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Sensory impacts and consumer acceptability of using dates as an alternative functional sweetener in traditional Indian sweets

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ABSTRACT

Background: Natural ingredients are increasingly valued by consumers, influencing the food industry significantly. While the functional and pharmacological benefits of Date Fruit are established widely, its application remains largely confined to traditional Indian sweets as a substitute for sugar. Traditional Indian sweets hold high cultural significance and, traditionally, rely on sugar for production. This study aims to understand the change in sensory characteristics of selective Indian sweets, specifically Seviyan Kheer when sugar is replaced with date syrup.

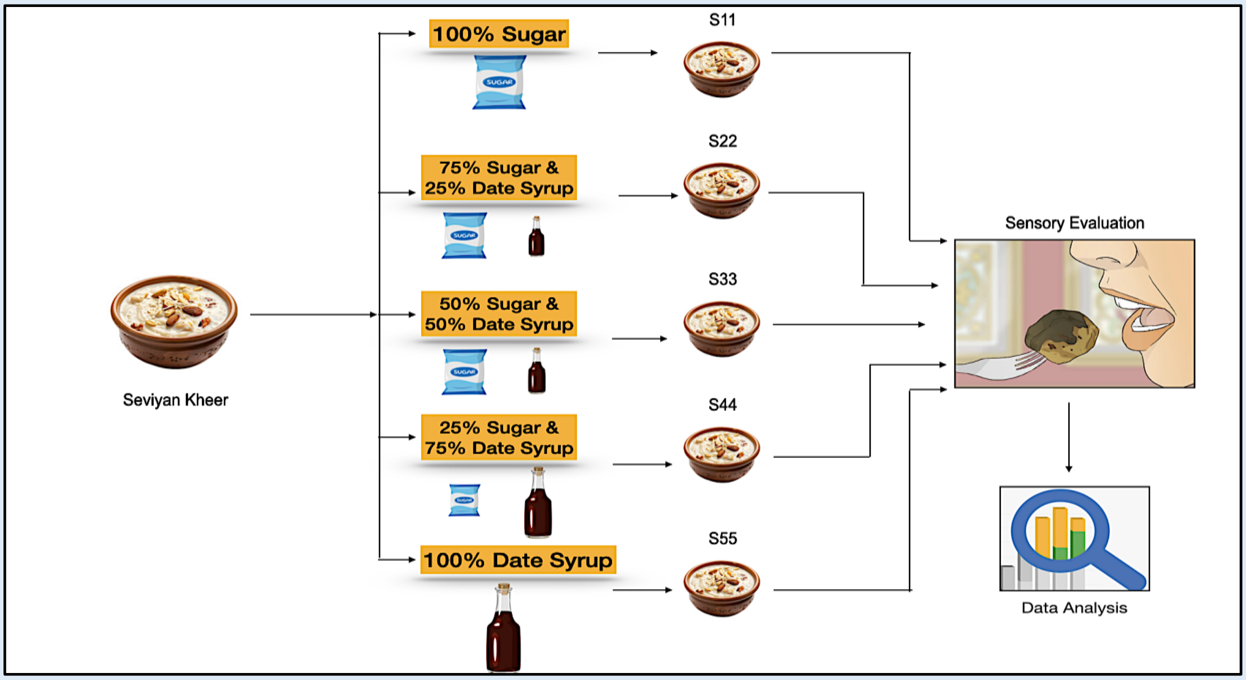
Objective: To review the functional properties of dates and investigate the effects of replacing sugar with dates in a traditional Indian sweet, Seviyan kheer, with a focus on sensory qualities.

Methods: Seviyan Kheer was prepared using varying amounts of date syrup as a sugar substitute. A comprehensive consumer preference test was carried out, and the data collected was analyzed using SPSS to determine significant differences between different samples.

Results: Among the five samples [S11, S22, S33, S44, and S55], the control sample [S11] showed highest preference. All samples were significantly different from each other across various sensory attributes [Colour, Taste, Aroma, Texture/Consistency, After Taste, and Overall Acceptability]. S11 received a cumulative satisfaction score of 100% before tapering down to 35.3% for S55. This general pattern supports a decrease in customer satisfaction as the percentage of date syrup rose, particularly in cases where there was a substantial sugar substitution.

Conclusion: These results suggest that although date fruit has its advantage as a functional sweetener and has the potential to be a sugar substitute, modifications may be necessary to achieve a sensory satisfaction level comparable to traditional sugar-sweetened versions.

Keywords: Dates, Functional Sweetener, Sensory Evaluation, Consumer Acceptability, Traditional Indian Sweets, Alternative Sweeteners.



Graphical Abstract: Sensory Impacts and Consumer Acceptability of Using Dates as an Alternative Functional Sweetener in Traditional Indian Sweets

INTRODUCTION

Customers increasingly prioritize natural ingredients, significantly influencing the food industry [1]. Sweeteners have been used for decades to increase flavor and draw in customers. However, the high-calorie sugar-to-diet ratio associated with these sweeteners contributed to the obesity epidemic, which has notably affected young children and infants [2]. Both artificial and natural sweeteners with minimal or no calories cater to dieters' needs.

There are two types of natural sweeteners: bulk sweeteners and high-potency sweeteners. The latter's sweetness potency is comparable to or less than one sugar molecule, while the former does not match sugar's potency, the global benchmark for sweetness [3]. Although the consumer interest level is high, finding a natural sweetener with the necessary sensory quality is a difficult task. Unlike artificial sweeteners, whose structures can be modified to enhance flavor, natural sweeteners must retain their original structure to maintain their "natural" status [4]. Natural sweeteners include many substances, including proteins, sugars, sugar alcohols, amino acids, terpenoid glycosides, and polyphenols [5-6].

However, the market offers only those sweeteners that meet certain requirements, including safety, good flavor, stability, solubility, and affordability [7-8]. Health-conscious consumers are increasingly using natural sweeteners that are produced using environmentally friendly practices, like honey, molasses, blackstrap molasses, maple syrup, coconut sugar, agave nectar, date syrup, steviol glycosides, and sorghum syrup. Most of these sweeteners are easily incorporated into various commercial goods, often marketed as healthier options appealing to consumers' preferences [9].

As the link between diet and health becomes more apparent, functional foods have gained significant attention among consumers. Beyond providing basic nutrition, these foods offer additional benefits such as the prevention and management of chronic diseases like cardiovascular issues, osteoporosis, obesity, and certain cancers. They also enhance memory, physical fitness, and overall well-being [10-17]. According to the Functional Food Center, Functional foods [FF] are defined as "natural or processed foods that contain biologically active compounds, which, in defined, effective, non-toxic amounts, provide a clinically proven and documented health benefit utilizing specific biomarkers, for improving general health, for the prevention, management, or treatment of chronic and viral diseases or their symptoms" [18].

The inclusion of bioactive compounds that help prevent diseases is a defining feature of functional foods [19]. The increasing prevalence of lifestyle-related disorders such as diabetes, obesity, and cardiovascular diseases has further underscored the importance of incorporating bioactive-rich foods into daily diets. Functional foods enriched with antioxidants, prebiotics, and polyphenols are now recognized as strategic tools for enhancing quality of life. This shift reflects a broader demand for food solutions that are both nourishing and preventive, signaling a transformative era in nutrition science.

Recent research has focused on developing functional food products by integrating bioactive compounds to address health and nutritional concerns [20-21]. Natural sweeteners have different functional properties, making them useful for various food applications. Honey is rich in antioxidants and antimicrobial properties [22] and is used in cereal bars, cereals, and brewing [23]. Molasses contains antioxidants, including phenolic acids [24], and is used in yogurts, fermentation processes, and foundry [23]. Maple syrup, one of the most popular tabletop sweeteners, is used in beverages and confectionery and has antioxidant and anti-inflammatory effects [25]. Coconut sugar has antioxidants such as phenolic acids [26], and it is used in bakery, chocolate, and beverages [27]. Agave nectar, having antioxidant and antibacterial properties [28], is used in bakery, cereal bars, and beverages [23]. Stevia, with its antifungal and antibacterial properties [29], is used as a tabletop sweetener and in beverages, ice cream, bakery products, spices, and yogurts [23]. Sorghum syrup shows antioxidant, anti-inflammatory, antidiabetic, and obesity prevention properties, along with cardiovascular disease prevention, and is used in steamed products, baked foods, deep-fried products, and fermented alcoholic beverages [30]. In addition, monk fruit and yacon syrup are emerging functional benefits [23].

Dates: The date palm [Phoenix dactylifera L.], a woody tree from the monocotyledonous Angiosperm family *Arecaceae*, comprises approximately 200 genera and 2,500 species [31]. Believed to have originated in southern Iraq around 6,000 years ago, the date palm has adapted to semi-arid and arid climates, spreading to regions like Australia, India, Pakistan, Mexico, Southern Africa, South America, and the United States [32]. The date palm tree is special because it can survive in hot and dry conditions, tolerating temperatures as high as 50°C and flourishing within a temperature range of 17.5-27.5°C [33].

Due to their spiritual and cultural value, dates are an essential agricultural product throughout the Middle East, North Africa, and South America. Date palms also act as a canopy, offering protection and shade to vulnerable citrus fruit trees in the summer and winter. India is a significant customer, while the largest producers are Saudi Arabia, Egypt, and Iran [34]. The average yearly production of dates globally is between 6 and 8 million tons, with a market worth of around $1 billion USD [35].

Known as the "tree of life," the date palm has been celebrated for its nutritious benefits, several medicinal qualities, and sweet fruits that boost physical energy when eaten immediately after harvesting or as frozen products, processed minimally or not at all. The edible portion is the pericarp surrounding the seeds, which account for 10–15% of the fruit's weight and are often repurposed for animal feed and fertilizers [36].

Before the date fruit ripens, it goes through five stages. Each stage has a name that varies slightly depending on the founding culture. The Hababouk stage, which lasts for four to five weeks following fertilization, is the initial phase of fruit production, during which the fruit is immature [37]. Kimri Satage, also known as the "green stage," is thought to be the longest stage of date fruit development. The duration might range from nine to fourteen weeks, depending on the kind of date. It moves to the solid green fruit, which is still unfit for consumption. The next stage is the Khalal stage, where the fruit turns from green to yellow or red [38]. The Rutab stage, known as the soft ripe stage, lasts two to four weeks. During this time, the fruit's top starts to ripen, its texture softens, and its color becomes brown or black, depending on the variety. It also loses weight due to its low moisture content. It becomes sweeter as the amount of sugar increases, which is the right time to harvest and store it [39]. The Tamr stage is the ultimate or fully mature stage of maturation. When ripe, dates take on a black or purple color [40].

Chemical Composition of Date Fruit: The chemical composition of dates varies based on cultivar, agronomic practices, soil type, and ripening stage [41]. When fully ripe, dates contain 72–88% sugar, making them a high-energy snack. The sugar composition evolves during ripening. For example, at the Khalal stage, 80–85% of the sugar content is sucrose. As ripening progresses, sucrose hydrolyzes into reducing sugars like glucose and fructose [42]. Additionally, the moisture content of dates decreases as they mature, ranging from 10% to 30% at full ripeness.

Functional/Pharmacological Effects of Date Fruit: Antioxidant Effects - Dates are known to enhance the body's antioxidant defense system by combating oxidative stress—an imbalance caused by excessive free radical production that contributes to the onset and progression of various diseases. Certain research found a substantial correlation between the antioxidant potential of dates and the rich concentrations of certain date phytochemicals [43- 47].

Anti-Inflammatory Effects - In addition to their antioxidant properties, dates have been found to reduce inflammation, a key factor in the development of numerous chronic diseases. The high antioxidant activity of dates is also linked to a decrease in the inflammatory state, primarily caused by oxidative stress from free radicals [43]. Consistent results were observed in other investigations following the consumption of dates or their pits [48-52]

Anticancer properties - According to reports from various studies, dates can effectively inhibit the growth of malignant cells. For instance, methanolic extracts from Ajwa dates have suppressed the proliferation of tumor cells in cancers related to the colon, breast, prostate, lung, and stomach. To thoroughly examine the anticancer qualities of dates, more research is needed. [53]

Antidiabetic properties - Dates are a great source of potent substances that have antidiabetic properties, including flavonoids, phenols, steroids, and saponins. Several studies using diabetic rats have demonstrated these substances' free radical scavenging capabilities. When ingested, Ajwa date extracts may help reduce oxidative stress and maintain optimal kidney and liver performance [54].

Traditional medicine and customary therapeutic uses - Dates have long been utilized as preventative and medicinal substances in various countries, including Morocco, Iraq, India, Algeria, Iran, and Egypt [55]. Historical records indicate that dates were utilized to treat hypertension and diabetes. The kernels from dates were associated with decreased wrinkles and anti-aging in females [56-57]. Additionally, it has been reported that dates can aid in the hardening of a baby's gums, and when cooked with cardamom and black pepper, they can also help alleviate headaches, lethargy, moderate fever, and dry cough [58].

Related Studies: Numerous research investigations have been carried out to develop bakery goods that include date and date by-products. Based on an analysis of multiple studies, there are benefits and drawbacks of utilizing date components in baked goods. Dates and date by-products, rich in nutrient-dense substances, can enhance the nutritional content of baked goods and offer potential therapeutic benefits against chronic illnesses like diabetes, cancer, and cardiovascular disorders. At the same time, empirical data indicates that adding dates to baked goods results in a deeper hue. However, more research is necessary to determine how dates and byproducts affect composite baked foods' shelf lives [59].

Energy bars, also referred to as snack bars, are very nutritious on-the-go foods that are consumed widely all over the world. Researchers worldwide have developed various formulations of date-based bars to create satisfying snacks and explore their potential as functional foods. [60].

Incorporating plant-based extenders, such as date fruit co-products, in meat processing presents a valuable opportunity to enhance nutritional quality while reducing production costs [61]. There is extensive evidence supporting the addition of date fruit co-products to meat products like spreadable liver pates [62], ground beef [63], pork liver pate [64-65], bologna sausage [66], paprika dry cure sausage [67], and sausage [68].

Due to their high protein, vitamin, and mineral content, milk and dairy serve as an ideal medium for incorporating functional ingredients such as dates [69]. Date fruit co-products have been successfully integrated into a variety of dairy products like dairy desserts [70-71], yogurt [72-74], ice cream [75-77], fermented milk [78-79], prebiotic chocolate milk [80], and mold-ripened soft cheese [81].

Gaps in Literature: Most of the current study on meals, including dates, has been conducted on meat items, baked goods, and snack bars. However, traditional Indian sweets using dates have received limited attention. Although research suggests that dates may have nutritional and medicinal benefits, little is known about how they affect sensory attributes, including flavor, texture, and shelf life in various food systems, including dairy and desserts. Furthermore, large-scale consumer preference studies on date-enriched products remain scarce, particularly regarding acceptance across different age groups. Further investigation is needed into the industrial viability and scalability of utilizing dates in mass-produced food products. Filling these gaps may offer important new perspectives on the sensory and functional advantages of date-based components across various food categories.

MATERIALS AND METHODS:

Materials: The local grocery store in Pune City, Maharashtra was the source of all the ingredients utilized in the preparation. The same grocery store was used to buy Date Syrup, ghee [Govind ghee], Seviyan [Ganesh seviyan roasted], rawa [GSD suji rawa], and other products, including sugar, dry fruits, milk, cardamom powder, and nutmeg. Six volunteers with culinary expertise handled the cooking and setup for the sensory assessments in the Symbiosis School of Culinary Arts & Nutritional Sciences, Pune's Foundation training kitchen, which was used to standardize the recipes. The normal methodology was followed in setting up the environment for the sensory examination.

Figure 1- Foundation training lab at Symbiosis School of Culinary Arts & Nutritional Sciences

Preparation of Selected Recipes

Seviyan Kheer [Control]: The dry fruits were sautéed with 5 grams of melted ghee. In the same pan, milk was boiled, and roasted vermicelli was added in a ratio of 1:10, stirring occasionally. Sugar was then added once Seviyan had finished cooking

Table 3- Standard recipe content of Seviyan Kheer.

Ingredients	Control Sample [S11]
Vermicelli	50 gm
Ghee	5 gm
Sugar	35 gm
Green Cardamom Powder	3 gm
Milk	500 ml
Raisin	10 gm
Pistachio	7.5 gm
Almond	7.5 gm

Five Seviyan Kheer samples were prepared in the Foundation training lab at Symbiosis School of Culinary Arts & Nutritional Sciences for the experimental analysis. Samples were prepared with different sugar and date syrup combinations, as given in Table 4.

Table 4- Sugar and date syrup proportion in different samples.

Sample Tag	Sugar % [gm]	Date Syrup % [gm]
S11 [Control]	100 [35]	0 [0]
S22 [Low Date]	75 [26.2]	25 [8.7]
S33 [Equal]	50 [17.5]	50 [17.5]
S44 [High Date]	25 [8.7]	75 [26.2]
S55 [No Sugar]	0 [0]	100 [35]

Figure 2- Sugar and date syrup proportion in different samples

Consumer Preference Test: In order to assess Seviyan Kheer prepared with varying amounts of date syrup as a sugar substitute, a comprehensive consumer preference test was carried out in the state-of-the-art Foundation Labs at Symbiosis School of Culinary Arts & Nutritional Sciences, Pune [Figure 2], with 34 participants who were MBA [Food Technology] students from Symbiosis School of Culinary Arts and Nutritional Sciences. The mean age of the participants was 21.94 ± 0.97 years. Most participants [76.47%] were females, while 23.53% were male. Written informed consent was obtained in accordance with ethical standards approved by the Institutional Review Board prior to the test, and each consumer was asked to provide demographic data, such as age and gender, in order to comprehend consumption trends across different groups. To ensure that the tasting remained blind to remove any possibility of bias, the samples were coded with three-digit numbers and presented in a random order. Each participant scored the Kheer samples on six different sensory attributes: color, taste, texture, aftertaste, and overall acceptability, using a 9-point hedonic scale [1 being severely disliked and 9 being greatly liked]. Participants received water to clear their palates in between samples, and the Kheer samples were presented in sterile, separate containers with lids. The blind-tasting technique combined with the carefully monitored laboratory setting guaranteed that the outcomes represented true preferences. Temperature control was implemented during the sensory evaluation to mitigate the impact of external variables on the taste sensation. When compared to similar research, including sensory ratings, the results are more credible because the test was conducted on a trained and unbiased panel of food technology students.

Statistical Analysis: For each of the five samples [S11, S22, S33, S44, and S55], a radar chart was made to show the average rank values of consumer preferences across a variety of sensory attributes [Color, Taste, Aroma, Texture/Consistency, After Taste, and Overall Acceptability]. The radar map highlights unique consumer preferences by offering an easy-to-understand comparison of the sensory qualities of each sample.

Cumulative Agreement on Sensory Attributes: Using a 9-point hedonic scale, cumulative scores were computed for every sample in order to evaluate the general agreement on preferences for sensory attributes. The samples' relative consumer satisfaction levels with sensory qualities were shown by plotting the cumulative percentages of agreement scores [6, 7, 8, and 9]. This graphic illustrates the preference evolution as the date syrup proportion increased.

One-Way ANOVA: To ascertain whether there were statistically significant variations in sensory preferences [for every attribute] among the five samples with different amounts of date syrup substitution, a one-way analysis of variance [ANOVA] was conducted. In order to determine whether substitution levels significantly impacted characteristics like Colour, Taste, Aroma, Texture/Consistency, Aftertaste, and Overall Acceptability, ANOVA compares the means of the groups. When ANOVA showed significance, post-hoc tests were used to identify pairwise differences between samples.

These approaches offer a strong framework for research that supports the study's goal, which is to investigate sensory acceptance and ascertain how date syrup influences the flavor, texture, color, and perfume of traditional Indian sweets.

RESULTS AND DISCUSSION

According to the present study findings, preference ratings for all sensory qualities tended to decline as the percentage of date syrup rose [Table 5].

Table 5. Average rank values of consumer preference data

Average rank values of consumer preference data.						
Samples	**Color**	**Taste**	**Aroma**	**Texture/Consistency**	**After Taste**	**Overall Acceptability**
S11	8.09	7.71	7.50	7.85	7.65	7.88
S22	7.12	6.29	6.03	5.44	5.47	6.03
S33	6.71	5.38	5.94	5.44	5.29	5.38
S44	6.21	4.65	4.71	4.76	4.35	4.65
S55	5.53	4.18	4.24	4.24	4.06	4.15

Consumers distinctly favored samples with higher sugar content in every assessed feature —particularly color, taste, and overall acceptability [Figure 3]. This implies that although date syrup might be a good substitute for sugar, its sensory effects should be considered, as it could change the product's attractiveness in terms of color, flavor, and texture. A similar study on rabri, an Indian dairy dessert, found that higher date syrup concentrations led to lower sweetness and color preferences, indicating decreased sensory preferences [82]. Similar to the findings in the current study, another study on idli, a steamed cake, found that higher date syrup content reduced sensory characteristics and overall acceptability [83]. Additional modifications to balance these characteristics could improve the acceptability of products that use date syrup instead of sugar.

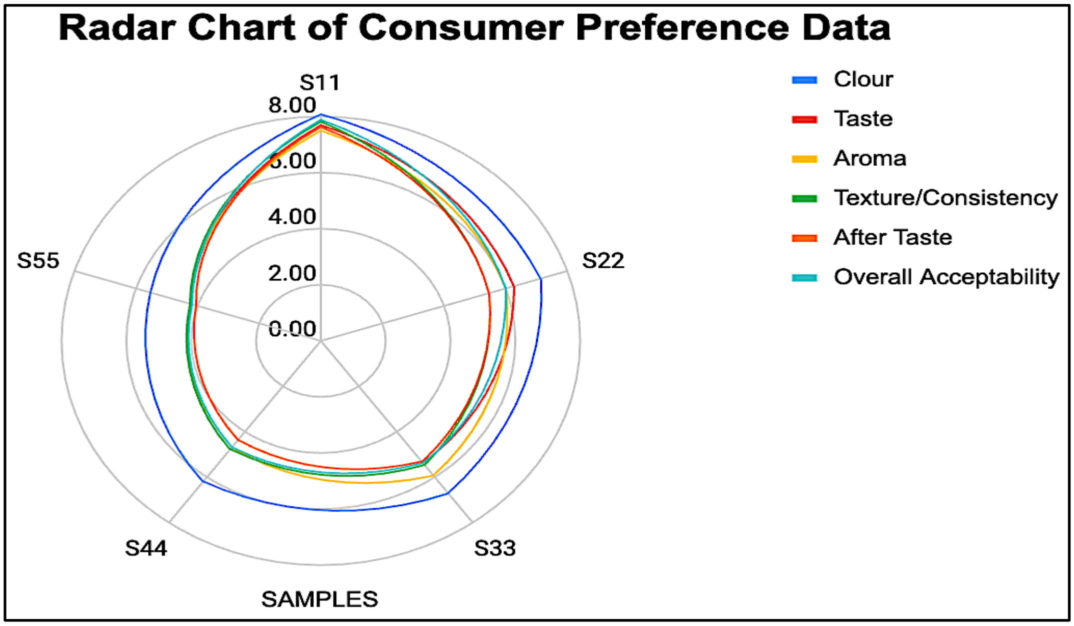


Figure 3. Radar chart of consumer preference data of all samples.

A distinct preference pattern is revealed by the cumulative percentage analysis of the samples' levels of consumer satisfaction with sensory attributes, with Sample S11 continuously surpassing the other samples in terms of customer happiness with all attributes.

Table 6. Cumulative percentages of agreement scores [6, 7, 8, and 9] for all samples across all parameters.

Sample	Cumulative Percentage [%]					
	Color	Taste	Aroma	Texture/Consistency	After Taste	General Acceptability
S11	100	94.1	94.1	97.1	97.1	100
S22	88.2	76.5	67.6	50	50	82.4
S33	82.4	55.9	64.7	50	41.2	58.8
S44	70.6	26.5	32.4	38.2	32.4	32.4
S55	50	23.5	32.4	29.4	35.3	35.3

This general pattern supports a decrease in customer satisfaction as the percentage of date syrup rose, particularly in cases where there was a substantial sugar substitution.

According to these findings, date syrup may need to be formulated differently to reach a degree of sensory satisfaction on par with conventional sugar-sweetened versions, even though it has potential as a sugar alternative. According to data analysis of a similar study, the date syrup had a major impact on the cake's physiochemical and sensory qualities [84].

Color, Taste, Aroma, Texture/Consistency, Aftertaste, and General Acceptability are all sensory qualities that show statistically significant variations across the various sample groups, according to the ANOVA results shown in Table 7. According to the low p-values [Sig. =.000 for each attribute], at least one sample significantly differs from the others in these sensory aspects. These results show that the differences in sugar and date syrup levels between samples substantially impacted the sensory profiles.

Table 7- Analysis of variance [ANOVA] for sensory characteristics of sweets for sugar and date syrup proportions

ANOVA [n=34]						
		Sum of Squares	**df**	**Mean Square**	**F**	**One-way ANOVA [P value]**
Color	Between Groups	126.200	4	31.550	12.239	.000
	Within Groups	425.353	165	2.578		
	Total	551.553	169			
Taste	Between Groups	268.259	4	67.065	23.805	.000
	Within Groups	464.853	165	2.817		
	Total	733.112	169			
Aroma	Between Groups	222.318	4	55.579	17.156	.000
	Within Groups	534.529	165	3.240		
	Total	756.847	169			
Texture/Consistency	Between Groups	260.859	4	65.215	22.359	.000
	Within Groups	481.265	165	2.917		
	Total	742.124	169			
After Taste	Between Groups	270.447	4	67.612	18.942	.000
	Within Groups	588.941	165	3.569		
	Total	859.388	169			
General Acceptability	Between Groups	287.588	4	71.897	23.512	.000
	Within Groups	504.559	165	3.058		
	Total	792.147	169			

After applying a one-way ANOVA, it was found that there was a significant difference in all parameters [Color, texture, aroma, taste, aftertaste, and general acceptability] across all samples [n=34] [S11, S22, S33, S44, S55].

The following is an interpretation of the Tukey HSD post hoc results with p-values across different sensory attributes:

Color Score: With a p-value < 0.05, S11 exhibits significant mean color differences from Samples S33, S44, and S55. This implies that the sample's color is greatly impacted by an increase in date syrup content.

Taste Score: S11 differs significantly [p < 0.05] from Samples S22, S33, S44, and S55 in all comparisons. Notably, the taste scores vary considerably with increasing date syrup concentration, suggesting that larger date syrup percentages have a noticeable impact on flavor.

Aroma Score: S11's mean difference from Samples S22, S33, S44, and S55 is substantial [p < 0.05], suggesting that the amount of date syrup in the samples alters their aroma.

Texture/Consistency Score: S11 clearly differs from all other samples in terms of mean differences [p < 0.05], suggesting that the texture and consistency change significantly as the amount of date syrup increases.

Aftertaste Score: S11's mean difference with Samples S22, S33, S44, and S55 is significant [p < 0.05], indicating that altering the ratio of sugar to date syrup changes the aftertaste.

Overall Acceptability Score: The substitution of date syrup impacts overall acceptability, as seen by the substantial mean differences between S11 and Samples S22, S33, S44, and S55 [p < 0.05] in all comparisons involving S11.

These findings demonstrate that substituting date syrup for sugar substantially affects sensory qualities in most samples, with greater date syrup ratios often deviating further from the control [S11]. This illustrates how date syrup consistently affects the taste of classic Indian desserts. Similar studies discovered that ice cream sweetened with date syrup gained a browner color, a distinct date scent, and flavor with higher syrup levels, even though it still had sensory characteristics similar to those of standard formulations. In line with customer desires for natural ingredients, the study sheds light on date syrup's potential as a natural sweetener and colorant in dairy products [85]. Another study investigates the addition of date syrup to fermented camel milk, emphasizing the product's taste qualities and potential health benefits, including its antioxidant activity. It emphasizes how date syrup may improve flavor and milk's nutritional profile, demonstrating its versatility for functional food applications [86]. A similar Omani study on date syrup established that moderate sweetness and optimal thickness are critical factors for consumer satisfaction. This is consistent with our finding where samples with lower levels of date syrup substitution [e.g., S11] scored higher in overall sensory acceptability [87]. Similar to the biscuit research with date powder, our study showed that moderate substitution levels maintained sensory acceptance. Although nutritional benefits improved with higher date syrup levels, sensory satisfaction was highest at lower substitutions, supporting the potential of dates as functional sweeteners [88]. The complete nutritional profile of dates makes them a good candidate as functional sweeteners, and it aligns with our study that moderate substitution levels improve the health profile of traditional sweets without losing sensory acceptance. Dates' comprehensive nutritional profile—rich in natural sugars (fructose and glucose) and essential minerals like calcium, magnesium, potassium, selenium, and B vitamins—adds to their value in food formulations. The water content, ranging from 10% to 30%, adds to their application versatility in food [89].

The superior nutritional properties of dates support improved health outcomes and fuel growing demand for their inclusion in innovative food formulations. The suggested 17-step regulatory process from the Functional Food Center offers an organized method focusing on open communication and scientific confirmation, which could guide the integration of dates into mainstream food products [18]. The study suggests that moderate substitution levels offer an optimal balance between sensory acceptability and nutritional benefits, preserving the traditional appeal of sweets while enhancing their health value.

Dates are rich in bioactive compounds such as polyphenols, vitamins, minerals, and dietary fiber. By examining the molecular and nutritional benefits of date syrup, the study contributes to understanding how natural alternatives can enhance the functional value of everyday foods while supporting health outcomes, including better glycemic control and reduced chronic disease risk. The work also addresses innovation in functional food development by adapting culturally significant recipes to meet modern health needs without compromising their traditional essence. It outlines a systematic approach to creating nutritionally optimized foods, ensuring both efficacy and safety for functional food creation. However, traditional Indian sweets are deeply ingrained in cultural practices, and even minor changes in taste, texture, or appearance may not appeal to certain groups, despite the health benefits.

CONCLUSION

According to the study, the literature review concludes that dates have notable pharmacological and physiological effects. Their anti-inflammatory and antioxidant qualities lower the risk of a variety of diseases. Additionally, dates have anti-diabetic qualities that help control oxidative stress and can potentially suppress cancer cell formation. Dates have long been utilized for various health purposes in many cultures, including treating diabetes, hypertension, and other conditions, demonstrating its therapeutic adaptability and promise as a natural medicinal resource. Despite being a promising natural sugar substitute with numerous health advantages, the study's results showed date syrup affects sensory attributes like color, taste, scent, texture, aftertaste, and general acceptability when employed in conventional sweet formulations. Statistical analyses, particularly ANOVA and the Tukey HSD test, reveal statistically significant p-values for each sensory attribute, emphasizing the impact of increasing date syrup substitution on these attributes.

Higher date syrup content tends to darken the product's color, which may detract from its aesthetic appeal when compared to samples that have been sweetened with sugar. Additionally, as the amount of date syrup increases, new taste and aroma profiles that differ from those found in conventional sugar-based versions are added. Despite being healthier, this change may affect consumer preferences because individuals may not be as used to these new flavors in desserts they are already familiar with. Additionally, the study demonstrates that texture and consistency are altered, with higher date syrup content significantly deviating from the typical sugar-sweetened samples. Similarly, the stronger aftertaste of date syrup than sugar appears to impact overall acceptance, especially when it constitutes a larger percentage of the sweetener.

These results imply that although date syrup is a useful sugar substitute with significant anti-inflammatory, anti-cancer, and antioxidant properties, its sensory impact necessitates a balanced strategy to preserve consumer appeal. Lower substitution levels, like up to 50%, might still provide nutritional advantages while preserving desired sensory qualities. Techniques like flavor masking or combining date syrup with other sweeteners to enhance taste and scent could potentially be used to modify formulations to consider their distinct sensory characteristics. Additional research on date syrup combinations with other natural sweeteners may contribute to developing a recipe that satisfies customer tastes for classic and contemporary desserts while capturing the health advantages.

In conclusion, date syrup is a nutritious and viable alternative to regular sugar; however, achieving widespread consumer acceptance in traditional food products will require careful formulation adjustments. This strategy will increase its potential as a workable alternative that meets consumers' sensory expectations while also adding nutritious value.

List of Abbreviations: USD: United States Dollar, g: gram, mg: milligram, kcal: kilocalories, DFE: dietary folate equivalents, GI: Glycemic Index, IU: international unit, DF: Dietary fiber, FF: Functional Food, EU: European Union, MBA: Masters in Business Administration.

Authors' contribution: RY conceptualized, carried out the work and prepared the successive manuscript. ARD conducted the data analysis for the study and helped in preparing the successive manuscript

Competing interest: The authors declare no conflict of interest

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