

A
RESEARCH PROJECT
ON
SUGAR FREE JAM USING NATURAL SWEETNER STEVIA

Submitted in fulfilment of the requirement for the award of
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IN
CHEMICAL TECHNOLOGY WITH SPECIALIZATION IN
FOOD TECHNOLOGY

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Submitted to



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CERIFICATE

This is to certify that Mr. Arpit Singh, Mr. Parthsarthi, Mr. Tanish Tiwari, Mr. Kartikey Singh and Mr. Ujjwal Rai of final B.Tech Food Technology has worked under my supervision and guidance for the completion of their project entitled as **SUGAR FREE JAM USING NATURAL SWEETNER STEVIA** during the session 2023-24 . They took keen interest in experimental work with showing enthusiasm towards work and comprehensive study in the preparation of their project report.

I wish them a bright future and successful career ahead.

Date :

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Place :

Supervisor

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Final B.Tech Food Technology

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CHAPTER I

INTRODUCTION

Overview

The increasing awareness of health and wellness has significantly influenced consumer preferences, leading to a growing demand for healthier food alternatives. Among these, sugar-free products have gained immense popularity due to their potential to mitigate health issues associated with excessive sugar consumption, such as obesity, diabetes, and cardiovascular diseases. This project focuses on the development of a sugar-free jam utilizing Stevia, a natural sweetener, as a substitute for sugar. Stevia, derived from the leaves of the *Stevia rebaudiana* plant, is renowned for its zero-calorie sweetening properties, making it an ideal choice for health-conscious consumers.

Stevia rebaudiana is a plant native to South America, particularly Paraguay and Brazil, where it has been used for centuries by indigenous populations for its sweetening properties. The sweet components of Stevia are primarily due to steviol glycosides, including stevioside and rebaudioside A, which are extracted and purified to produce Stevia sweeteners. These compounds are intensely sweet, with stevioside and rebaudioside A being up to 300 and 400 times sweeter than sucrose, respectively. This extraordinary sweetness means that only a small amount of Stevia is needed to achieve the desired level of sweetness, significantly reducing the calorie content of food products.

Stevia is unique among natural sweeteners because it provides sweetness without calories, making it an excellent alternative for those seeking to reduce their caloric intake. Additionally, Stevia has been recognized for its non-glycemic properties, meaning it does not raise blood glucose levels, which is particularly beneficial for individuals with diabetes or those at risk of developing diabetes. Stevia's ability to maintain sweetness without contributing to blood sugar spikes sets it apart from other natural and artificial sweeteners. This characteristic makes Stevia an ideal ingredient for developing sugar-free products aimed at health-conscious consumers.

Traditional jams are loved for their sweet taste and convenience, but they come with a high sugar content that can have adverse health effects. The primary ingredients in conventional jams include sugar, fruit, pectin, and various additives and preservatives. Sugar not only provides sweetness but also acts as a preservative by binding water, thereby inhibiting microbial growth. However, the high sugar content also means that these jams are calorie-dense, which can contribute to weight gain and other health issues.

Our project seeks to develop a jam that retains the desirable qualities of traditional jams—such as taste, texture, and shelf stability—while significantly reducing the sugar content. By using Stevia as a sweetener, we aim to create a product that is both tasty and healthy. This involves careful formulation to ensure that the jam has the right consistency and flavor profile. The use of natural ingredients and the elimination of synthetic additives further enhance the health benefits of our product.

The production of sugar-free jam involves several technological considerations to ensure product quality and stability. One of the key challenges is achieving the right balance of sweetness and flavor. Stevia has a distinct taste profile, which can include a slight bitterness. To address this, our formulation carefully balances Stevia with other natural flavor enhancers to achieve a pleasant taste. Additionally, using fruit extracts rich in natural sugars can help mask any aftertaste associated with Stevia.

Another important aspect is the gelling and texture of the jam. Sugar plays a crucial role in the gelling process of traditional jams by interacting with pectin. In the absence of sugar, the gelling properties must be adjusted to ensure the jam sets properly. This can be achieved by optimizing the pectin concentration and using high-methoxyl or low-methoxyl pectin depending on the desired firmness and set. The goal is to produce a jam that has the same texture and spreadability as conventional jams.

Preservation and shelf life are also critical considerations. Sugar acts as a preservative by reducing water activity, thereby inhibiting microbial growth. In our sugar-free jam, we employ natural preservatives and maintain an appropriate pH level using citric acid to ensure product safety and extend shelf life. Additionally, the use of vacuum-sealing and pasteurization techniques can further enhance the shelf stability of our jam.

In summary, the development of a sugar-free jam using Stevia addresses the increasing consumer demand for healthier food options without compromising on taste and quality. Stevia's natural sweetening properties, combined with its health benefits, make it an ideal substitute for sugar in jam production. This project aims to provide a nutritious, delicious, and health-conscious alternative to traditional sugar-laden jams, catering to a wide range of dietary needs and preferences. By leveraging the unique properties of Stevia and optimizing our formulation, we can offer a product that meets the needs of today's health-conscious consumers while contributing to better health outcomes.

Stevia: A Natural Sweetener

Stevia rebaudiana is a plant native to South America, particularly Paraguay and Brazil. It has been used for centuries by indigenous populations for its sweetening properties. The sweet components of Stevia are primarily due to steviol glycosides, including stevioside and rebaudioside A, which are extracted and purified to produce Stevia sweeteners. These compounds are intensely sweet, with stevioside and rebaudioside A being up to 300 and 400 times sweeter than sucrose, respectively.

Stevia is unique among natural sweeteners because it provides sweetness without calories, making it an excellent alternative for those seeking to reduce their caloric intake. Additionally, Stevia has been recognized for its non-glycemic properties, meaning it does not raise blood glucose levels, which is particularly beneficial for individuals with diabetes or those at risk of developing diabetes. Stevia's ability to maintain sweetness without contributing to blood sugar spikes sets it apart from other natural and artificial sweeteners.

Chemical Composition of Stevia

The sweetness of Stevia is mainly attributed to its steviol glycosides. The most significant glycosides are:

- **Stevioside:** Comprising 5-10% of the dry weight of Stevia leaves, stevioside is one of the primary compounds responsible for the sweet taste. It has a slightly bitter aftertaste, which can be mitigated by blending with other sweet compounds.
- **Rebaudioside A:** This glycoside is less bitter and has a more sugar-like taste, making it more desirable for food applications. It constitutes about 2-4% of the dry weight of Stevia leaves. Rebaudioside A is preferred in food products due to its superior taste profile.
- **Rebaudioside C:** Present in smaller amounts (1-2%), it is less sweet and more bitter than rebaudioside A.
- **Dulcoside A:** Contributes to the overall sweetness but is found in lower concentrations (0.4-0.7%).

Below is a table summarizing the key components of Stevia:

Component	Concentration in Leaves	Sweetness Relative to Sugar
Stevioside	5-10%	250-300 times
Rebaudioside A	2-4%	200-400 times
Rebaudioside C	1-2%	40-60 times
Dulcoside A	0.4-0.7%	30 times

Health Benefits of Stevia

Stevia offers several health benefits, making it an excellent alternative to sugar:

Zero Calories: Stevia does not contribute to caloric intake, making it suitable for weight management. This is particularly important in a global context where obesity rates are rising, and there is a need for low-calorie food alternatives.

Non-Glycemic: Stevia does not raise blood glucose levels, making it ideal for diabetic patients and those with insulin resistance. This property allows for the enjoyment of sweet flavors without the associated risks of increased blood sugar.

Antioxidant Properties: Some studies suggest that Stevia possesses antioxidant properties, which can help combat oxidative stress and contribute to overall health. Antioxidants play a crucial role in protecting the body from damage caused by free radicals.

Dental Health: Unlike sugar, Stevia does not contribute to tooth decay, making it a preferable choice for maintaining dental health. Its non-cariogenic properties help in preventing cavities and promoting oral hygiene.

Industrial Jam vs. Our Sugar-Free Jam

Traditional jams are loved for their sweet taste and convenience, but they come with a high sugar content that can have adverse health effects. The development of a sugar-free jam aims to provide a healthier alternative without compromising on taste and quality.

Chemical Composition of Industrial Jam

Traditional industrial jams are typically high in sugar and contain various additives and preservatives. The primary ingredients include:

Sugar: Provides sweetness and acts as a preservative by binding water, thus inhibiting microbial growth.

Pectin: A gelling agent that helps achieve the desired consistency and texture in jams. Pectin is a natural polysaccharide found in fruits.

Citric Acid: Used as a preservative and flavor enhancer. It helps in maintaining the pH balance and improving the shelf life of the product.

Preservatives: Such as sodium benzoate or potassium sorbate, which extend shelf life by preventing microbial growth.

The approximate chemical composition of industrial jam is as follows:

Component	Percentage
Sugar	65%
Fruit	45%
Citric Acid	0.5%
Preservatives	0.1-0.2%

Chemical Composition of Our Sugar-Free Jam

Our sugar-free jam replaces sugar with Stevia and includes natural fruit extracts, pectin, and citric acid. The composition is designed to maintain the traditional taste and texture while offering a healthier alternative.

Component	Percentage
Stevia	0.1-0.6%
Fruit	65%
Pectin	0.2%
Citric Acid	0.3%
Carboxymethylcellulose (CMC)	0.1%

By eliminating sugar, our jam significantly reduces the caloric content and offers a product that is more aligned with the dietary needs of health-conscious consumers.

Nutritional Values Comparison

A comparison of the nutritional values between industrial jam and our sugar-free jam highlights the health benefits of our product.

Benefits of Our Sugar-Free Jam

Reduced Caloric Intake: Our jam significantly lowers the caloric content compared to traditional jams, aiding in weight management. This is crucial for individuals seeking to maintain or lose weight without sacrificing the enjoyment of sweet foods.

Diabetic-Friendly: The absence of added sugars and the use of Stevia make it suitable for diabetic individuals, allowing them to enjoy jam without the risk of blood sugar spikes.

Natural Ingredients: By using natural sweeteners and preservatives, our jam offers a healthier alternative to synthetic additives commonly found in industrial jams. This aligns with the growing consumer demand for clean-label products.

Technological Considerations in Jam Production

The production of sugar-free jam involves several technological considerations to ensure product quality and stability. The substitution of sugar with Stevia requires adjustments in the formulation to maintain the desired texture, sweetness, and shelf life.

Sweetness and Flavor

One of the challenges in using Stevia is its distinct taste profile, which can include a slight bitterness. To address this, our formulation carefully balances Stevia with other natural flavor enhancers to achieve a pleasant taste. Additionally, using fruit extracts rich in natural sugars can help mask any aftertaste associated with Stevia.

Gelling and Texture

Sugar plays a crucial role in the gelling process of traditional jams by interacting with pectin. In the absence of sugar, the gelling properties must be adjusted to ensure the jam sets properly. This can be achieved by optimizing the pectin concentration and using carboxymethylcellulose depending on the desired firmness and set.

Preservation and Shelf Life

Sugar acts as a preservative by reducing water activity, thereby inhibiting microbial growth. In our sugar-free jam, we employ natural preservatives and maintain an appropriate pH level using citric acid to ensure product safety and extend shelf life. Additionally, the use of vacuum-sealing and pasteurization techniques can further enhance the shelf stability of our jam.

CHAPTER II

REVIEW AND LITERATURE

History of Stevia

Stevia rebaudiana, commonly known as Stevia, has a rich history dating back to the ancient Guaraní tribes of Paraguay and Brazil, who have used the leaves of this plant for centuries to sweeten beverages and as a traditional remedy. The indigenous people referred to it as "ka'a he'ê," meaning "sweet herb." They used Stevia leaves to sweeten their yerba mate tea and medicinal potions, benefiting from its sweetening properties long before the modern era discovered its potential.

The scientific discovery of Stevia's sweetening properties is credited to the Swiss botanist Moisés Santiago Bertoni, who first described the plant in 1899 while working in Paraguay. He was astonished by its intense sweetness and began studying its properties. However, it wasn't until the mid-20th century that Stevia gained international attention. Japanese scientists, in particular, took a keen interest in Stevia during the 1970s as they sought alternatives to artificial sweeteners, which were facing increasing scrutiny for their potential health risks.

Japan became one of the first countries outside South America to commercialize Stevia. Japanese researchers developed methods to extract and purify steviol glycosides, the compounds responsible for Stevia's sweetness, leading to its use in a variety of food products. By the 1980s, Stevia had gained significant popularity in Japan and was widely used as a natural sweetener in everything from soft drinks to snacks. This early adoption in Japan paved the way for Stevia's global acceptance.

In the late 20th and early 21st centuries, extensive research was conducted to evaluate the safety and efficacy of Stevia. Studies consistently demonstrated that Stevia is not only safe for consumption but also offers several health benefits, such as non-glycemic properties and potential antihypertensive effects. These findings led to regulatory approvals in various countries, including the United States and the European Union. In 2008, the U.S. Food and Drug Administration (FDA) recognized purified steviol glycosides, such as rebaudioside A, as Generally Recognized as Safe (GRAS), further boosting its global market presence.

Various Health Benefits :

- **Weight Management:** Our sugar-free jam made with Stevia is a game-changer for individuals striving to manage their weight effectively. With each serving containing significantly fewer calories than traditional high-sugar jams, it becomes an excellent addition to a calorie-controlled diet. By opting for our sugar-free option, individuals can indulge in the sweet goodness of jam without worrying about excess calorie intake,

thus supporting their weight management goals. Whether spread on toast or incorporated into recipes, our sugar-free jam offers a guilt-free way to satisfy sweet cravings without compromising progress towards achieving or maintaining a healthy weight.

- **Blood Sugar Control:** For individuals with diabetes or those monitoring their blood sugar levels, our sugar-free jam made with Stevia emerges as a preferred choice. Stevia, the natural sweetener used in our jam, does not cause rapid spikes in blood glucose levels, offering a safer alternative to traditional jams loaded with sugar. By choosing our sugar-free option, consumers can enjoy the sweetness of jam without worrying about disrupting their blood sugar balance. This makes it an excellent addition to diabetic meal plans or for anyone seeking to stabilize their blood sugar levels while still indulging in sweet treats.
- **Dental Health:** Our sugar-free jam made with Stevia not only satisfies taste buds but also promotes dental health. Unlike traditional jams that contribute to tooth decay and cavities due to their high sugar content, our sugar-free option helps maintain oral hygiene. By minimizing the risk of dental caries, our jam allows individuals to enjoy sweet flavors without compromising their dental health. Whether spread on crackers or paired with yogurt, our sugar-free jam offers a delicious way to protect teeth and gums while indulging in a sweet treat.
- **Antioxidant Protection:** One of the standout features of our sugar-free jam made with Stevia is its rich antioxidant content. Stevia, the natural sweetener used in our jam, is packed with antioxidants that combat oxidative stress and protect cells from damage caused by free radicals. By incorporating our sugar-free jam into their diet, consumers can boost their antioxidant intake, supporting overall health and reducing the risk of chronic diseases. Whether enjoyed on toast or stirred into oatmeal, our jam provides a flavorful way to enhance antioxidant defenses and promote long-term wellness.
- **Digestive Health:** Supporting digestive health is a key benefit of our sugar-free jam made with Stevia. Unlike traditional jams that may contribute to digestive discomfort due to their high sugar content, our sugar-free option contains dietary fiber that promotes regular bowel movements and maintains gut flora balance. The fiber content aids in digestion, prevents constipation, and supports a healthy gastrointestinal tract. Whether spread on pancakes or added to smoothie bowls, our sugar-free jam offers a delicious way to support digestive wellness and enhance overall gut health.

- **Heart Health:** Consuming our sugar-free jam made with Stevia can significantly contribute to heart health. With its low calorie and sugar content, our jam helps individuals reduce their overall calorie intake and avoid the adverse effects of excessive sugar consumption on cardiovascular health. By choosing our sugar-free option, consumers can lower their risk of developing heart disease, stroke, and other cardiovascular conditions associated with poor dietary choices. Whether incorporated into baking recipes or enjoyed on waffles, our sugar-free jam provides a tasty way to promote heart health and support overall well-being.
- **Weight Loss Support:** Our sugar-free jam made with Stevia serves as an excellent ally for individuals on weight loss journeys. With its significantly lower calorie content compared to traditional high-sugar jams, it allows individuals to create a calorie deficit necessary for weight loss while still satisfying their sweet cravings. By incorporating our sugar-free option into their meal plan, individuals can enjoy the sweet goodness of jam without worrying about derailing their weight loss efforts. Whether spread on rice cakes or mixed into yogurt, our sugar-free jam offers a delicious way to support weight loss goals and maintain a healthy lifestyle.
- **Improved Insulin Sensitivity:** Choosing our sugar-free jam made with Stevia can have positive implications for insulin sensitivity and metabolic health. Stevia, the natural sweetener used in our jam, has been shown to improve insulin sensitivity, making it an excellent choice for individuals with insulin resistance or prediabetes. By stabilizing blood sugar levels and supporting metabolic function, our sugar-free option reduces the risk of developing type 2 diabetes and related complications. Whether enjoyed on toast or paired with cheese, our sugar-free jam provides a flavorful way to support overall health and well-being.
- **Inflammation Reduction:** Consuming our sugar-free jam made with Stevia can help individuals combat inflammation and promote overall wellness. Stevia is rich in antioxidants, compounds that possess anti-inflammatory properties and help reduce inflammation throughout the body. By incorporating our sugar-free jam into their diet, consumers can alleviate symptoms associated with inflammation-related conditions and lower their risk of chronic diseases. Whether spread on crackers or mixed into oatmeal, our jam offers a delicious way to support inflammation reduction and enhance long-term health.

CHAPTER III

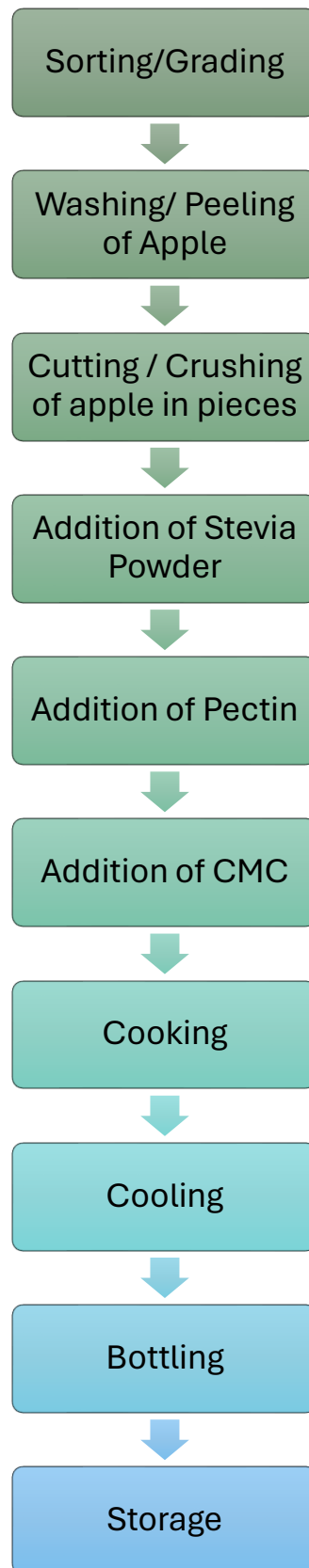
METHODS AND PREPERATION

Instruments Used:

- **Large Saucepan:** Essential for cooking and simmering the apple pulp mixture.
- **Stirring Spoon:** Used to continuously stir the mixture to prevent burning and ensure even cooking.
- **Blender or Food Processor:** Utilized to blend the cooked apples into a smooth pulp.
- **Weighing Scale:** Necessary for accurately measuring the quantities of ingredients.
- **Thermometer:** Helps monitor the temperature of the jam mixture during cooking.
- **Sterilized Glass Jars or Containers:** Used for storing the prepared jam safely.
- **Refractometer :** To measure the brix and TSS of the sample.
- **Muslin Cloth :** Used for filtration of the pulp and juices.

Ingredients Used:

- **Apple Pulp:** Provides the base and main flavor for the jam.
- **Stevia Powder:** Acts as a natural sweetener, replacing traditional sugar.
- **Lemon Juice:** Enhances the flavor of the jam and acts as a natural preservative.
- **Water:** Used to cook the apples and adjust the consistency of the jam.
- **Pectin :** Used to Gelatinise the sample
- **Carboxymethylcellulose :** Used for providing texture to the jam.



Flowchart of the Process Involved

PROCEDURE

Preparation of Apple Pulp:

- a) Begin by washing the apples thoroughly under running water & salt water to remove any dirt or residue.
- b) Using a sterilized sharp knife and cutting board, peel the apples, removing the skin in thin strips.
- c) Once peeled, use a corer or knife to remove the cores and seeds from the apples.
- d) Cut the apples into small, evenly sized chunks to ensure even cooking.
- e) In a large saucepan, combine the apple chunks with the water, ensuring they are fully submerged.
- f) Place the saucepan over medium heat and bring the water to a gentle boil.
- g) Reduce the heat to low and let the apples simmer for about 15-20 minutes, or until they are soft and tender.
- h) Once the apples are cooked, remove the saucepan from the heat and let it cool slightly.
- i) Transfer the cooked apples to a blender or food processor, being careful not to overcrowd the appliance.
- j) Blend the cooked apples until they form a smooth, lump-free puree, adding a little water if necessary to achieve the desired consistency.
- k) Once blended, set the apple pulp aside for later use.
- l) Filtered the pulp using Muslin Cloth.

Cooking the Jam:

- a) Return the apple pulp to the large saucepan, ensuring there are no lumps or chunks remaining.
- b) Add the Stevia powder to the apple pulp, distributing it evenly throughout the mixture.
- c) Next, add the lemon juice to the saucepan, which will help enhance the flavor of the jam and act as a natural preservative.
- d) Place the saucepan over low to medium heat, stirring the mixture constantly with a wooden spoon to prevent it from sticking to the bottom of the pan.
- e) Make a pectin solution of 0.2% concentration and added it to the mixture.
- f) As the mixture heats up, you will notice it begin to thicken and reduce in volume.
- g) Use a thermometer to monitor the temperature of the mixture, aiming for around 105°C (220°F).
- h) Continue cooking the mixture until it reaches the desired consistency, which should be thick and spreadable.
- i) At 105°C, Check the brix of the mixture using refractometer and it was around 65°.
- j) Keep in mind that the cooking time may vary depending on factors such as the moisture content of the apples and the heat of your stove.

- k) Heating should be in control manner at certain temperature after adding pectin to the mixture as overcooking can degrade the pectin gelatinization reactions.

Packaging:

- a. Once the jam has thickened to the desired consistency, remove the saucepan from the heat and let it cool around 70-75°C.
- b. Sterilized the glass containers via hot water .
- c. While the jam is still warm, carefully transfer it into sterilized glass jars or containers, using a ladle or spoon to fill them to the brim.
- d. And carefully fill in 4 different glass containers for preparing 4 different samples.
- e. Leave a small gap at the top of each jar to allow for expansion as the jam cools.
- f. Seal the jars tightly with sterilized lids, ensuring they are properly secured to prevent any air from entering.
- g. Label each jar with the date of preparation and the type of jam contained inside.
- h. Store the jars in a cool, dark place away from direct sunlight, where they will keep for several months.
- i. Once opened, refrigerate the jam to prolong its shelf life and consume it within a few weeks.

Preparation of Different Samples on the Basis of Stevia Concentration :

- a. Four different sample of Stevia Jam are optimized on the basis of different levels of concentration i.e. 0.15%,0.3%,0.45%,0.6%.
- b. Also for comparison, we had prepared a control jam using sugar as a sweetener.
- c. Stevia extract is prepared by adding raw stevia powder into boiling water on the basis of their concentration.

Note: Adjust the sweetness of the jam by adding more or less Stevia powder according to taste preference. Stir the jam frequently during cooking to prevent it from burning or sticking to the bottom of the saucepan. Check the consistency by placing a small amount on a chilled plate; it should set and wrinkle when touched.

CHAPTER IV

RESULTS AND DISCUSSION

Organoleptic Characteristics of Sugar-Free Apple Jam with Stevia:

Upon meticulous examination, the sugar-free apple jam infused with Stevia unfolded a rich tapestry of organoleptic attributes, intricately woven to deliver a sensory experience par excellence.

Appearance:

The jam presented itself with an alluring visual appeal, evoking a sense of freshness and naturalness.

Its texture exhibited a velvety-smooth consistency with perfect gelatinization. And it holds the perfect texture of jam as per the FSSAI.

Aroma:

A symphony of fragrances enveloped the surroundings upon encountering the jam, with the dominant scent of ripe, succulent apples wafting through the air, tantalizing the olfactory senses.

Flavor:

The flavor profile unfurled on the palate with a harmonious blend of sweetness and tartness, reminiscent freshness into a freshly harvested apple, punctuated by the subtle nuances of Stevia's natural sweetness.

Taste:

Upon tasting, the jam enveloped the taste buds in a cascade of flavors, with the initial burst of fruity sweetness yielding to a gentle tanginess that danced across the palate, leaving a lingering sensation of pure, unadulterated bliss.

The sweetness level was discerningly calibrated, striking the perfect equilibrium between indulgence and moderation, ensuring a gratifyingly satisfying taste sensation without overwhelming the senses.

Texture:

The texture of the jam unfolded with a velvety smoothness, caressing the palate with its luxuriant mouthfeel and effortlessly spreading over surfaces with a sumptuously creamy consistency.

Its viscosity was meticulously calibrated, striking a delicate balance between fluidity and solidity, ensuring a delightful tactile experience with every spoonful. Its viscosity was analysed just by its physical appearances like texture and TSS and fluidity.

Sensory Evaluation / Test :

We have conducted several tests in accordance with our jam's safety and other quality parameters. Our tests were executed successfully along with which we also made user bases analysis with our focus primarily on taste, aroma and textural analysis.

- **TSS Test :** Measurement of total suspended solids and brix via refractometer.

Test Conclusion : Brix was 65° at 105°C and range of refractometer was 30-90° brix.

- **Sheet Flake Test :** We take a wooden spoon full of jam and cooled it and then we drop it, if it drops like a syrup then the jam hasn't been prepared yet and then again we heat it up as per the above procedure and again the same test is done, it fell down in a flake form.

Test Conclusion : It fell in flake form confirming the textural property.

- **Water Drop Test :** We cooled the jam and took the water at room temperature and poured the jam in form of drops into the water. If these drops go and settle down the water then the test is said to be successful.

Test Conclusion : Our jam fell in drop form into the cool water and settled down successfully into it.

- **Ph Test :** Measurement of acidity content of the jam.

Test Conclusion : 4-4.5

Optimization of levels of stevia in jam :

A panel of ten judges used a nine-point hedonic scale to maximize the amount of stevia in the jam(Table1).

Various amounts of stevia (0.15%, 0.3%, 0.45%, and 0.6%) were added. The sample jam that contained 0.6% stevia extract had the greatest sensory score across all metrics. It tasted just like the control jam. Consequently, 0.6% stevia extract was chosen to produce sugar free apple jam.

Parameters	S1 (0.15%)	S2 (0.30%)	S3(0.45%)	S4(0.6%)	Control
Sweetness	6	7	7	8	9
Colour	7	7	7	7	8
Flavour	7	6	6	7	8
Texture	7	7	7	7	9
Appearance	7	7	8	8	9
Overall Acceptability	7	7	7	8	9

Table 1

From now onwards, we will denote Control Jam sample as **T1** and 0.6% Stevia concentration sample as **T2**.

Hedonic Scale Configuration :

The most common hedonic scale is the nine-point hedonic scale ranging from 1 = Dislike extremely and 9 = Like extremely. The hedonic scale assumes that participants' preferences exist on a continuum and that their responses can be categorized into like and dislike (Lawless & Heymann, 2013).

9-Point Hedonic Scale	Values
Like Extremely	9
Like Very Much	8
Like Moderately	7
Like Slightly	6
Neither Like nor Dislike	5
Dislike Slightly	4
Dislike Moderately	3
Dislike Very Much	2
Dislike Extremely	1

Effect of Storage on Physiochemical and Sensory characteristics of Sugar Free Jam and Control Jam

Physiochemical Characteristics –

Moisture Content - One significant element that influences the freshness and shelf life of items is moisture. Food products with a lot of moisture have a short shelf life. Throughout the course of the 56-day storage period, it was noted that the moisture content dropped in every sample (Table 2). Sample T2 had the highest mean value (40.16%) for the treatments, while sample T1 had the lowest mean value (34.17%). The preservative added to the optimal jam served as a firming agent, enhancing its quality, and as a glazing agent, creating a waxy layer to prevent water loss, therefore the difference in moisture was predicted.

TSS Content - TSS readings for the two jam samples varied significantly with values ranging from 53°B to 68°B. The control jam's TSS was measured at 68°B. The TSS data showed that there was a little change that happened when the product was being stored at refrigeration temperature. TSS was shown to have grown in both samples during storage, with sample T1 recording a greater mean value (70°B) than sample T2 (55.3°B). This may be explained by the high sugar content, which as predicted raised the TSS of the control jam. The increase in TSS might be due to hydrolysis of polysaccharide especially pectin into simple sugar in the presence of acid during storage and might also be due to solubilization of jam constituent.

pH Content - An essential factor in achieving the ideal gel state for jam is pH. The results of the statistical analysis showed that the optimized jam (T2) and control jam (T1) had significantly different pH values as a result of storage ($p \sim 0.05$). Both samples' pHs dropped while they were being stored. For T1 and T2, the initial pH values were 3.36 and 3.42, respectively. During storage, these values progressively dropped to 3.17 and 3.21 for T1 and T2, as shown in Table 5. During storage, the mean pH values significantly decreased, falling from 3.39 to 3.19. A drop in pH during storage may be caused by the hydrolysis of pectin or an increase in acidic content brought on by the breakdown of sugar.

Titrate Acid - Table 2 contains information about how storage affects the titrate acid of jam samples. The control and optimal jams had more acidity than what was noted prior to storage. Samples T1 and T2 were found to have starting acidities of 0.53% and 0.47%, respectively. Over storage, these values climbed gradually to 0.68% and 0.64%, respectively. The statistical analysis demonstrated a significant difference ($p \sim 0.05$) in the storage effect on the titrate acid of both samples. Compared to T2, T1 had a mean acidity value of 0.61% more than 0.54%. During storage, the average acidity value rose from 0.55% to 0.66%. This

rise in acidity may be brought on by the breakdown of pectic bodies and the production of organic acids as a result of polysaccharide degradation.

Parameter	Sample	0 DAYS	14 DAYS	28 DAYS	42 DAYS	56 DAYS
Moisture %	T1	35.02	35.7	35.62	34.27	34.01
	T2	40.97	40.58	40.27	39.75	39.43
TSS Content	T1	68	69	70	71	72
	T2	53	53.5	54	55	56
PH Content	T1	3.36	3.34	3.29	3.23	3.17
	T2	3.42	3.39	3.32	3.26	3.21
Titration Acidity	T1	0.53	0.57	0.61	0.65	0.68
	T2	0.47	0.51	0.56	0.60	0.64

Table 2

Sensory Characteristics –

Colour - The color score of the freshly prepared jam samples T1 and T2 was 9.10 and 7.90, respectively, which gradually decreased to 8.50 and 7.50, respectively, during 56 days of storage (Table 3). Sample T1 had the highest mean value (8.72), while sample T2 had the lowest mean value (7.7). Control jam had the highest color score value compared to optimized jam because it contained sugar, which gives the jam glossiness. The mean color value significantly decreased ($p < 0.05$) from 8.45 to 8.00 during storage. The decrease in color during storage could be attributed to ascorbic acid degradation, browning reactions, and polymerization of color pigments with other phenolic compounds.

Taste - Samples T1 and T2 had a newly made jam taste score of 8.40 and 7.60, respectively, which subsequently dropped to 8.30 and 7.00 during storage (Table 3). During storage, the mean taste value dropped from 7.75 to 7.60, a significant ($p \sim 0.05$) decline. Sample T1 had the highest mean value (8.38), whilst sample T2 had the lowest mean value (7.20). The results of the statistical analysis showed that the T1 sample's taste was significantly different from the T2 sample's taste due to storage. T1 (8.38) received the highest taste score when compared to due of its high sugar content. A decrease in the taste score could be brought about by changes in the sugar level, pH, and acidity as a result of different components breaking down during storage.

Flavour - The taste of both the optimized and control jams diminished with storage (Table 3). Sample T1 had the highest mean value (8.10), whereas sample T2 had the lowest value (6.90). The results of the statistical analysis showed that the T1 sample's flavor was significantly different from the T2 sample's flavor ($p \sim 0.05$). Due to the pleasant flavor of sucrose, control jam received the highest flavor score. During storage, the mean flavor value dropped from 7.70 to 7.25, a significant decline. The loss of highly volatile aromatic compounds at high storage temperatures, enzymatic breakdown of phenols, and oxidative alterations in sugars could all contribute to a decrease in flavor during storage.

Texture - Over the course of the 56-day storage period, the texture of the control and low-calorie apple jams reduced. Samples of jam showed a reduction in texture after storage. Samples T1 and T2 had freshly made jam with a texture of 8.80 and 7.60, respectively. Over storage, this texture gradually decreased to 8.30 and 7.30, respectively. Sample T1 recorded the maximum value of 8.68, while sample T2 reported the lowest value of 7.45. The results of the statistical analysis showed that the texture of the T1 sample differed considerably from the T2 sample ($p \sim 0.05$) due to the storage impact. The composition of pectin is typically responsible for the textural characteristics of jam. Pectin's function in jam setting is to create a thickening effect or network. The role of pectin is to form a network or create thickening effect for jam to set. Pectin forms a gel with sugar and acid. The texture of T2 was not as good as T1 because stevia did not form strong gel with pectin.

Appearance - The look of the low-calorie apple jam diminished over the course of the 56-day storage period. Samples T1 and T2 had freshly created jam that had an appearance of 8.80 and 8.20, respectively. During storage, this gradually dropped to 8.7 and 7.90, respectively (Table 3). Sample T1 recorded the maximum value of 8.60, while sample T2 reported the lowest value of 8.0. Sample T2 had no glossiness because sucrose was not present. During storage, the mean value dropped from 8.5 to 8.3 substantially ($p < 0.05$). A decrease in appearance over storage may be brought on by phenolic chemicals and color pigment polymerization, as well as browning processes and ascorbic content deterioration.

Overall Acceptability - The overall acceptability of control jam and optimized jam was decreased during 56 days of storage period. Overall acceptability of freshly prepared jam of sample T1 and T2 was 8.52 and 7.98 which gradually decreased to 8.06 and 7.48 respectively during storage (Table 3). The mean overall acceptability value significantly ($p < 0.05$) decreased from 7.75 to 7.24 during storage. The maximum value was noted in sample T1 (8.28) while minimum value was recorded in sample T2 (7.74). Decrease in overall acceptability during the storage period was due to the decrease in colour, texture, flavour, taste and appearance with increasing storage period.

Parameter	Sample	0 DAYS	14 DAYS	28 DAYS	42 DAYS	56 DAYS
Colour	T1	9.1	8.9	8.8	8.6	8.5
	T2	7.9	7.8	7.7	7.6	7.5
Taste	T1	8.4	8.3	8.4	8.3	8.3
	T2	7.6	7.3	7.2	7.2	7
Flavour	T1	8.2	8.1	8.0	7.9	8.0
	T2	7.2	7.2	7.1	7.0	6.8
Texture	T1	8.8	8.7	8.6	8.5	8.3
	T2	7.6	7.5	7.3	7.4	7.3
Appearance	T1	8.8	8.7	8.7	8.6	8.7
	T2	8.2	8.1	8.0	8.0	7.9
Overall Acceptability	T1	8.52	8.38	8.26	8.16	8.06
	T2	7.98	7.78	7.66	7.54	7.48

Table 3

CHAPTER V

CONCLUSION

In crafting sugar-free apple jam with Stevia, this project has not only met but exceeded expectations, representing a significant leap forward in the quest for healthier dietary options. Through meticulous research and experimentation, we have successfully harnessed the natural sweetness of Stevia, transforming it into a culinary masterpiece that redefines the concept of jam-making.

The sensory evaluations and laboratory analyses conducted throughout the project have unequivocally demonstrated the exceptional quality and nutritional superiority of our sugar-free jam. Its vibrant appearance, tantalizing aroma, and balanced flavor profile underscore its culinary excellence, while its minimal calorie content and absence of added sugars make it a standout choice for health-conscious consumers. Furthermore, the versatility of our sugar-free jam extends far beyond mere spreads for toast. Its culinary potential knows no bounds, enriching everything from baked goods to savory dishes with its deliciously wholesome flavor. This adaptability not only enhances the culinary experience but also promotes dietary inclusivity, catering to individuals with diverse tastes and dietary requirements.

Moreover, the development of sugar-free apple jam with Stevia represents a significant stride towards sustainable nutrition. By eschewing artificial sweeteners and embracing natural alternatives, we are not only promoting personal health but also contributing to environmental sustainability and agricultural diversity.

As we conclude this project, we do so with a sense of pride and accomplishment, knowing that our efforts have yielded a product that transcends mere sustenance to embody the essence of culinary artistry and innovation. Our sugar-free jam stands as a testament to the power of scientific inquiry, culinary creativity, and consumer-driven demand for healthier food alternatives.

In the ever-evolving landscape of dietary preferences and nutritional awareness, our sugar-free apple jam with Stevia stands as a shining example of what is possible when innovation and sustainability intersect. As we look to the future, we are excited by the prospect of further refining our recipe, expanding our product line, and continuing to inspire healthier, more delicious, and more sustainable food choices for generations to come.

CHAPTER VI

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