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Comparison of Nutritional and Antioxidant Properties of Ready to Drink Maize and Sweet Corn Silk Based Beverage

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Abstract*—Corn silk is an underutilized agricultural by-product with potential applications in the development of functional foods and beverages. The present study was undertaken to develop and compare ready-to-drink (RTD) beverages prepared from maize silk and sweet corn silk and to evaluate their sensory acceptability, nutritional composition and antioxidant activity. Maize and sweet corn silk extracts were prepared and used for the development of RTD beverages. Different formulations were standardized using sugar, jaggery and palm jaggery as sweetening agents. The developed products were subjected to sensory evaluation by a panel of 10 members, and the most acceptable formulations were selected for further analysis. Among the maize silk beverage formulations, the jaggery-based sample (S2) obtained the highest overall acceptability score of 4.05 ± 0.43. Similarly, the sweet corn silk beverage formulated with jaggery showed the highest overall acceptability score of 4.90 ± 0.21. The standardized maize silk and sweet corn silk beverages were further evaluated for moisture, carbohydrate, protein, crude fibre, iron, vitamin C and antioxidant activity. The moisture content of maize silk and sweet corn silk beverages was 75.4% and 79.2%, respectively. The maize silk beverage showed higher carbohydrate content (9.17 g/100 ml), crude fibre (15.16 g/100 ml), iron (0.55 mg/100 ml) and antioxidant activity (75.67%) than the sweet corn silk beverage. The sweet corn silk beverage contained higher protein (0.80 g/100 ml), moisture (79.2%) and vitamin C (21.43 mg/100 ml) than the maize silk beverage. The findings demonstrate the potential of maize and sweet corn silk, which are commonly discarded during corn processing, as value-added ingredients for the development of functional RTD beverages. Both beverages showed favourable sensory acceptance and appreciable nutritional and antioxidant characteristics, with the jaggery-based formulations emerging as the most acceptable.

***Index Terms*—Corn silk, maize silk, sweet corn silk, ready-to-drink beverage, jaggery, antioxidant activity, functional beverage.**

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I. INTRODUCTION

The increasing demand for convenient and health-oriented foods has encouraged the development of ready-to-drink beverages containing natural and functional ingredients. Ready-to-drink beverages are convenient, pre-packaged products that can be consumed without further preparation. The category includes fruit beverages, tea, coffee, energy drinks and other functional beverages. Consumer interest in products that combine convenience with nutritional value has contributed to the diversification of the RTD beverage sector.

The utilization of agricultural by-products for the development of value-added foods has gained considerable attention. Such an approach can reduce food-processing waste while improving the economic value of agricultural commodities. Corn silk, is generally discarded during the processing and consumption of maize and sweet corn, represents one such underutilized plant material. The present study was therefore designed to explore the potential utilization of maize silk and sweet corn silk in the development of ready-to-drink beverages. Corn silk consists of the elongated styles and stigmas of the female flowers of Zea mays. It has traditionally been used in different forms and is reported to contain several bioactive constituents, including flavonoids, phenolic compounds and other phytochemicals. The source material for the present study also describes maize silk and sweet corn silk as ingredients with potential antioxidant and nutritional properties. Although corn silk has traditionally been used as an herbal ingredient, its application in commonly consumed food products remains limited. Converting this agricultural by-product into a ready-to-drink beverage may provide a practical strategy for improving its utilization. Therefore, the present investigation focused on the development and sensory standardization of maize silk and sweet corn silk beverages using different sweeteners, followed by a comparative evaluation of their nutritional composition and antioxidant activity.

The objectives of the study were to collect maize and sweet corn silk, prepare their extracts, develop and standardize ready-to-drink beverages, compare their proximate composition and determine their antioxidant activity.

II. MATERIALS AND METHODS

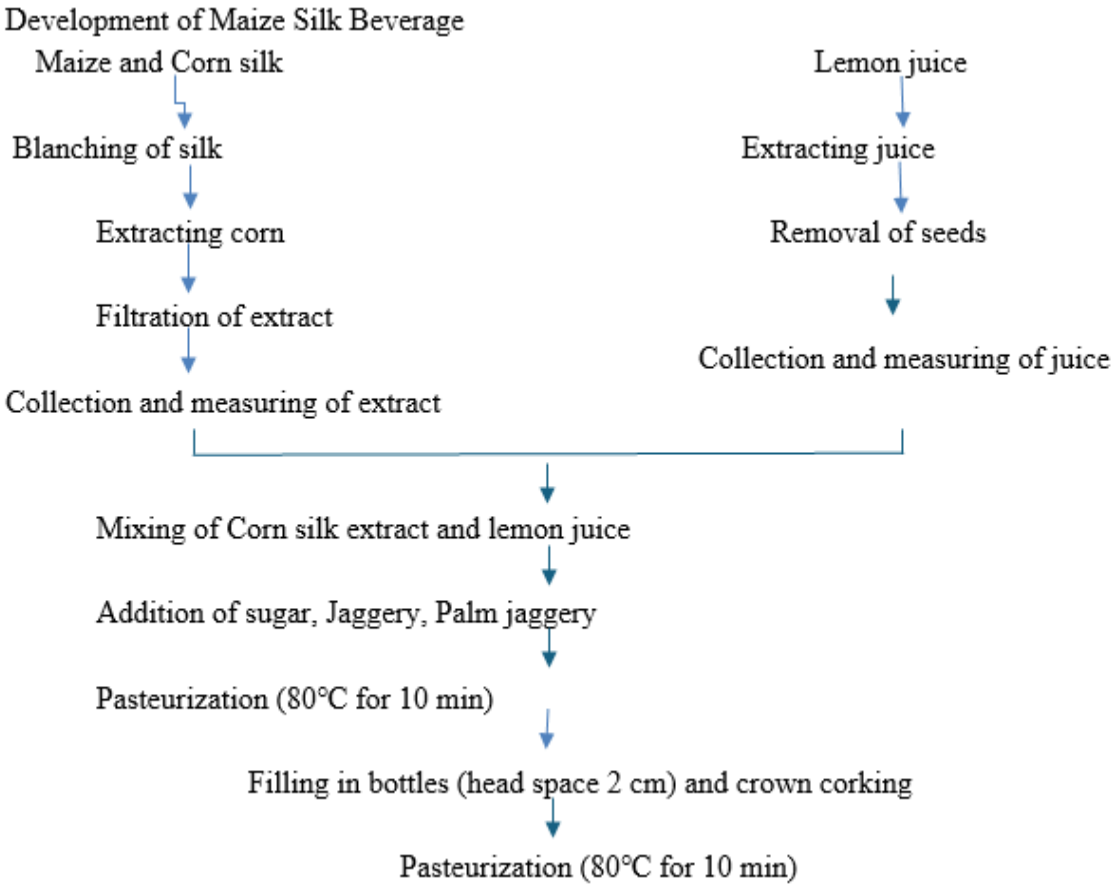
2.1 Collection of Raw Materials

Maize silk and sweet corn silk were collected for the preparation of the experimental beverages. The collected silk samples were processed for the preparation of extracts. Other ingredients required for beverage preparation, including sugar, jaggery and palm jaggery, were used for the standardization of different formulations.

2.2 Preparation of Maize and Sweet Corn Silk Extract

Separate extracts were prepared from maize silk and sweet corn silk and used as the base ingredients for beverage development. The prepared extracts were incorporated into the respective ready-to-drink beverage formulations.

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Flow chart – 1

2.3 Development and Standardization of RTD Beverages

Ready-to-drink maize silk and sweet corn silk beverages were developed using different sweeteners. The formulations included a control and three experimental samples prepared using sugar, jaggery and palm jaggery.

- S0: Control
- S1: Sugar-based formulation
- S2: Jaggery-based formulation
- S3: Palm jaggery-based formulation

Both maize silk and sweet corn silk beverages were subjected to sensory evaluation. The study used 10 panel members, and mean sensory scores were statistically analysed.

2.4 Sensory Evaluation

The sensory characteristics of the maize silk and sweet corn silk beverages were assessed by 10 judges were five points. Hedonic scales the panelist was asked to give scores for colour, flavour, texture, taste over all acceptability. The sensory scores were expressed as mean ± standard deviation. Based on the sensory evaluation, the most acceptable maize silk and sweet corn silk formulations were selected for nutritional and antioxidant analysis.

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2.5 Nutritional Analysis

The standardized beverages were analysed for the following parameters moisture content, carbohydrate, protein, crude fibre, iron and Vitamin C. The values were expressed per 100 ml, except moisture, which was expressed as percentage.

2.6 Determination of Antioxidant Activity

The antioxidant activity of the beverage samples was evaluated using the DPPH free-radical scavenging method. The study describes DPPH as the basis for assessing the radical-scavenging capacity of the extracts and beverages.

2.7 Statistical Analysis

The sensory evaluation results were expressed as mean ± standard deviation. Comparative interpretation was performed for the developed formulations and standardized beverages.

III. RESULTS AND DISCUSSION

3.1 Sensory Evaluation of Maize Silk Beverage

Four maize silk beverage formulations were evaluated for sensory characteristics. The control sample recorded an overall acceptability score of 3.75 ± 0.79. Among the experimental formulations, the jaggery-based sample S2 obtained the highest overall acceptability score of 4.05 ± 0.43.

Table 1. Sensory evaluation of developed maize silk beverage

Sensory attribute	Control (S0)	Sugar (S1)	Jaggery (S2)	Palm jaggery (S3)
Taste	3.90 ± 0.84	3.70 ± 0.42	4.20 ± 0.42	3.35 ± 0.53
Flavour	3.80 ± 0.75	3.75 ± 0.48	4.35 ± 0.33	3.65 ± 0.34
Mouthfeel	3.75 ± 0.79	3.55 ± 0.36	4.40 ± 0.45	3.45 ± 0.64
Colour	3.85 ± 0.78*	3.50 ± 0.47	4.00 ± 0.62	3.20 ± 0.58
Overall acceptability	3.75 ± 0.79	3.60 ± 0.45	4.05 ± 0.43	3.10 ± 0.52

The results indicate that the jaggery-based maize silk beverage was the most preferred formulation. It recorded the highest scores for taste, flavour, mouthfeel and overall acceptability among the experimental samples. The original study similarly identifies S2 as the superior formulation.

The improved acceptability of the jaggery formulation may be associated with its characteristic sweetness and flavour, which may have complemented the sensory properties of the maize silk extract.

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3.2 Sensory Evaluation of Sweet Corn Silk Beverage

The sweet corn silk beverage formulations were also evaluated by the sensory panel. The jaggery-based formulation, S2, obtained the highest overall acceptability score of 4.90 ± 0.21.

Table 2. Sensory evaluation of developed sweet corn silk beverage

Sensory attribute	Control (S0)	Sugar (S1)	Jaggery (S2)	Palm jaggery (S3)
Taste	4.90 ± 0.31	4.25 ± 0.79	4.65 ± 0.41	3.55 ± 0.72
Flavour	4.90 ± 0.31	4.60 ± 0.45	4.70 ± 0.34	3.70 ± 0.67
Mouthfeel	4.90 ± 0.31	4.65 ± 0.47	4.65 ± 0.47	3.67 ± 0.70
Colour	4.70 ± 0.48	4.70 ± 0.42	4.60 ± 0.45	3.70 ± 0.67
Overall acceptability	4.80 ± 0.42	4.50 ± 0.47	4.90 ± 0.21	3.75 ± 0.58

The sweet corn silk beverage showed high sensory acceptance overall. Among the experimental formulations, jaggery was selected as the most acceptable sweetener based on overall acceptability. The original study also reports S2 as the formulation with the highest overall acceptability among the developed sweet corn silk beverages.

The findings from both product categories indicate that jaggery was the preferred sweetener for the development of the standardized corn silk beverages. Therefore, the jaggery-based maize silk and sweet corn silk beverages were selected for further nutritional and antioxidant analysis.

3.3 Comparative Nutritional Composition of Standardized Beverages

The standardized control, maize silk beverage and sweet corn silk beverage were analysed for moisture, carbohydrate, protein, crude fibre, iron and vitamin C.

Table 3. Comparative nutritional composition of ready-to-drink corn silk beverages

Parameter	Control	Maize silk beverage	Sweet corn silk beverage
Moisture (%)	60.96	75.40	79.20
Carbohydrate (g/100 ml)	6.90	9.17	7.69
Protein (g/100 ml)	0.35	0.72	0.80
Crude fibre (g/100 ml)	0.49	15.16	13.77
Iron (mg/100 ml)	0.01	0.55	0.45
Vitamin C (mg/100 ml)	39.00	14.30	21.43

3.3.1 Moisture Content

The moisture content of the control, maize silk beverage and sweet corn silk beverage was 60.96%, 75.40% and 79.20%, respectively. Sweet corn silk beverage showed the highest moisture content, followed by maize silk beverage.

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The higher moisture content observed in the developed beverages is consistent with their liquid formulation and the use of aqueous extracts. Moisture is an important quality characteristic of RTD beverages and may influence product stability and shelf life.

3.3.2 Carbohydrate Content

The carbohydrate content was highest in the maize silk beverage at 9.17 g/100 ml, compared with 7.69 g/100 ml in the sweet corn silk beverage and 6.90 g/100 ml in the control. The higher carbohydrate content of the maize silk beverage may reflect differences in the formulation or extract composition. The result reports that maize silk beverage had the highest carbohydrate content among the analysed samples.

3.3.3 Protein Content

The protein content of the maize silk beverage was 0.72 g/100 ml, whereas the sweet corn silk beverage contained 0.80 g/100 ml. Both developed beverages showed higher protein content than the control, which contained 0.35 g/100 ml.

Among the two developed beverages, sweet corn silk beverage showed a marginally higher protein content. Although the absolute protein levels were low, the results demonstrate that the incorporation of corn silk extract contributed to the overall nutritional profile of the developed beverages.

3.3.4 Crude Fibre Content

A substantial difference in crude fibre content was observed between the control and the developed beverages. The maize silk beverage contained 15.16 g/100 ml of crude fibre, followed by the sweet corn silk beverage with 13.77 g/100 ml. The control showed a much lower value. The study reports maize silk beverage as having the highest fibre content among the samples.

These findings support the potential of corn silk as a source of dietary fibre. However, because the reported fibre values are relatively high for a liquid beverage, the analytical calculation and unit expression should be carefully verified before publication.

3.3.5 Iron Content

The iron content was 0.55 mg/100 ml in the maize silk beverage and 0.45 mg/100 ml in the sweet corn silk beverage, compared with 0.01 mg/100 ml in the control. Thus, both developed beverages showed higher iron values than the control. The higher iron content may contribute to the micronutrient profile of the developed beverages. Among the experimental products, maize silk beverage demonstrated the higher iron content.

3.3.6 Vitamin C Content

The vitamin C content of the control was 39 mg/100 ml, while the maize silk and sweet corn silk beverages contained 14.30 mg/100 ml and 21.43 mg/100 ml, respectively. Sweet corn silk beverage contained more vitamin C than maize silk beverage, although both had lower values

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than the control. The difference may be influenced by the composition of the base ingredients and the processing conditions used during beverage preparation.

3.4 Antioxidant Activity

The antioxidant activity of the developed beverages was evaluated using the DPPH radical scavenging method.

Table 4. Antioxidant activity of ready-to-drink corn silk beverages

Sample	Antioxidant activity (%)
Control	67.56
Maize silk beverage	75.67
Sweet corn silk beverage	74.32

The maize silk beverage exhibited the highest antioxidant activity at 75.67%, closely followed by the sweet corn silk beverage at 74.32%. Both developed beverages demonstrated higher antioxidant activity than the control. The observed antioxidant activity may be associated with the presence of bioactive compounds reported in corn silk, including phenolic compounds and flavonoids.

IV. RESULT AND DISCUSSION

The present investigation demonstrated the feasibility of utilizing maize silk and sweet corn silk in the development of ready-to-drink functional beverages. Corn silk is generally treated as a by-product of maize and sweet corn processing, despite its reported content of bioactive constituents and its history of traditional use. The conversion of this material into an acceptable beverage provides an opportunity for value addition and improved utilization of agricultural resources.

The sensory evaluation results clearly indicated that the type of sweetener influenced consumer acceptability. Among the experimental formulations, jaggery-based S2 was selected as the most acceptable formulation for both maize silk and sweet corn silk beverages. The maize silk beverage obtained an overall acceptability score of 4.05 ± 0.43, while the sweet corn silk beverage obtained a higher score of 4.90 ± 0.21.

The comparative nutritional analysis demonstrated differences between the two standardized beverages. Sweet corn silk beverage had higher moisture, protein and vitamin C content, whereas maize silk beverage had higher carbohydrate, crude fibre, iron and antioxidant activity. These variations may be attributed to differences in the raw materials and beverage formulations.

The antioxidant results were particularly noteworthy. Both corn silk beverages showed greater DPPH radical scavenging activity than the control, with maize silk beverage recording the highest value of 75.67%. The antioxidant potential of corn silk has been associated with its phytochemical composition, particularly flavonoids and phenolic compounds.

Overall, the results suggest that both maize silk and sweet corn silk can be successfully incorporated into palatable RTD beverages. The findings also highlight the potential for utilizing agricultural by-products in the development of functional foods.

V. CONCLUSION

The present study demonstrated the successful development and evaluation of ready-to-drink beverages prepared from maize silk and sweet corn silk. Different formulations containing sugar, jaggery and palm jaggery were developed and subjected to sensory evaluation.

Among the experimental formulations, the jaggery-based formulation was selected as the most acceptable for both maize silk and sweet corn silk beverages. The standardized sweet corn silk beverage showed superior overall sensory acceptability, with a score of 4.90 ± 0.21, compared with 4.05 ± 0.43 for the standardized maize silk beverage.

Comparative nutritional analysis revealed that sweet corn silk beverage had higher moisture, protein and vitamin C content, whereas maize silk beverage showed higher carbohydrate, crude fibre, iron and antioxidant activity. The maize silk beverage exhibited the highest DPPH radical scavenging activity at 75.67%, followed closely by sweet corn silk beverage at 74.32%.

The study therefore demonstrates the potential of maize silk and sweet corn silk as value-added ingredients for the development of functional ready-to-drink beverages. The utilization of corn silk in food product development may contribute to the reduction of agricultural waste while providing beverages with desirable nutritional and antioxidant characteristics.

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