

Processing of *Zea mays* L. for Antioxidant and Fibre Rich Jam Development: A Survey Approach

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Abstract: *This study aimed to develop an antioxidant and fiber-rich jam from Maize or Corn (*Zea mays* L.) fruit, utilizing a questionnaire survey methodology as a statistical tool. The independent variables chosen were sugar and lemon, while the dependent variables were sensory attributes such as taste and consistency. The investigation revealed that sugar had a more pronounced effect on the taste score, whereas lemon had a significant impact on the consistency score. Optimum conditions for achieving the highest taste and consistency scores were identified as 50 gm of sugar and 1 tbsp of lemon per 150 gm of the recipe. Furthermore, the evaluation of shelf stability indicated noticeable changes in the nutritional constituents during storage, except for acidity and pH, over a period of one month at the recommended storage temperature of 25 °C. This research sheds light on the feasibility of incorporating maize fruit into the production of value-added products, highlighting its potential in the development of functional food products. The findings contribute to the expansion of the scope for utilizing maize as a raw material in the food industry, emphasizing its benefits in the context of creating nutritious and long-lasting food products.*

Keywords: Antioxidant and fibre-rich jam, Shelf stability, Questionnaire survey methodology

I. INTRODUCTION

Maize or maize (*Zea mays* L.) is a plant native to Mexico and used as a staple food throughout the world. When Europeans came to America in the late 15th and early 16th centuries, they brought corn home and spread it around the world. ^[01] While corn is a staple food in components of the world, it has many applications, inclusive of animal feed, biofuel and sweetener. ^[02] Corn is native to America. Christopher Columbus first discovered corn in Cuba and brought it to Europe. While three major varieties of corn are grown in the United States, corn, which gives the cob its yellow color, is the most well-known variety commonly eaten on the cob. Regardless of the variety, corn plants have the same basic plant components and structure. ⁽⁰⁹⁾

Demand for food, fuel, and feed continues to grow, and corn is widely grown in the United States and around the world to meet these needs. The growing use of food crops such as corn for biofuel production will exacerbate the risk of hunger among the world's poor. The challenge for agriculture is to produce enough food to meet the needs of a growing population and the production of biofuels, which is especially important for corn, one of the world's three largest crops. ⁽⁰⁷⁾

Maize - also known as corn, the scientific name is *Zea mays* subsp. It is May and belongs to the grass family or Poaceae. The family of cereals, numbering about 12,000 species, is found almost all over the world. Grass can be found almost everywhere: backyards, grasslands, African savannahs, many forests and deserts, seas and high mountains. Nixtamalization is an ancient culinary technique used on maize (corn) dating back thousands of years from Latin American times. Nixtamalization is a process known as "thermobase hydrolysis". (Alkaline water is made from ash and lime <calcium oxide>). This treatment is widely used to treat corn to reduce the aflatoxin content of mycotoxin-contaminated corn. ⁽⁰⁸⁾

Corn is mainly composed of carbs and fairly high in fiber. It also packs a decent amount of low-quality protein. ⁽¹⁰⁾ Corn is the third largest plant food source in the world. Although corn is an important staple food in many parts of the world, it is inferior in nutritional value to other cereals. The protein is low quality and contains no niacin. A regular diet often causes pellagra (niacin deficiency). Corn is rich in fiber and antioxidants. Corn oil, valued for its mild flavor and bright color, is mainly used as food. Being low in cholesterol, it is preferred as a salad oil and cooking oil. Unlike many other

cereals, cornmeal is gluten-free and cannot be used alone to make bread. It is also used in popcorn, confectionery, and various breakfast cereals.^[04]

The objectives of the study on the development of an antioxidant and fiber-rich jam from maize or corn (*Zea mays* L.) fruit can be summarized as follows:

To utilize maize or corn fruit as a raw material for the production of a value-added food product, namely an antioxidant and fiber-rich jam.

To assess the impact of specific independent variables, namely sugar and lemon, on the sensory attributes of the jam, particularly focusing on taste and consistency.

To identify the optimal conditions, in terms of the quantity of sugar and lemon, that would result in the highest sensory scores for taste and consistency in the maize fruit jam recipe.

To evaluate the shelf stability of the maize fruit jam over a one-month period, considering changes in nutritional constituents, with a specific emphasis on acidity and pH, at the recommended storage temperature of 25°C.

To demonstrate the potential of maize fruit as a functional food product in the food industry, highlighting its capacity for the development of nutritious and durable food items with potential health benefits.

To contribute to the expansion of the utilization of maize as a versatile raw material, emphasizing its viability and potential in creating value-added food products with enhanced nutritional content and extended shelf life.

II. REVIEW OF LITERATURE

Corn, a commonly consumed grain, is generally regarded as safe, yet certain considerations have been raised in the existing literature.

One prominent issue highlighted is the presence of antinutrients, particularly phytic acid, which can hinder the absorption of essential dietary minerals such as iron and zinc. Various traditional processing methods, including soaking, sprouting, and fermenting, have been proposed as effective strategies to mitigate phytic acid levels in corn, enhancing its nutritional value^[10].

Moreover, the potential presence of mycotoxins, a group of harmful substances produced by fungi, poses a significant health risk associated with the consumption of contaminated corn. Exposure to mycotoxins has been linked to various health concerns, including an increased risk of cancer and neural tube defects, leading to potentially severe birth defects or even mortality. To address this issue, preventive measures such as the use of fungicides and appropriate drying techniques have been suggested in the literature^[10].

Furthermore, the presence of proteins known as zein in corn has raised concerns regarding corn intolerance, particularly for individuals with gluten intolerance or celiac disease. The symptoms associated with gluten intolerance include fatigue, bloating, diarrhea, and weight loss, emphasizing the need for careful consideration and monitoring of corn consumption among susceptible individuals^[10].

While corn does contain a diverse array of vitamins and minerals, the specific nutritional composition can vary significantly depending on the type of corn consumed. Popcorn, for instance, tends to be richer in minerals, whereas sweet corn often boasts higher levels of various vitamins. Understanding these variations is crucial for individuals seeking to maximize their nutritional intake from corn-based products^[10].

Additionally, the historical significance of corn in the Mesoamerican diet underscores the importance of the nixtamalization technique, which played a critical role in addressing deficiency ailments such as pellagra and niacin deficiency. By providing essential amino acids to complement maize, this traditional processing method served to enhance the overall nutritional value of corn-based diets^[10].

This review of literature sheds light on the multifaceted considerations surrounding the consumption of corn, emphasizing the importance of appropriate processing techniques, awareness of potential contaminants, and understanding the varying nutritional profiles of different corn varieties. Further research is warranted to explore sustainable strategies for enhancing the nutritional quality and safety of corn-based food products for diverse populations.

Corn or maize is the 2d most-produced crop in the world, and it's more than simply a staple in our diets. From the sweetener in our coffees to the ethanol that powers our vehicles, corn has lots of uses.^[08]

Many components of the corn plant are used in industry, and quite a few kinds of corn are grown specifically for their industrial applications. Corn grain is processed by using moist milling, in which the grain is soaked in a dilute solution of sulphurous acid; via dry milling, in which the corn is exposed to a water spray or steam; and by way of fermentation, in which starches are changed to sugars and yeast is employed to convert the sugars into alcohol. Cornstarch (made from wet-milled corn) can be damaged down into corn syrup, a frequent sweetener that is normally much less highly priced than sucrose. Corn syrup is bought commercially as either mild or dark corn syrup. Light corn syrup has been clarified and decolorized; it is used in baked goods, jams and jellies, and many other food products. Because it cannot crystallize when heated, it is especially valued as an ingredient in candies. Dark corn syrup is made through combining corn syrup with molasses and caramel coloring and is sweeter than light corn syrup. Dark corn syrup is used in equal methods as light; it is also used as a desk syrup. Corn syrup can be further processed into high-fructose corn syrup, which is used substantially in processed foods such as smooth drinks and candies. Corn stalks are made into paper and wallboard; husks are used as filling material; cobs are used directly for fuel, to make charcoal, and in the practice of industrial solvents. Corn husks additionally have a long record of use in the folk arts for objects such as woven amulets and corn-husk dolls. In the United States the vibrant variegated traces recognized as Indian corn are traditionally used in autumn harvest decorations.^[04]

The colour of the Corn fruit was golden yellow, the diameter between 7.2 and 6.8 mm is median corn kernel, and has sweet taste. The proximate composition results of fruit show in table 1 and 2.

Table 01 – Macronutrient composition in corn

Macronutrients

COMPONENTS	VALUES (GM AND %)
Calories	96kcal
Protien	3.4gm
carbohydrates	21gm
Fats	1.5gm
Fiber	2.4gm
Sugar	4.5gm
Water	73%

Table 02 – Micronutrient composition in corn

III. METHODOLOGY

Raw Materials:

The corn jam recipe utilizes only three organic ingredients, resulting in a product that offers a sweet corn mouthfeel, enhanced by the inherent creaminess derived from the rich starch content of corn. Sugar serves to lend a glossy texture to the jam, while lemon functions as an acid regulator.

Development of Corn Jam:

The standard procedure, outlined in Figure 1, was followed for the development of the corn jam. The approach involved experimenting with varying levels of sugar and lemon to achieve the desired taste and consistency. The sugar content ranged from 50 to 120 gm, while the lemon quantity varied between 1 tbsp to 3 tbsp per 200 gm of the recipe.

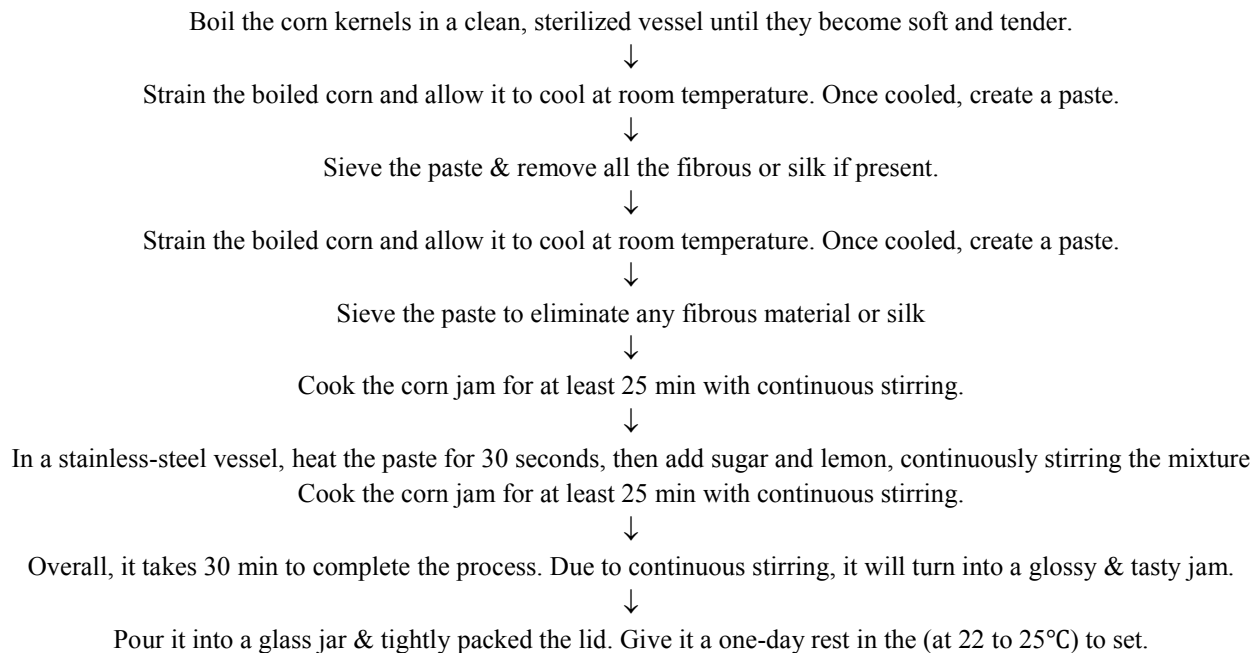


Fig. 1 – Flow diagram of development of corn jam

Sensory evaluation

On the 6th of March, 2023, a sensory evaluation of Corn Jam was conducted by a panel comprising 28 semi-trained individuals. The panelists were instructed to assess the jam based on various parameters, including color, consistency, flavor, aroma, texture, sweetness, aftertaste, and mouthfeel. The evaluation was conducted using a common Composite scoring test, with a scale ranging from 10 for "like extremely" to 1 for "dislike extremely." The results of the sensory evaluation provided valuable insights into the overall sensory profile and acceptability of the Corn Jam, aiding in the assessment of its quality and desirability among consumers.

Average Score of Sensory Evaluation, Nutri-CORN Jam		
Parameters	Maximum Score	Average Score
Color	10	9.6
Consistency	20	18.7
Flavors	10	9.3
Aroma	10	9
Sweetness	20	18.8
Mouthfeel	10	9.3
Aftertaste	10	9.5
Texture	10	9.4

Statistical Analysis:

The experimental procedures were conducted in triplicate, ensuring the reliability and consistency of the obtained data. For the analysis of the gathered data, Microsoft Excel 365 was employed to perform the analysis of variance (ANOVA). This statistical technique allowed for the assessment of the variations within the datasets, enabling the identification of any significant differences or trends in the experimental results. The utilization of ANOVA facilitated a comprehensive understanding of the experimental data, aiding in the interpretation of the outcomes and providing valuable insights into the relationship between the variables under investigation.

IV. RESULT AND DISCUSSION

Corn Jam –

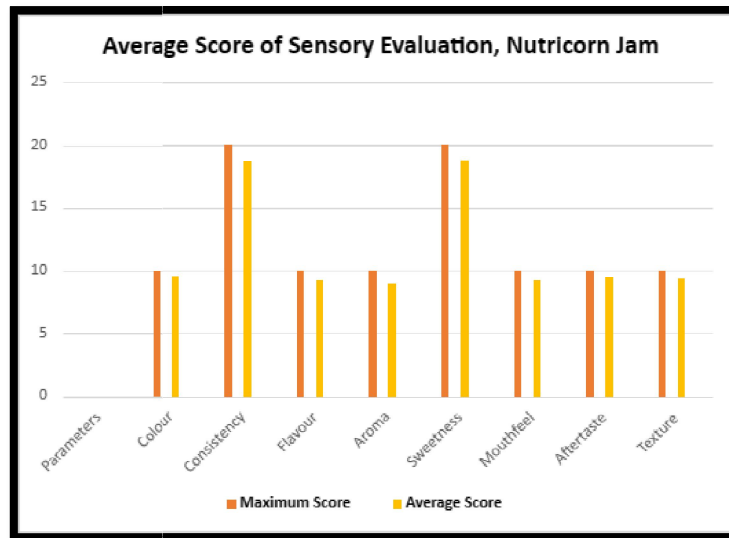


Fig. 2 – Graphical representation of average scoring

Survey Analysis:

i. General Data:

The survey aimed to gather a minimum of 100 responses and successfully obtained 125 responses in total. Of the total respondents, 15.20% (19 individuals) identified as male, while 84.80% (106 individuals) identified as female. The majority of the respondents belonged to the 10 to 25 age group, reflecting the participation of a predominantly youthful demographic in the survey. This diverse dataset provides a comprehensive representation of varied perspectives and opinions, contributing to a more nuanced understanding of the subject matter under investigation.

ii. Analysis:

The survey analysis revealed various insights related to the respondents' awareness and preferences regarding corn. A significant portion, 87.20% (109 individuals), demonstrated awareness of corn, while a smaller fraction, 8.80% (11 individuals), seemed unfamiliar with corn as a vegetable or fruit. Some respondents, accounting for 4.00% (5 individuals), did not provide a response to this question.

Moreover, the majority of respondents, 89.60% (112 individuals), expressed their liking for consuming corn, whereas only 4.80% (6 individuals) indicated their dislike for it, and a few respondents remained undecided. Further questions in the survey sought to determine the preferred forms of consuming corn, the number of corn varieties known to respondents, the availability of different-colored corn, the preferred part of the corn consumed, and the frequency of corn consumption among respondents.

Furthermore, the survey aimed to gauge the level of awareness about the health benefits and potential disease-reducing properties of corn. The responses indicated that a substantial number of respondents were aware of the health benefits of corn, particularly its role in reducing cardiovascular diseases, improving bone health, boosting the immune system, and serving as a rich source of vitamins and minerals.

The survey also inquired about respondents' familiarity with various uses of different parts of the corn plant. Responses indicated that certain individuals had heard of corn silk being used in green tea, corn cobs being used as a sweetener, and corn husks being used as a wrap. Additionally, the survey sought information on whether individuals had ever utilized corn as a main ingredient and their awareness of corn-based products such as corn jam and corn silk snacks.

The analysis further addressed respondents' preferences for consuming corn-based products, with a significant portion expressing interest in consuming both corn jam and corn silk snacks. The survey also explored the expected expenditure on 100-gram packs of these products, revealing varying spending preferences among respondents.

V. CONCLUSION

The comprehensive product research conducted on corn has highlighted its diverse benefits across various domains, including health, household, livestock, and industrial applications. As a primary staple in livestock feed, corn plays a crucial role in the global food supply chain and finds widespread use in numerous food products. Its versatility is evident in its use in the production of starch, corn oil, sweeteners, beverages, and ethanol, contributing significantly to the functionality and sustainability of our society.

Corn's nutritional benefits, including its rich source of Vitamin C and antioxidants, make it an essential component in promoting human health, particularly in supporting eye health and preventing lens damage that can lead to cataracts. The wide array of nutrients and chemical compounds present in corn further contribute to its potential health benefits and applications.

Moreover, the research underscores the multifaceted nature of corn, where every part of the corn plant is found to be usable. The planned introduction of corn jam and corn silk snacks in the market has garnered positive responses from the audience, indicating a potential market demand for these products. Although the general awareness regarding corn jam and corn silk snacks may be limited, the survey results suggest that there is a willingness among consumers to explore and consume these novel corn-based products.

The online survey, conducted via Google Forms, yielded a total of 125 responses, which were meticulously analyzed to derive meaningful insights. The findings and analyses from the survey have contributed to a comprehensive understanding of the consumer perspective on corn and its related products, emphasizing the potential for the successful introduction and acceptance of innovative corn-based food items in the market.

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