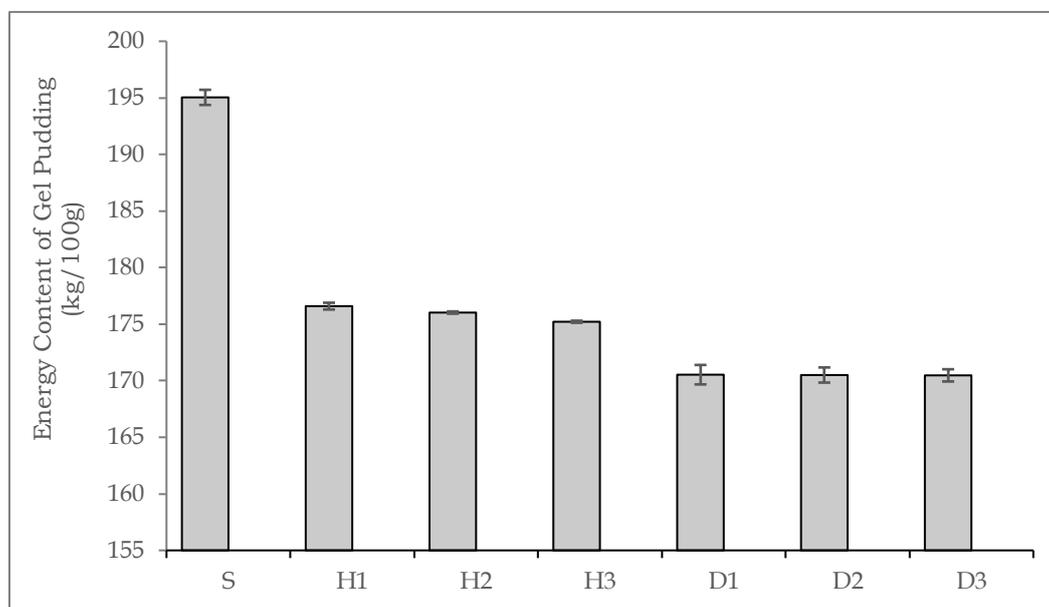


Fig. 1. Estimated energy of the formulated pudding.

The energy content of food products is a crucial aspect of their nutritional profile. It is primarily derived from the macronutrients: carbohydrates, fats, and proteins. In the context of coconut milk and carrot puddings, the energy content will be influenced by the choice of sweetener, as the proportions of carrot and coconut milk are identical for all the samples. Standard dairy-based puddings typically have 120-180 calories per 100 grams of energy ([Aguilar-Raymundo and Vélez-Ruiz, 2018](#)). Considering the values exhibited in Fig. 1, it is evident that sample S contains the maximum amount of energy (195.04), followed by H1. It is because sugar,

being highly concentrated, provides the highest energy. Honey, while similar, has water and nutrients, slightly diluting its calorie density. Dates, being whole foods with fiber and water, are less energy-dense. This results in sugar > honey > dates in energy content.

#### **Vitamin and mineral analysis of formulated pudding**

Table 4 expresses the vitamin A content and Mineral analysis (Calcium, Potassium and Sodium) content of formulated carrot and coconut milk pudding.

Table 4. Vitamin A and Mineral content of formulated pudding.

| Sample | Vitamin A (RAE/g)         | Calcium (mg/g)           | Potassium (mg/g)         | Sodium (mg/g)             |
|--------|---------------------------|--------------------------|--------------------------|---------------------------|
| S      | 29.12 ± 0.02 <sup>d</sup> | 1.42 ± 0.02 <sup>f</sup> | 1.66 ± 0.01 <sup>g</sup> | 55.08 ± 0.07 <sup>d</sup> |
| H1     | 28.95 ± 0.02 <sup>e</sup> | 1.60 ± 0.02 <sup>d</sup> | 2.10 ± 0.02 <sup>d</sup> | 57.10 ± 0.02 <sup>b</sup> |
| H2     | 28.43 ± 0.03 <sup>f</sup> | 1.50 ± 0.02 <sup>e</sup> | 1.94 ± 0.01 <sup>e</sup> | 55.90 ± 0.02 <sup>c</sup> |
| H3     | 27.90 ± 0.02 <sup>g</sup> | 1.30 ± 0.02 <sup>g</sup> | 1.74 ± 0.01 <sup>f</sup> | 53.40 ± 0.02 <sup>f</sup> |
| D1     | 29.85 ± 0.05 <sup>a</sup> | 3.98 ± 0.02 <sup>a</sup> | 3.83 ± 0.02 <sup>a</sup> | 58.90 ± 0.02 <sup>a</sup> |
| D2     | 29.44 ± 0.04 <sup>b</sup> | 3.50 ± 0.02 <sup>b</sup> | 3.60 ± 0.02 <sup>b</sup> | 57.10 ± 0.02 <sup>b</sup> |
| D3     | 29.01 ± 0.03 <sup>c</sup> | 3.32 ± 0.02 <sup>c</sup> | 3.33 ± 0.02 <sup>c</sup> | 55.70 ± 0.02 <sup>c</sup> |

Means ± SD and values in the same rows with the same superscripts are not statistically significant ( $P < 0.05$ )

Table 4 demonstrates that the vitamin A concentration of the formed puddings varies from 27.90 to 29.12 RAE/g. All samples exhibit identical amounts, predominantly derived from the carrots. A 100-gram portion of carrots comprises roughly 835 micrograms (69.58 RAE/g) of vitamin A, predominantly in the form of provitamin A carotenoids, mainly beta-carotene, which the body metabolizes into retinol (active vitamin A) (Tang et al., 2005). Processing, particularly cooking, can reduce the vitamin A content of green vegetables by 15-20% and yellow vegetables by 30-35% (Kramer, 1977).

In terms of calcium and potassium, the date-sweetened puddings possess the highest calcium (3.98, 3.50, 3.32 mg/g) and potassium level (3.83, 3.60, 3.33 mg/g), followed by the honey-sweetened pudding (1.60, 1.50, 1.30 mg/g). The control with sugar has the lowest calcium and potassium levels, as sugar does not contribute to calcium content.

The utilization of natural sweeteners enhances the overall mineral profile, although it may also lead to elevated sodium levels. The values ranged from 53.40 to 58.90 mg/g sodium content. Coconut milk, although its relatively low sodium concentration (15 mg/100 g), nevertheless contributes to the overall sodium levels. Natural sweeteners, such as dates and honey, possess a higher mineral content, including sodium, in comparison to refined sugar (Padmanabhan, 2024). The interactions among ingredients during processing may influence the distribution and concentration of minerals (Choobkar et al., 2022).

### Sensory evaluation

The following radar graph exhibits the result of sensory evaluation of the formulated pudding. The overall acceptance was compared against the control sample S.

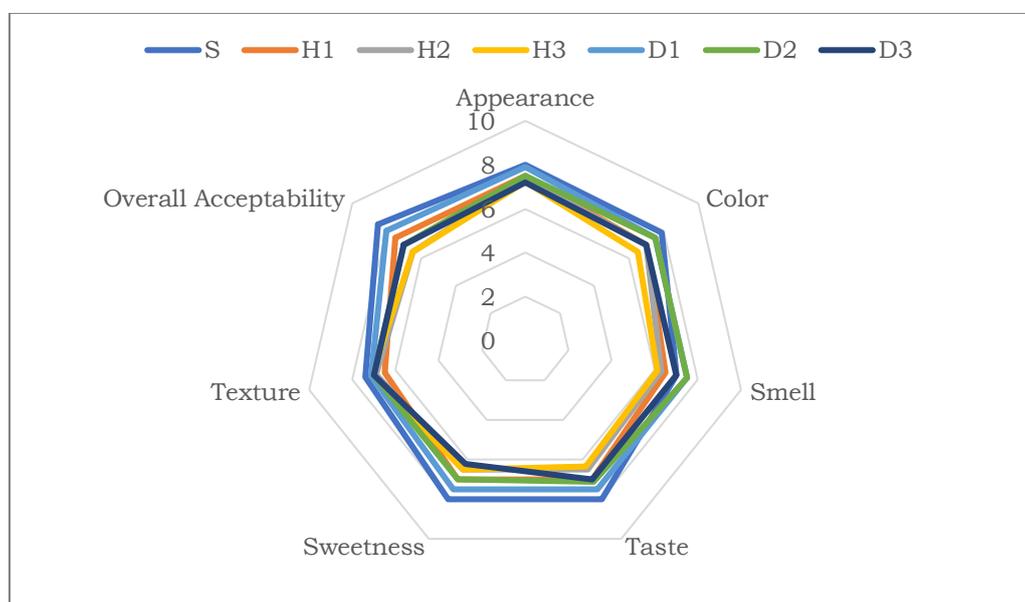


Fig. 2. Sensory evaluation of the formulated pudding.

The incorporation of natural sweeteners such as dates and honey in this formulation addresses the growing customer demand for clean-label products and natural ingredients. The significant acceptability of the date-sweetened custard (D1), closely trailing the control sample (S), indicates the feasibility of using dates as a substitute for refined sugar in custard recipes. This discovery corroborates prior studies indicating that dates can effectively substitute sugar in conventional confections while preserving sensory pleasure (Yargatti and Deshmane, 2025). The favorable reception of D1 can be ascribed to the rich, caramel-like flavor of dates, which enhances the foundation components while preserving an appealing level of sweetness (Yargatti and Deshmane, 2025). Following D1, H1 exhibits the best overall appeal; yet, it is deficient in aroma and texture. The unfavorable reaction to the honey-sweetened pudding, especially concerning aroma and consistency,

illustrates prevalent issues noted in prior research. The powerful and unique fragrance of honey can dominate other components, possibly resulting in an imbalance in the overall flavor profile. The incorporation of honey has demonstrated an impact on the structural characteristics of desserts, potentially leading to a less favorable texture assessment (Medeiros et al., 2024). Regarding sweetness, it is comparable to control S. Upon deeper examination, alternative forms of honey, H2 and H3, exhibit minimal sweetness and overall acceptability. D2 and D3 appear generally appropriate in terms of dates. D1 is heartily embraced by all participants. When solely considering the sensory properties, D1 can entirely dominate S.

#### **Microbial analysis (SPC, Yeast and Mold)**

Microbiological evaluation of experimental gel pudding is illustrated in Table 5.

Table 5. Microbial analysis of formulated pudding.

| Formulations of jelly pudding | TVC (ml)  |                    |                   | Yeast & mold |
|-------------------------------|-----------|--------------------|-------------------|--------------|
|                               | 0 days    | 3 days             | 7 days            | 7 days       |
| S                             | No growth | $2.62 \times 10^2$ | $204 \times 10^4$ | No growth    |
| H1                            | No growth | $1.31 \times 10^2$ | $11 \times 10^3$  | No growth    |
| H2                            | No growth | $1.50 \times 10^2$ | $67 \times 10^3$  | No growth    |
| H3                            | No growth | $2.04 \times 10^2$ | $80 \times 10^3$  | No growth    |
| D1                            | No growth | $2.32 \times 10^2$ | $95 \times 10^4$  | No growth    |
| D2                            | No growth | $1.18 \times 10^2$ | $105 \times 10^3$ | No growth    |
| D3                            | No growth | $1.87 \times 10^2$ | $120 \times 10^3$ | No growth    |

The lack of microbial development at day 0 in all formulations (S, H1-H3, D1-D3) signifies commendable beginning hygiene procedures and efficient processing conditions. This foundational sterility is essential for guaranteeing product safety and quality during manufacture.

#### **Total Viable Count (TVC) Progression**

All formulations exhibited comparatively low bacterial counts on day 3, ranging from  $1.18 \times 10^2$  to  $2.62 \times 10^2$  CFU/ml. The control sample (S) demonstrated the highest total viable count (TVC) at  $2.62 \times 10^2$  CFU/ml, indicating that refined sugar offers inferior antimicrobial protection relative to natural sweeteners. Samples containing honey (H1-H3) had generally lower total viable counts (TVC) than date samples, a phenomenon attributable to honey's inherent antibacterial characteristics (Albaridi, 2019; Mandal and Mandal, 2011). The sugar-based control (S) exhibited the maximum microbial multiplication ( $204 \times 10^4$  CFU/ml), suggesting minimal preservation efficacy of refined sugar. The elevated growth rate can be

attributed to sugar's fundamental function as a nutrition supply rather than as an antibacterial agent. Samples H1-H3 exhibited markedly reduced total viable count ( $11 \times 10^3$  -  $80 \times 10^3$  CFU/ml) in comparison to the control. The exceptional antibacterial efficacy can be ascribed to honey's several preservation mechanisms: Reduced water activity, Natural acidity (pH 3.2-4.5), Presence of hydrogen peroxide, Bioactive constituents including methylglyoxal. Date-containing formulations (D1-D3) exhibited moderate microbial proliferation ( $95 \times 10^4$  -  $120 \times 10^3$  CFU/ml) (Almasaudi, 2021). Although dates have certain antibacterial characteristics, they are less effective than honey in inhibiting microbial development.

The lack of yeast and mold proliferation on day 7 across all formulations is significant and can be ascribed to: The synergistic antibacterial effects of coconut milk, which contains lauric acid with inherent antimicrobial capabilities. The lowering of water activity attained by incorporating sweets. Potential synergistic interactions

among components that render conditions unfavorable for fungal proliferation (Mauro and Garcia, 2019). The observed microbial counts, while showing growth over time, remain within acceptable ranges for similar dessert products according to food safety guidelines (Gilbert et al., 2000).

## Conclusion

In recent years, considerable attention in food research has focused on the creation of novel designed goods. Pudding, being a delicious and nutritious option, constitutes an exemplary choice for persons pursuing a healthy breakfast or snack. This experiment used honey and dates as sugar substitutes in gel pudding to examine their impact on the nutritional attributes and sensory characteristics of the resulting products. This study showed that, while energy content and sensory acceptance are greater in sugar-based products, the nutritional value was dramatically elevated in the treatment puddings, particularly the one made with dates (D1). The microbial content was mild in accordance with food safety standards. Consequently, the findings indicated the feasibility of employing date paste or honey for the commercial production of sweet desserts and confections. This preliminary study supports future research focused on optimizing substitute inclusion concentrations, evaluating panel test performance for broad public acceptance, and identifying potential bioactive compounds to assess their health benefits and various biological factors in humans.

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