Physicochemical Characteristics and Sensory Evaluation of Cookies using Different Sweeteners

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ABSTRACT

The increasing awareness of health risks associated with refined sugars and trans fats had led to growing interest in developing nutritionally enriched alternatives to conventional bakery products . The research objective was to develop cookies using different sweeteners, evaluating their physicochemical and sensory parameters. Three different cookies were developed using sugar, stevia and jaggery. One hundred consumers participated in this evaluation. From these results indicated that sugar-based cookies exhibited the highest spread ratio and were most preferred in sensory evaluation, particularly in terms of taste, flavor, and overall acceptability. Jaggery-based cookies showed improved crispness, while stevia-based cookies demonstrated greater structural integrity and the highest hardness due to better gluten network formation.

Although stevia emerged as a healthy alternative , it was less favored in sensory evaluation by the panelists . The study concludes that a blend of stevia and jaggery may offer an optimal balance between health benefits and consumer acceptability , thereby providing viable approach to formulating functional bakery products with improved nutritional profiles.

Keywords- cookies, sensory, sweeteners.

1. INTRODUCTION

A cookie is a small, sweet baked or cooked food that is usually small flat and sweet. Cookies are often served and enjoyed with beverages such as milk, coffee or tea and sometimes people prefer to dunk cookies in their drinks, which releases more flavor and helps to soften the cookies. The cookie formula consists of refined flour, hydrogenated fat, sugar and other additives. It is well documented that most of the ingredients used in commercial cookies lack important nutrients.

The refined flour is deficient in dietary fiber and micronutrients which are important health promoting components. The hydrogenated fat contains trans-fats which have proven to be harmful to human health. Recognizing the negative health effect of trans-fats many countries have banned the use of trans-fats in foods and have recommended a policy of zero tolerance to trans-fats.

Sugar cookies are sweet, buttery and soft or crisp cookies made from a basic dough of sugar, flour, butter, and baking powder or baking soda. They are often rolled out and cut into shapes and baked. Jaggery cookies are either traditional or fusion variants cookies made by replacing refined sugar with jaggery (gur) a natural sweetener obtained from sugarcane or palm sap. These cookies are rich in minerals and posses a deep rich caramel like flavor. Stevia cookies are healthier alternative to conventional cookies because they use stevia, a natural zero calorie sweetener, instead of sugar. They are often made for people who are; diabetic, watching their sugar intake, following keto or low-carbs diets and trying to eat healthier desserts. The study of objective to investigate how various sweeteners impart the texture , appearance and overall acceptability of cookies.

2. Materials and methods

2.1 Method of sampling and sample collection

All ingredients required for the preparation of cookies i.e. Refined wheat flour, sugar, jaggery, hydrogenated vegetable oil, milk, baking powder, baking soda, packaging material (LDPE) were procured from the local market of Palampur, Himachal Pradesh. Stevia used is manufactured by the Usas Natural and Herbal Products private limited Palampur, Himachal Pradesh linked formally to Him-Pure Stevia was also procured from the local market. Each ingredient was stored under appropriate conditions prior to use to maintain its physicochemical properties.

2.1.1Description of ingredients :

A) **Refined purpose flour:** Provides structure through gluten formation.

- Helps trap gases produced during leavening.
- Influences texture — more flour makes cookies denser and firmer.

B) **Sweeteners (Sugar, Jaggery, Stevia):**

1.Sugar (White/Granulated): Adds sweetness.

- Promotes browning via caramelization and Maillard reaction.
- Contributes to crispness and spread of cookies.

2.Jaggery:

- Natural sweetener with a distinct caramel/molasses flavor.
- Adds moisture, enhances color and flavor complexity.

3.Stevia: A zero-calorie natural sweetener.

- Used in sugar-free or low-calorie cookies.
- May alter texture as it doesn't caramelize or add bulk like sugar.

C) **Fat (butter, ghee, oil):**

- Contributes to tenderness and richness.
- Aids in spreading of cookies.
- Provide flavor.
- Affects crispness vs chewiness (more fat = softer cookies).

D)**Leavening Agents (Baking Soda & Baking Powder):**

1.Baking Soda (Sodium bicarbonate): Reacts with acidic ingredients to release CO_2.

Promotes spread and browning.

2.Baking Powder**:** Contains both acid and base, releases CO_2 when wet and heated.

Produces a lighter texture.

E) **Milk**:

- Hydrates flour helps form gluten.
- Adds moisture and influences texture.

2.1.2 Proximate Composition of Raw Material

The data on proximate analysis of refined wheat flour, sugar, jaggery, stevia, hydrogenated vegetable oil, milk, baking soda, baking powder is depicted in table no. 1 which reflects its suitability in cookies formulations was calculated using NIN manual.

Fat is major source of energy in food and plays significant role in cookies texture enhancement. The highest fat content observed in hydrogenated vegetable oil(665g) followed by refined wheat flour (9.8g) and then milk (4.0g). Protein is core component of food product which has major role in body building. Refined wheat flour had the highest protein content(104g), followed by milk (8.25g) and then jaggery (2.13g) justifying raw ingredient as protein enhancing component. Carbohydrates are one of our diet's macronutrients, and their primary role is to supply energy to the body. refined wheat flour contains more carbohydrates than others.

Table 1. Proximate composition of raw material

Raw material	Protein (grams)	Carbohydrates(grams)	Fats (grams)	Energy (kj)
Refined wheat flour(1kg)	104	760	9.6	15230
Sugar(465g)	0	463.14	0	7560.6
Hydrogenated vegetable oil(665g)	0	0	665	24625
Baking powder(2tbsp)	0	14	0.1	170
Baking soda(2tbsp)	0	0	0	0
Milk (266g)	8.25	13.3	4.0	510.72
Jaggery (532g)	2.13	521.3	0.53	8528
Stevia(53g)	0	0.50	0	0.53

3.Preparation of Cookies :

Ingredients	Formulation 1(P1) (Sugar cookies)	Formulation 2(P2) (Jaggery cookies)	Formulation 3(P3) (Stevia cookies)
Refined wheat flour (kg)	1	1	1
Hydrogenated vegetable oil (g)	665	665	665
Baking powder and baking soda (tbsp)	2	2	2
Milk (ml)	266	266	266
Sugar (g)	465	-	-
Jaggery (g)	-	532	-
Stevia (g)	-	-	53

Preparation steps:

- Add all ingredients in a bowl and mix thoroughly in a dough mixer, until desired consistency is achieved.

- Place the dough in refrigerator for 10-15 min to harden.

- Take out the dough and make small balls, dip it in water and roll in coconut dust for better grip.

- Roll and shape the cookies and place them in baking tray in 9 rows and 4 columns, on each tray.

- Place the tray in preheated oven at temperature 150-175 C, for 15 min.

- After baking, take out the cookies and store in airtight container.

- In case of jaggery cookies, (if big chunks), grind with the help of mortar and pestle, and then add milk to it before adding other ingredients.

- For stevia cookies, add stevia to milk before mixing other ingredients.

4. Physical evaluation of cookies

Cookie Diameter, Height and Spread Ratio:

For measuring cookie diameter in cm, six cookies were laid end to end, and a scale was used, then rotating the series at 90⁰ and repeating the measurement. The mean diameter was calculated by the average of two measurement and divided by six. The measurements were taken on three sets of cookies from the same batch for each variation and the result is calculated by mean± S.D. The diameter was measured as per the procedure in AACC(2000).

For measuring cookie height in cm, six cookies were piled on top of one another, and height was recorded, then repiling and recounting. The average of two readings divided by six was taken as mean height. The measurements from same batch for each variation 3 sets of cookies were taken, and the result is calculated by mean ± S.D.

Above calculated average height and average diameter were used to calculate spread ratio which is defined as the ratio of mean diameter to mean height.

5.Cookie texture

The evaluation for the texture of cookies were measured by a texture analyzer (TX 700) (France) fitted with a 50 kg load cell. This equipment is used to measure mainly hardness, elasticity and cohesiveness.

A) Hardness: Hardness is the maximum force required to compress sample during first compression cycle. Its unit is Newton.

B) Elasticity: It is the distance the sample recovers in height during the time between the end of first compression and start of second.

C) Cohesiveness: It is the ratio of area under the second compression curve to the area under the first compression curve.

It was measured with in 48 hours of baking using a 5mm cylindrical probe which provides peak force for penetration.

Sensory acceptability of cookies

The sensory evaluation was carried out to assess the overall acceptability of cookies prepared using three different sweeteners: sugar, stevia and jaggery. The evaluation is done by 100 untrained panelists, consisting of undergraduate, postgraduate students, teacher and staff of our College, College of Community Science, CSKHPKV Palampur, Distt. Kangra HP, India. The cookies were evaluated based on different sensory attributes such as color, flavor, texture, taste and overall acceptability was calculated. The panelists fall in age group between 19 to 50 years. The sample were coded randomly and evaluated on 5 point score. A 5-point scale was used, ranging from 1 – dislike extremely to 5 – like extremely to collect data of individual preference.

The testing was conducted under standard conditions in sensory room using uniform white lighting. This evaluation was conducted in the mid-morning, after 3-4 hours of breakfast.

The average score (mean± standard deviation) for each cookie variant were calculated to determine the most liked sweetener-based cookie on sensory response.

Statistical method used:

Anova is used for the data analysis, which shows preferred sample among the total samples of cookies. Anova test shows that the higher value of sample 1 which is sugar cookies= 13707.67 which value is higher than other two samples (sample2 = 11657.95 then sample 3 = 13706.8).

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	1	395	395	#DIV/0!
Column 2	1	392	392	#DIV/0!
Column 3	1	409	409	#DIV/0!
Column 4	1	388	388	#DIV/0!
Column 5	1	525.7	525.7	#DIV/0!

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Between (	13707.67	4	3426.918	65535	#NUM!	#NUM!
Within Gr	0	0	65535			
Total	13707.67	4				

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	1	365	365	#DIV/0!
Column 2	1	285	285	#DIV/0!
Column 3	1	290	290	#DIV/0!
Column 4	1	321	321	#DIV/0!
Column 5	1	412.7	412.7	#DIV/0!

ANOVA

ce of Varia	SS	df	MS	F	P-value	F crit
Between (	11657.95	4	2914.488	65535	#NUM!	#NUM!
Within Gr	0	0	65535			
Total	11657.95	4				

Sample1: sugar   sample 2: stevia

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	1	398	398	#DIV/0!
Column 2	1	384	384	#DIV/0!
Column 3	1	398	398	#DIV/0!
Column 4	1	391	391	#DIV/0!
Column 5	1	523	523	#DIV/0!

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Between (	13706.8	4	3426.7	65535	#NUM!	#NUM!
Within Gr	0	0	65535			
Total	13706.8	4				

Sample 3: jaggery

6. Result and discussion:

1.Cookie diameter:

During baking cookie spread occurs mainly due to the formation of syrup which causes the dough to flow more. This property of syrup formation is exhibited by sucrose the most and then jaggery and least by stevia. Cookies made with sucrose (P1) had mean diameter of 5.67± 0.04 cm, for jaggery the mean diameter(P2) was 5.55±0.02cm and the mean diameter(P3) for stevia was 4.59 ±0.09cm. Same observations were observed by kissel et.al (1973) and Vetter et al. (1984) . Larger diameter of sucrose cookies was found because of the higher syrup levels in sucrose (Franck 2002) .Before

baking, sucrose only partially dissolves during baking undissolved sucrose dissolve and forms a syrup. Jaggery on the other hand contains more moisture and minerals therefore it causes less syrup formation, restricting dough flow during baking. Stevia being non caloric sweetener contributes non bulk or syrup forming behavior hence does not melt and do not promote spread.

2.Cookie height:

In baked products, gluten development contributes to increased height of the cookies. The mean height of (P1) sugar cookies was 1.19 ± 0.002, the mean height for (P2) jaggery cookies was 1.23±0.001 and for stevia cookies it was 1.27±0.003. In sugar cookies, during baking water binds with sucrose and very less water available for the development of gluten which causes weak structure of gluten which results in dough to spread more and rise less leads to lower height. During baking stevia do not contribute binding with water or dissolve into a syrup which leads to more water available for the formation of gluten which results in the formation of stronger gluten network. Stronger dough structure in stevia holds a better shape and rises more resulting in greater height of cookie. In case of jaggery, which is more hygroscopic in nature which helps to retain water in the dough this decreases free water for the development of gluten like sugar, but it causes more stronger gluten network than sugar- based dough because of the already minerals and molasses present in it.

3.Cookie spread ratio:

 Higher spreading of cookies was considered more desirable and appealing (Yamamoto et al.1996). . The spread ratio for sugar cookies (P1) was 4.76, for jaggery cookies (P2) was 4.51 and for stevia cookies (P3) was 3.67. Thus, most desirable and higher spread was sucrose cookie followed by jaggery and then stevia was also observed by (Finney et al. 1950 and Kissel and Prentice 1979).

Cookie texture:

After analysis cookie prepared with 100% stevia having mean peak force of 94.583 N which shows the highest hardness, the cohesiveness was 0.256 and elasticity was measured as 1.000 similar results were observed by Belcourt and labuza 2007.The mean peak force of jaggery was found to be 47.795 N hardness, cohesiveness was 0.111 and elasticity was 1.000. At last, for sucrose cookies the mean peak force was 84.494 N, cohesiveness was 0.205 and the elasticity was same 1.000. For the jaggery cookies lower was the force and crispier was the texture, which the greater acceptance and superior quality.
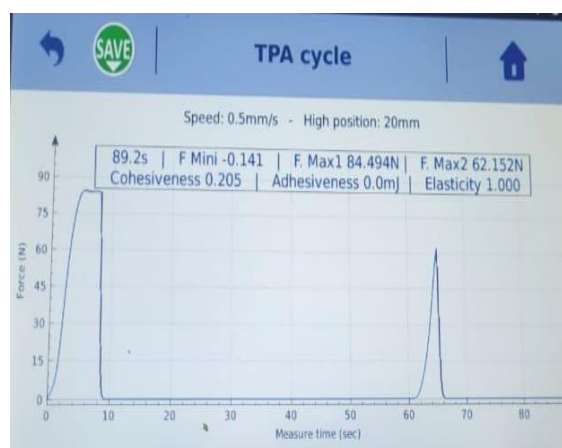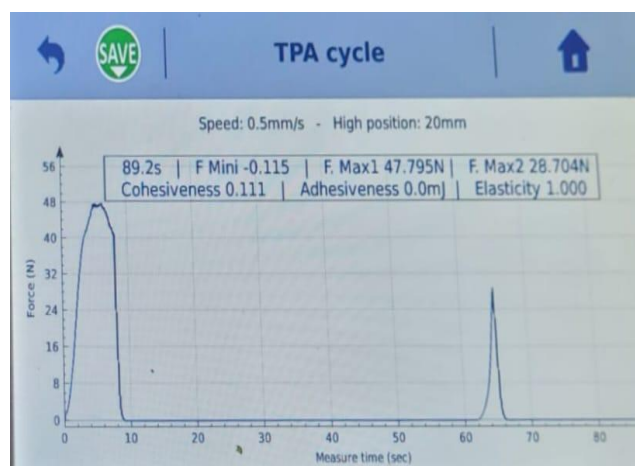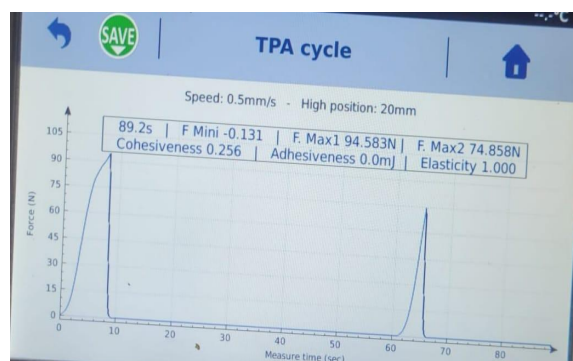

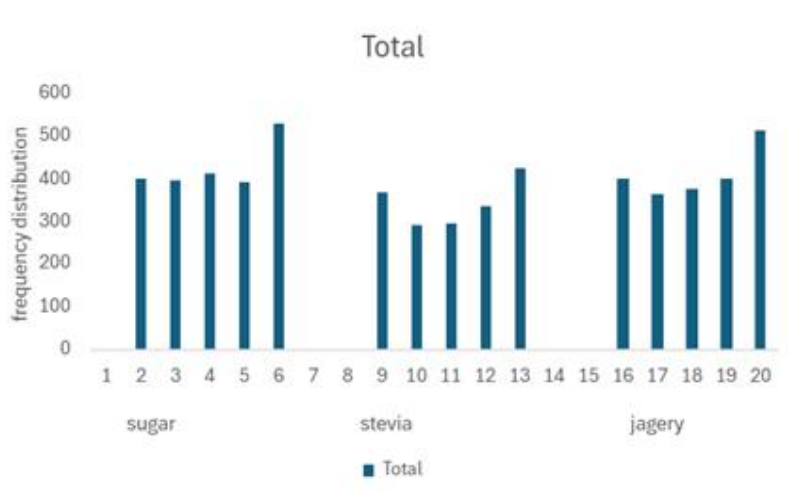
Fig1: SUGAR COOKIE

Fig2: JAGGERY COOKIE

Fig3: STEVIA COOKIE

Sensory Acceptability Tests

The result of sensory evaluation (below table) reveled that cookies made with sugar were rated higher by the panelists as compared to cookies made with stevia and jaggery on color, flavor, texture and appearance basis .The overall acceptability score for sugar cookies was 3.92 on a 5 point hedonic scale while overall acceptability score for jaggary and stevia cookies was 3.88 and 3.12 respectively. The mean score for the texture of jaggery cookies was 3.87 which is highest compared to sugar cookies 3.84 and stevia cookies 3.1. The mean score for the color of jaggary cookies was 3.94 which is higher than sugar 3.91 and stevia 3.61. The mean score for the taste of sugar cookies was 4.04 which is higher than jaggery 3.94 and stevia 2.87. The mean score for the flavor of sugar cookies was 3.88 which is higher than jaggery cookies 3.81 and stevia cookies 2.82. So, sugar cookies were mostly liked by the panelists. The below graph shows higher frequency distribution of cookies in which 2,9,16 indicates color , 3,10,17 indicates flavor , 4 ,11 , 18 indicates taste , 5,12,19 indicates texture and 6, 13 ,20 indicate overall acceptability.

7. Conclusion

Stevia being a non-nutritional sweetener is healthier than the other two sweeteners namely sugar and jaggery. But according to our research, sugar cookies were most acceptable by the consumer panelists, followed by jaggery and then stevia. Consumer liked sugar cookies in all the aspects of sensory attributes we had mentioned.

In terms of healthier option stevia cookies can be formulated by using in synergy with jaggery as an alternative so that it has both the characteristic of sweetness and health benefits.

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