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Sensory characteristics of selective traditional Indian sweets using Agave syrup and Stevia: an observatory study

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ABSTRACT

Background: Indian sweets largely contribute to the rising graph of obesity and cardiovascular diseases in India. An urgent update in lifestyle and dietary patterns has become necessary to stay risk-free. Replacement of sucrose with natural sweeteners in traditional Indian sweets is one way of dealing with the consequences of high sucrose consumption. This study tries to understand the change in sensory characteristics of selective Indian sweets on the replacement of sucrose with natural sweeteners like Agave syrup and Stevia.

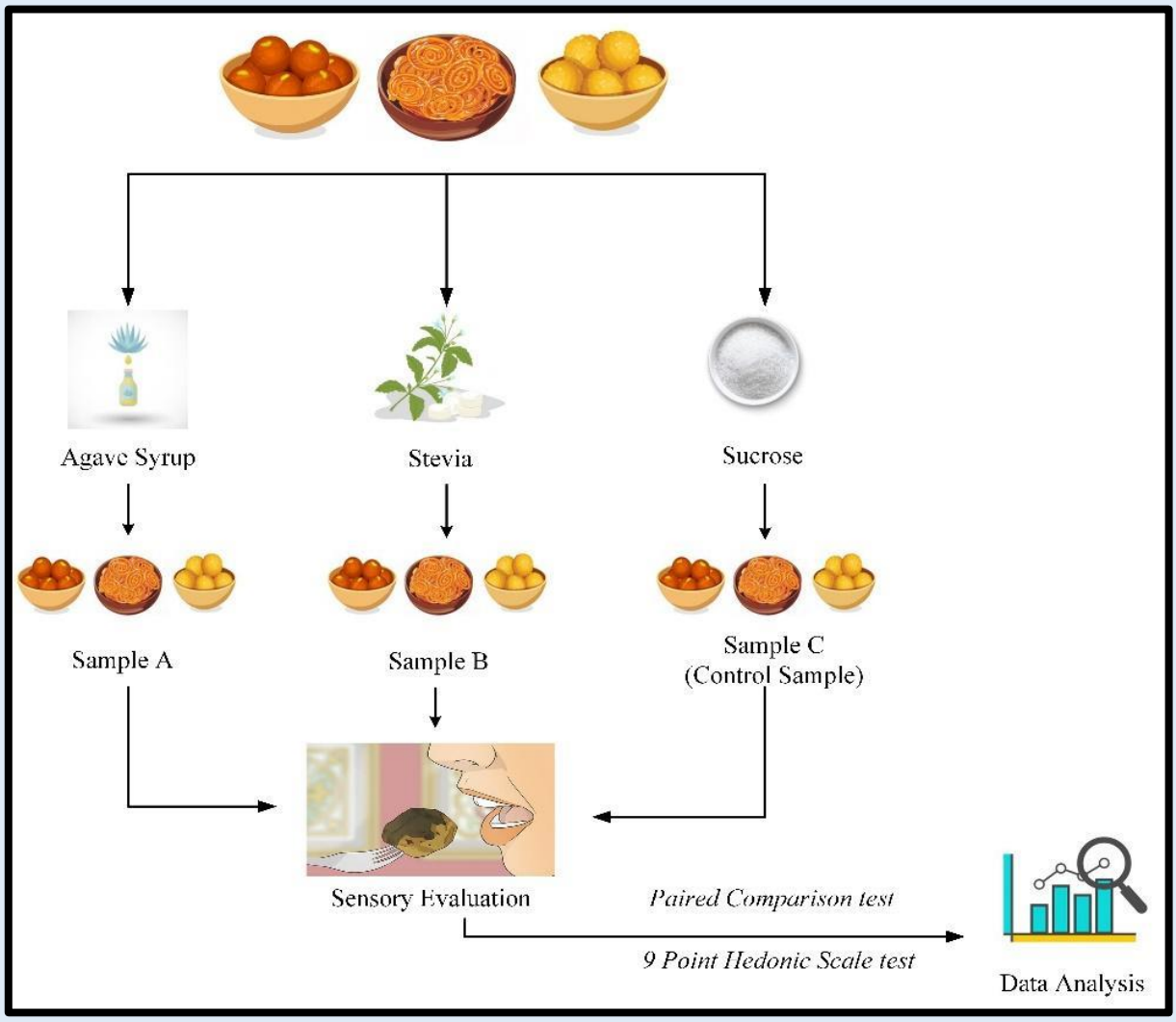
Objectives: In this observatory study, sensory characteristics of traditional Indian sweets (Gulab Jamun, Jalebi, and Motichoor Ladoo) are observed after sucrose replacement with natural sweeteners.

Methods: In order to examine the flavour and appearance of selected Indian sweets, sucrose is substituted with agave syrup and stevia. Product characteristics namely appearance, flavour, colour, odour, aftertaste, and overall acceptability of the standardized sweets are compared with the control samples prepared with sucrose.

Results: Results using the 9-point hedonic scale conclude that out of the two natural sugars used as a substitute for sucrose, stevia showed better overall acceptability for Gulab Jamun (84%) and Motichoor Ladoo (59%), but not for Jalebi (30%). Results for the paired comparison test conclude that substituting Agave syrup with sucrose had an undesirable effect on colour, taste, and mouthfeel while substituting Stevia had a detrimental effect on taste and mouthfeel only.

Conclusion: The results conclude an initial understanding of sucrose replacement using natural sugars namely Stevia and Agave syrup in the context of traditional Indian sweets and Stevia is better-suited replacement in Gulab Jamun.

Keywords: Natural sweeteners, Sucrose replacement, Indian sweets, Sensory evaluation, new product development, Agave syrup, Stevia



INTRODUCTION

Restrictions imposed by the government on the promotion of alcohol to youngsters have proven to be extremely effective, but no such policy exists for products that are high in sugar even though sugar poses more health hazards. Because sugar or sucrose is affordable, delicious, and popular, both businesses and consumers are less motivated to make any modifications in the preparations. But the underlying truth is that an increase in non-communicable diseases is correlated with high

sugar consumption. It is time to focus on lowering, limiting, or replacing sucrose [1].

Excess sucrose consumption both directly and indirectly contributes to the onset of type 2 diabetes (T2DM) and cardiovascular disease (CVD). The direct pathway involves uncontrolled hepatic absorption and metabolism of fructose, which causes lipids buildup in the liver, dyslipidemia, reduced insulin sensitivity, and increased concentrations of uric acid [2] which increases the prevalence of obesity and the occurrence of metabolic syndromes. Recent data has shown that 1 in 5 diabetics are Indian and 20 million Indians are either obese or abdominally obese, with children being the main targets. By 2025, it is anticipated that the number will increase to a shocking 68 million [3]. Consuming added sugar has also been linked to cognitive decline, particularly poorer hippocampus memory function [4]. Switching children from regularly drinking sugar-sweetened beverages to milk may impact lean body mass and growth positively with minimal changes in body fat percentage [5].

Since ancient times, sugar and sweet preparations have been a staple of Indian culture, rituals, and faith. According to dietary recommendations for Indians, a maximum 10% sugar intake of total daily energy is proposed. Also, it is advised that this percentage be lowered further. In India, it is customary to consume sweets to mark any occasion, event, or ceremony. In addition, it is also common practice to "sweeten the mouth" post every meal, joyful occasion, religious celebration, social gathering, etc. Every religious occasion is thought to necessitate the offering of sweets to the Almighty [6].

Rare sugars that are naturally occurring have therefore recently become a new class of alternative sweeteners. Exploring natural sweeteners with beneficial effects on metabolism and body weight could aid in implementing the existing recommendations to limit simple sugar consumption [7]. Due to the widespread popularity of these competing "natural sweeteners," which are ostensibly healthier than cane sugar; products like maple syrup, honey, coconut sugar, agave syrup, or nectar, are among these novel sweeteners [8].

Agave has been used as a food and beverage source since pre-Columbian times. Although agave was used medicinally by pre-Hispanic societies in Mesoamerica, little is known about its bioactive components [9]. Tequila, mezcal, sotol, and bacanora are just a few of the alcoholic drinks made in Mexico mostly from plants in the Agave genus. Because agave fructans improve human health, the food sector has recently become interested in extracting fructose-polysaccharides from Agave species [10]. Among various biochemical properties, the low glycemic property of agave makes it a curious choice among researchers who are on a continuous lookout for functional food that can replace sucrose. Its potential to replace sucrose still heavily depends on long-term health benefits [11].

Japan, America, Asia, and several other nations have utilised stevia plant extracts and stevioside as sweeteners for a very long time. In Japan, stevia accounts for around 40% of the market for sweeteners. In some food products, such as non-carbonated drinks [12], low-calorie cakes [13], and shortcrust pastry [14], stevia can partially replace sugar, without much alteration to the sensory properties. It is also ideal for diabetic patients as stevia has no calories and can help preserve dental health [12]. Eventually, numerous nations in Asia and Latin America began to utilize stevia. All major regulatory agencies worldwide have approved high-purity steviol glycosides as sweeteners [15].

Stevia rebaudiana which is native to Paraguay and Brazil, leaf extracts have been demonstrated in several clinical studies to improve glucose tolerance in healthy, normal participants. Stevia may therefore be useful in the management of type 2 diabetes [16].

In this paper, we aim to explore the utility of Agave syrup and Stevia sweeteners to mitigate various side effects of sucrose in long-term health benefits.

MATERIALS AND METHODS

Sensory analyses were conducted on three traditional Indian sweet samples made by replacing sucrose with Agave syrup and Stevia. Paired comparison and hedonic scale test are performed, and data analysis is done to get an initial understanding of different sensory changes.

***The paired comparison test*:** In a paired comparison test objects or samples are presented in pairs to a panel of judges who act independently. The basic purpose of this test is the comparison of two objects by a single judge who in a simple situation must state which one the panelist prefers [17].

***9-point hedonic scale test*:** For more than six decades hedonic scale tests have been used for food product development. This test comprises of nine ranges from 'like mostly' to 'dislike mostly'. These ranges are consigned numerical values starting from 1 for 'dislike mostly' to 9 for 'like mostly'. Panelists are entailed to taste a dish and mark it according to their degree of likeness [18].

Selected Indian traditional sweets: Three traditional Indian sweets were selected for this study.

1. Gulab Jamun- This famous sweet is made with reduced milk solid called *khoa,* shaped in softballs which are deep fried in clarified butter or oil and then soaked in sugar syrup. Each portion of Gulab Jamun used in this study weighed 12 grams after preparation of which 10 grams contributed to milk solids and approximately 2 grams was sweetener A, B, or C.
2. Motichoor Ladoo – This popular dessert is made with deep-fried fried pearls of gram flour batter called *boondi* and then shaped into golf size balls using sugar syrup as a binding agent. Each portion of Motichoor Ladoo used in this study weighed 15 grams after preparation of which 10 grams contributed to *boondi* and approximately 5 grams was sweetener A, B, or, sweetener C.
3. Jalebi – This popular dessert is made with refined flour batter which is fermented overnight using curd. This batter is then deep-fried in a spiral shape till crispy and then soaked in sugar syrup. Each portion of jalebi used in this study weighed 20 grams after preparation of which 17 grams contributed to fried jalebi and approximately 3 grams was sweetener A, B, or C.

Sample Preparations: Sweeteners – Three types of sweeteners were used to make the chosen sweets.

Sweetener A- Agave Syrup (83.3 grams) was added to water (416.7 grams). The total weight of sweetener A was 500 grams.

Sweetener B- Stevia (80 grams) was added to water (420 grams). The total weight of sweetener B was 500 grams.

Sweetener C- Sucrose (305 grams) was added to water (195 grams). The total weight of sweetener C was 500 grams.

Figure 1: Jalebi trails with sweeteners A, B, and C

Trained panelists and participants involved in the study:

- Panelist 1 - With a decade's experience in the food industry and academics panelist 1 has with ample knowledge of all cuisines and desserts.
- Panelist 2 - With more than three decades of experience in the food industry and academics panelist 2 has a deep understanding of traditional Indian sweets.
- Panelist 3-With around eight years of experience in the food industry and academics panelist 3 specializes in baked desserts.
- Panelist 4 - With two years of the food industry and academic experience panelist 4 has a fair understanding of Indian sweets and other cuisines.
- Panelist 5 - With more than three decades of experience in the food industry and academics panelist 5 is an expert in traditional Indian sweets preparations.
- Panelist 6 - With around seven years of experience in the food industry and academics panelist 6 specializes in sugar works and patisserie.

Apart from the above six experts who took part in sensory evaluation, another chef expert was in charge of preparing and standardizing the desserts and sweetener samples for this study. He has three decades of experience in making traditional Indian sweets.

Set-up of sensory evaluation trials – The expert panel was briefed about both tests. They were then escorted to individual cubicles where the set-up was already arranged. It included a questionnaire sheet, pen, pencil, eraser, a glass of water, and a bowl of tomato wedges as a palate cleanser. A sample of 12 grams to 20 grams was served and coded with A, B and C. Sensory attributes evaluated were the degree of liking (DOL) for taste, texture, bitter after-taste, colour, sweetness, and overall acceptability. All panelists evaluated the samples using a 9-point category hedonic scale where 1 meant dislike mostly; 5 meant neither like nor dislike; 9 meant like mostly

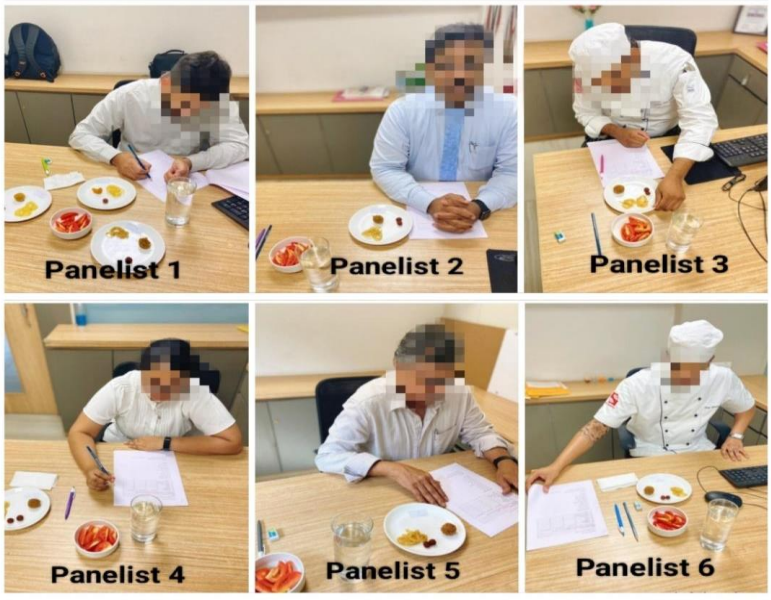


Figure 2: Sensory evaluation by the expert panel
Photo Courtesy – All six-panel members have given permission to reprint images for this study and publication

RESULTS AND DISCUSSION

The scores of sensory evaluations were recorded for two tests. The first test was the 9 points hedonic scale test and the second was paired comparison test.

9-point hedonic scale test

Motichoor Ladoo: As seen in figure 3 overall acceptability of controlled sample C which was made using sucrose was recorded (77%). The percentage overall accuracy is computed as an average over all the parameters using a subjective test carried out by a panel of six members. Compared to this sample A which was made by using Agave Syrup recorded overall acceptability of (39%) with maximum acceptability in appearance (54%) and lowest in both taste and flavour (37%).

Compared to control sample C's overall acceptability (77%), sample B which was made by using Stevia recorded overall acceptability of (46%) with maximum acceptability in appearance (70%) and lowest in after-taste/mouthfeel (35%).

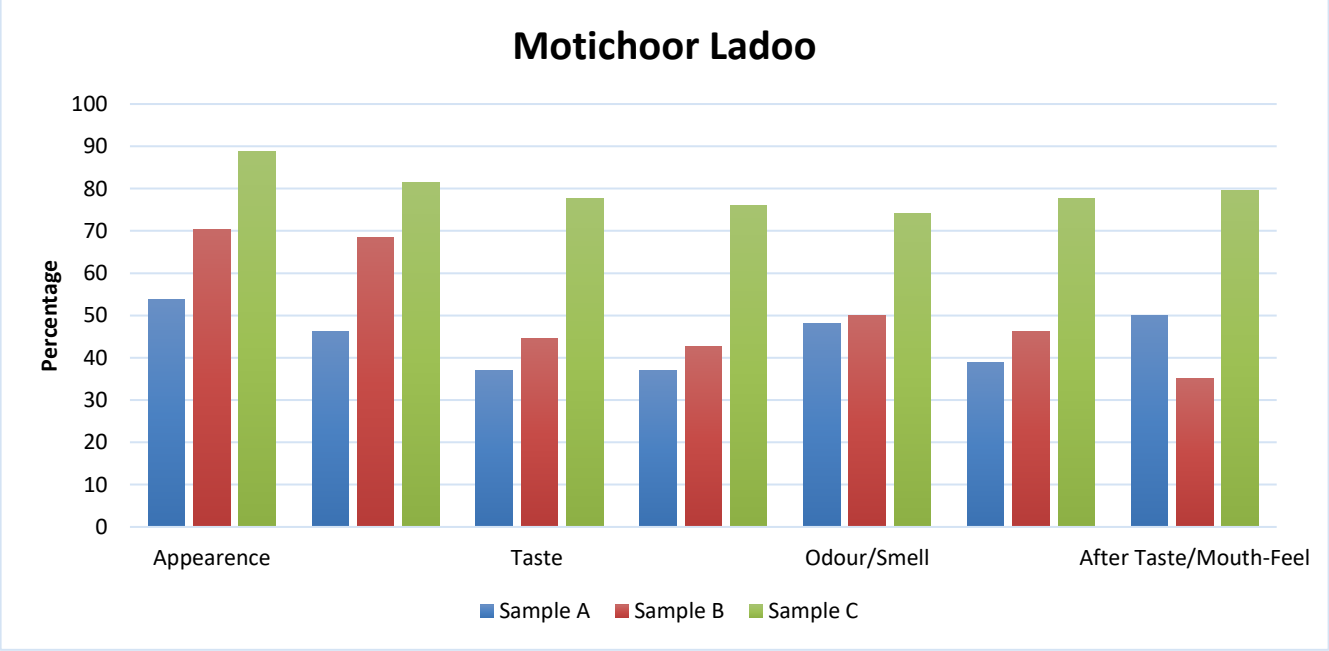


Figure 3: Analysis of 9-point hedonic scale test for Motichoor Ladoo.

Jalebi: As seen in figure 4 overall acceptability of controlled sample C which was made using sucrose was recorded (80%). Compared to this sample A which was made by using Agave Syrup recorded overall acceptability of (35%) with maximum acceptability in appearance (51%) and lowest in after-taste/mouthfeel (33%). Compared to control sample C's overall acceptability (80%), sample B which was made by using Stevia recorded overall acceptability of (24%) with maximum acceptability in appearance (40%) and lowest in after-taste/mouthfeel (19%).

Gulab Jamun: As seen in figure 5 overall acceptability of controlled sample C which was made using sucrose was recorded (63%). Compared to this sample A which was made by using Agave Syrup recorded overall acceptability of (48%) with maximum acceptability in appearance (65%) and lowest in taste (39%). Compared to control sample C's overall acceptability (63%), sample B which was made by using Stevia recorded overall acceptability of (53%) with maximum acceptability in appearance (78%) and lowest in odour and overall acceptability (53%).

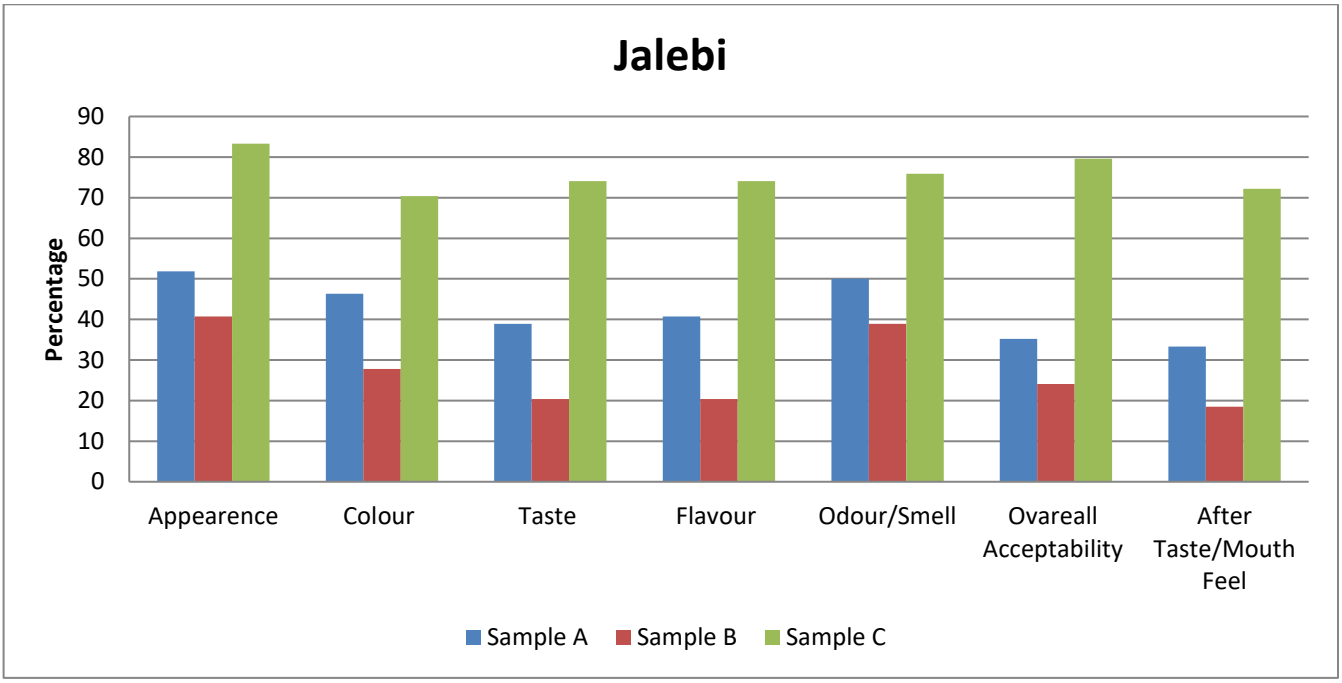


Figure 4: Analysis of 9-point hedonic scale test for Jalebi

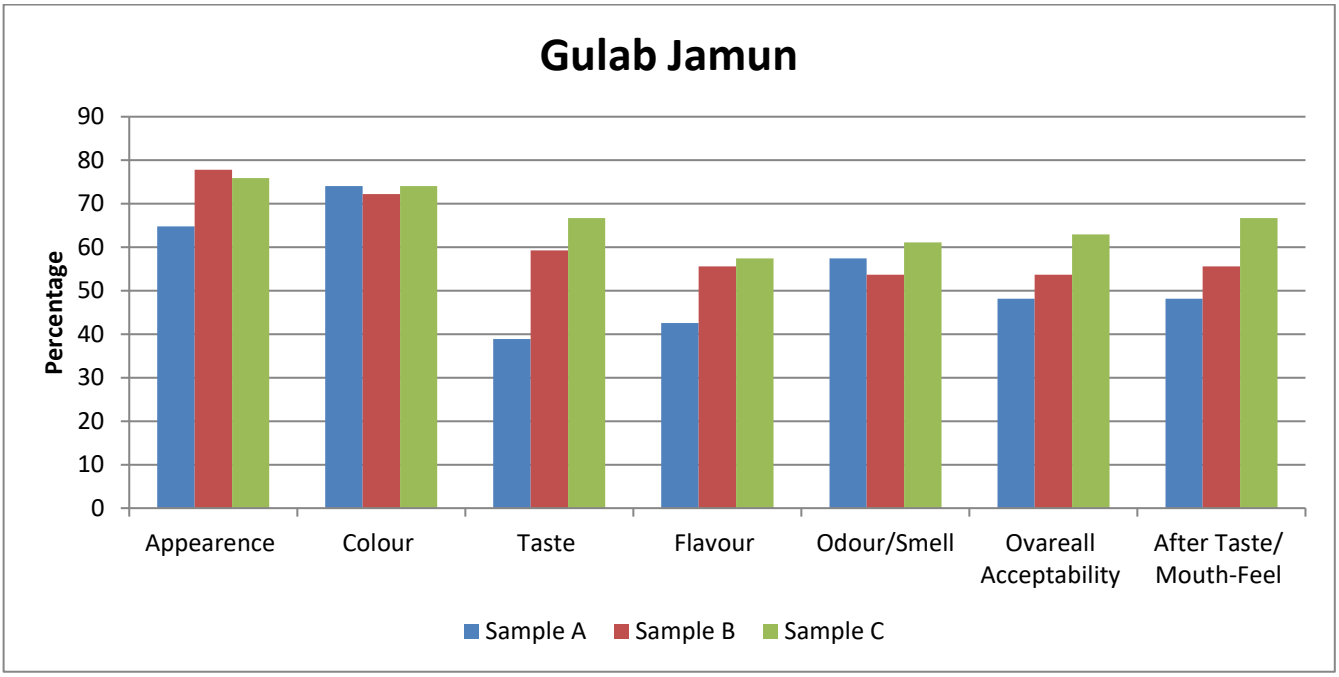


Figure 5: Analysis of 9-point hedonic scale test for Gulab Jamun.

The paired comparison test: Sample A (Agave Syrup) versus Sample C (Sucrose) - All three sweet samples made from agave syrup were served against their counterpart made with control Sample C for comparative analysis. Motichoor Ladoo with agave syrup showed 20% relativity against Motichoor Ladoo made with sucrose in three parameters each viz. flavour, texture, and aftertaste. Jalebi with agave syrup against jalebi with sucrose

showed 40% relativity in consistency and 20% each in flavour and texture. Gulab Jamun with Agave syrup against its control sample showed 20% relativity each in flavour, colour, taste, and consistency.

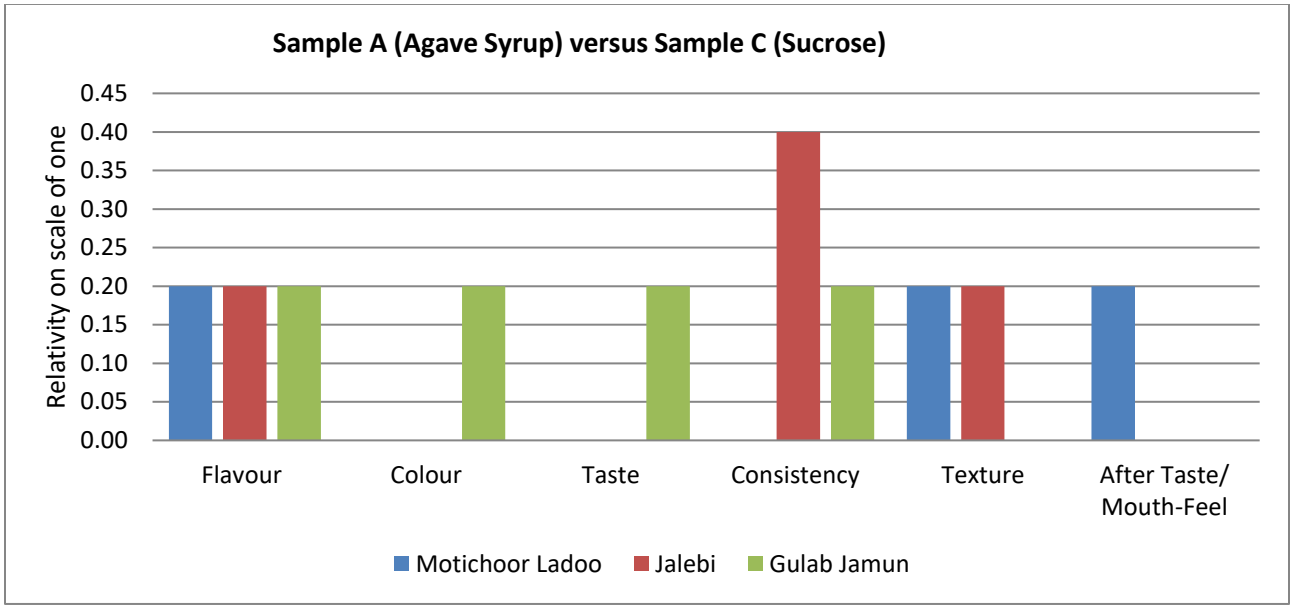


Figure 6: Analysis of paired comparison test for sample A versus control sample C.

Sample B (Stevia) versus Sample C (Sucrose)-All three sweet samples made from stevia were served against their counterpart made with control Sample C to measure relativity. Motichoor Ladoo with stevia showed 40% relativity against Motichoor Ladoo made with sucrose in consistency, 33% in colour and 20% each in flavour and texture. Jalebi made with stevia showed no relativity when compared to the control sample. Gulab Jamun with stevia showed 40% relativity in colour and texture and 20% each in flavour, taste, consistency and after taste/mouthfeel.

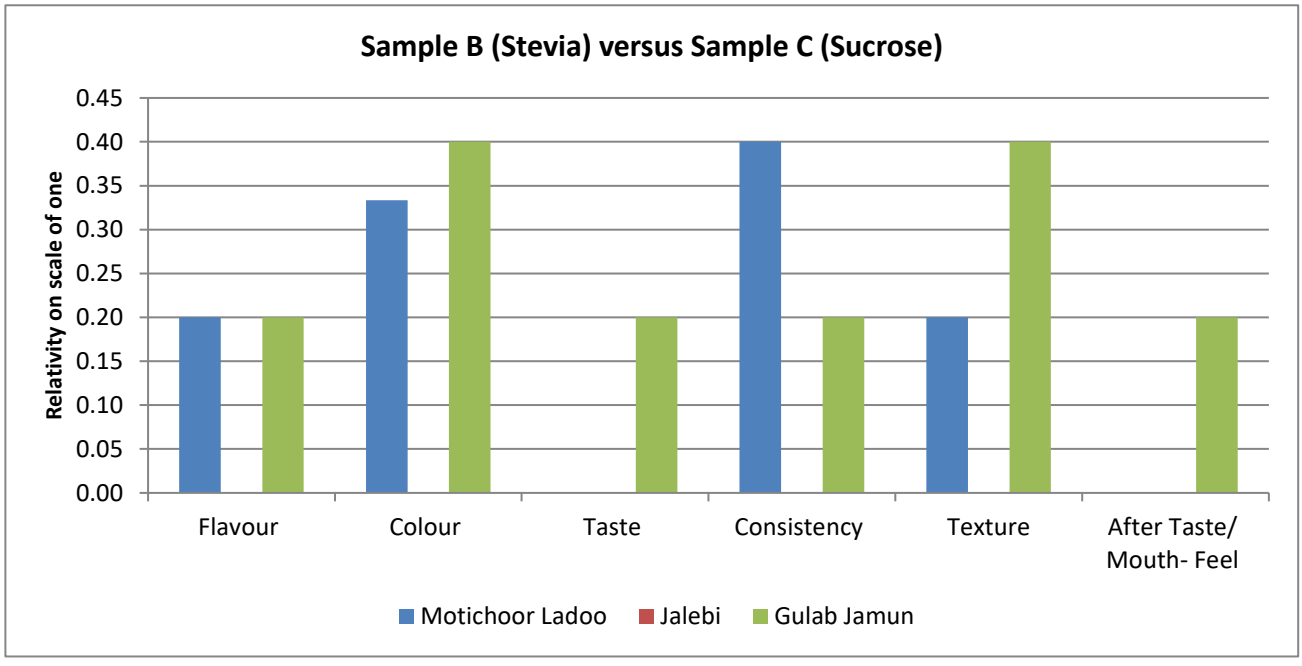


Figure 7: Analysis of paired comparison test for sample B versus control sample C.

DISCUSSION

Motichoor Ladoo made with Stevia showed better acceptability results overall compared to Motichoor Ladoo made with agave syrup. In terms of appearance, Motichoor Ladoo made with Stevia was the closest to the control sample made with sucrose.

Jalebi made with Agave syrup showed better acceptability results overall compared to Jalebi made with Stevia. Jalebi with Stevia recorded the lowest acceptability scores in after -taste which indicates a strong after taste for Jalebi made with Stevia.

Gulab Jamun made with Stevia showed better acceptability results overall compared to Gulab Jamun made with Agave syrup. In terms of appearance, Gulab Jamun made with Stevia was the closest to the control sample made with sucrose.

Results from the 9-point hedonic scale conclude that out of the two natural sugars used as a substitute for sucrose, stevia showed better overall acceptability for Gulab Jamun (84%) and Motichoor Ladoo (59%), but not for Jalebi (30%). Similarly, Agave showed overall acceptability of 76%, 44%, and 51% for Gulab Jamun, Jalebi, and Motichoor Ladoo respectively.

Results in paired comparison test indicated that samples of all three sweets made with Agave syrup affects colour, taste, and after-taste of the final product in comparison with sweets made with sucrose, while sweets made with stevia have a strong after taste and affects the taste of the final product.

Agave Syrup and Stevia have been used as a replacement in multiple studies in various sweet dishes [11]. Patricia et al. used Agave in a dairy product-Yoghurt where the samples showed strain thinning and weaker viscoelastic gel properties with an improvement in mouth-feel and textural characteristics [19] Giri et al. investigated the utility of stevia as a replacement for sucrose to maximize the level of sweetness in *kulfi* another popular Indian sweet. It was found that up to 50% sugar can be replaced by stevia in *kulfi* without affecting its sensory characteristics. A higher level of replacement decreases the calorific value, and usage of stevia more than 50% of sugar replacement resulted in brittleness and bitterness of the *kulfi* [20]. Saniah and Samsiah have explored the usage of stevia in carbonated drinks as a sugar replacement. The study has shown Stevia can partially replace the amount of sucrose without drastically affecting the physical properties and consumer acceptability. Though increasing the amount of Stevia decreases the viscosity of the carbonated drink [21].

CONCLUSION

In this study, the attempt was to replace sucrose with 2 natural sugars and record the changes in sensory characteristics of selected Indian sweets. Both Stevia and Agave syrup has their challenges when used as a replacement. It was observed that with more heat applied the product made with stevia developed a strong aftertaste. Agave syrup on other hand is fairly new to the Indian market. The Agave syrup colour ranges from light to dark amber and gives a darker shade to the appearance of the end product. This study gives an initial understanding of sucrose replacement using natural sugars viz. Stevia and Agave syrup in the context of traditional Indian sweets. With a larger sample size, a much clearer picture would appear. Furthermore, attempts at tweaking the recipes according to the above results may yield a much better acceptability score in the future.

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Abbreviations: T2DM: type 2 diabetes mellitus, CVD: cardiovascular disease, DOL: degree of liking.

Competing Interest: The authors declare no conflict of interest

Authors Contribution: Rizwan Yargatti conceptualized and carried out the work as well prepared the successive manuscript drafts. Arti Muley conceptualized the study and reviewed and approved the final draft of the manuscript.

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