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VALORISATION, NUTRITIONAL AND PHYTOCHEMICAL ANALYSIS OF CORN SILK POWDER

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ABSTRACT

Agricultural food waste happens on a large scale in par with the agricultural produce that is being utilized, triggering environmental, economic and nutritional perils. Agricultural food waste primarily embraces skins, rinds, stalks, shoots, seeds, husks, coats, and residues of vegetables and fruits or their plants. These wastes which host treasure of nutrients are habitually thrown off in lands causing environmental hazards, at times used as fodder and occasionally to make manure. In this line, this research was carried out to provide an insight to how corn silk, an agro-food waste can be utilized as a value enhancer in muffins, a commonly consumed bakery product. Corn silk was powdered and functional properties were assessed. The corn silk powder was substituted in the proportion of 25%, 50% and 75% in wheat flour and muffins were formulated. The formulated variations of value-added muffins were subjected to sensory evaluation and the highly accepted variation of muffins (50% incorporation of corn silk powder) was further subjected to analysis of nutrients and phytochemicals. The results of functional properties showed that corn silk powder along with gluten rich ingredients will be suitable for bakery food formulation. The results of nutritional analysis showed the presence of higher proportion of protein (7.6g), fibre (6.4g), ash (1.6g), calcium (200mg), potassium (317mg), copper (1.2mg) and iron (0.88mg) in the 50% incorporation of corn silk powder muffins. The presence of phytochemicals viz. polyphenols, flavonoids, tannins and saponins was also noted proving that corn silk powder addition to any food product will be viable for consumption as well as nutritionally adequate.

KEYWORDS *Antioxidants, Corn Silk, Muffins, Phytochemicals*

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INTRODUCTION

The food industry is captivated with the term functional foods in recent years. Agricultural food waste is a promising source for finding viable ingredients for the formulation of functional foods (Pérez-Marroquín *et al.,*2023). The bioactive elements which provide benefits like prevention of degenerative diseases, apart from providing basic nutrition are termed as Functional foods (Kumar *et al.,*2021). The functional foods can include bakery foods, beverages, dairy foods, health drinks and so on (Jibril & Abubakar 2021).

In this study, corn silk, the maximum region of the corn plant that is disposed off as agricultural waste or used as food for animals is used as a major ingredient. The therapeutic traits of corn silk are due to good amount of resins, mucilage,fibersand wide range of polyphenols and flavonoids in addition to essential macronutrients and micro nutrients (Singh *et al.,*2022; Žilić *et al.,* 2016).

The in-vivo and invitro studies have proved the efficacy of corn silk as fit for human consumption (Saheed *et al*.,2015). Literature states that corn silk powder had been utilized at 5% and 10% levels to develop value added paratha, chapati, raita and dhal (Singh & Raghuvanshi.,2020). Corn silk powder tea infusions had also been formulated (Taiwong., 2020).Microwaved corn silk powder patties were also found to be nutritionally superior (Castillo *et* al., 2020). Similarly, this study has been adopted with the objective of formulating corn silk powder incorporated muffins and evaluating its nutritional and antioxidant properties. The study hypothesize that incorporation of cornsilk in muffins increases nutritional value and phytochemical composition.

NEED AND SCOPE OF THE STUDY

The study aims at development of sustainable low-cost food products, ecological waste management, maintenance of optimal nutritional status and prevention of non-communicable diseases. The corn silk powder muffins which are made by combining ecological waste corn silk, wheat flour, brown sugar, milk, baking powder will prodigiously influence the intake of complex carbohydrates, protein, fiber, micronutrients and nutraceuticals. These products when consumed regularly may help the prevention of chronic diseases.

METHODOLOGY

PROCUREMENT OF RAW MATERIALS: The ingredients required for the formulation of corn silk muffins like wheat flour, brown sugar, and baking powder, were purchased from the retail shop in Salem, TamilNadu, while corn silk was procured from nearby fields and they were kept safely until they were used.

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PROCESSING OF CORN SILK INTO POWDER: Good quality corn silk free from infestation was collected and washed with distilled water several times and shade dried for 14 days, ground in a mixer, sieved in 80micrometer mesh and made into a fine powder (Sarepoua *et al.,*2015).

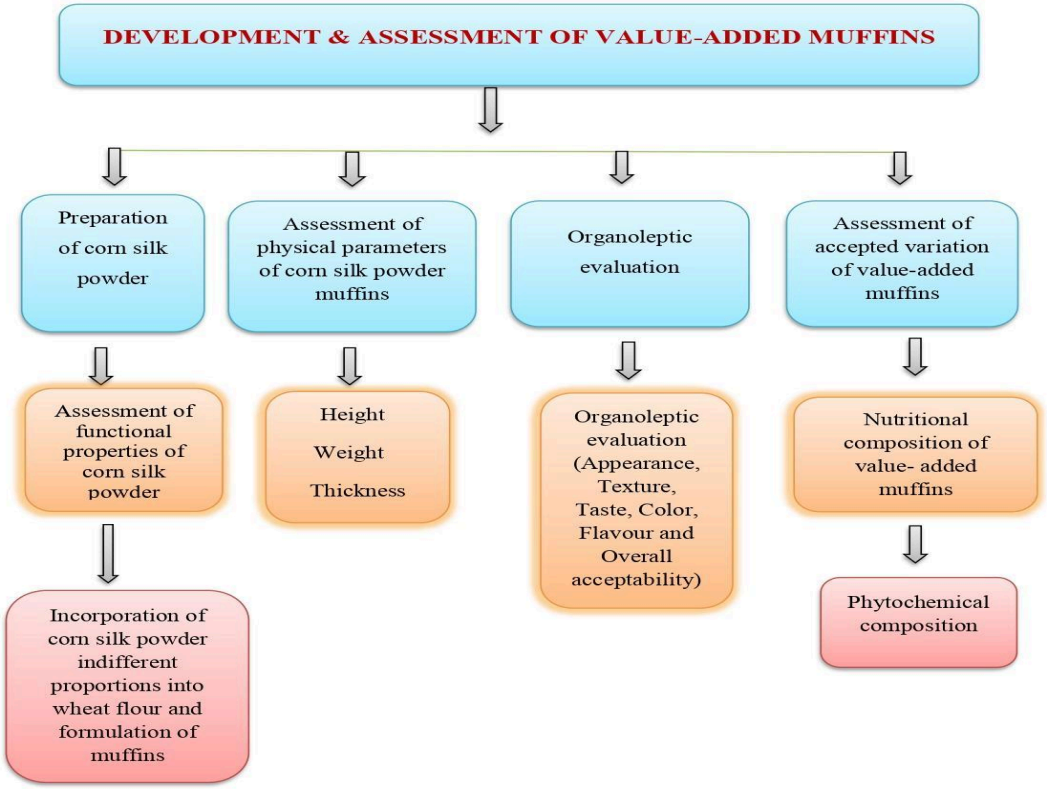

FIGURE 1- DEVELOPMENT AND ASSESSMENT OF CORNSILK MUFFINS

FORMULATION OF DIFFERENT VARIATIONS OF CORN SILK POWDER INCORPORATED MUFFINS: For the formulation of different variations of the corn silk powder incorporated muffins (CSPM I, CSPM II and CSPM III), 25g, 50g, and 75g of the corn silk powder was added to 75g, 50g, and 25g of refined wheat flour respectively. All the ingredients were mixed together in the proportion as shown in table-1 to prepare the batter of required consistency.

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TABLE-1. INGREDIENTS FOR PREPARATION OF CORN SILK POWDER MUFFINS

INGREDIENTS	CONTROL	CSPM I	CSPM II	CSPM III
Refined Wheat flour (g)	100	75	50	25
Corn silk powder (g)	-	25	50	75
Milk (ml)	10	10	10	10
Brown sugar (g)	15	15	15	15
Baking powder (tsp)	1	1	1	1
Vanilla extract (tsp)	½	½	½	½

The cornsilk flour enriched batter was poured into the mould and placed in the preheated oven. Bake at 180^0C for 20 minutes until the muffins are done well.

ACCEPTABILITY OF THE MUFFINS BY ORGANOLEPTIC EVALUATION: The control muffins and the developed muffins (CSPM I, CSPM II and CSPM III) were subjected to organoleptic evaluation. The panelist evaluated the muffins in terms of sensory characteristics using a 9-point hedonic scale.

ANALYSIS OF NUTRIENTS AND PHYTOCHEMICALS IN THE CONTROL AND THE ACCEPTED VARIATION OF CORN SILK POWDER INCORPORATED MUFFINS: The highly rated variation of corn silk powder incorporated muffins was assessed for nutrients and phytochemicals as per standard laboratory procedures (AOAC, 2023).

RESULTS AND DISCUSSION

ORGANOLEPTIC EVALUATION OF THE CORN SILK POWDER MUFFINS: The developed variations of CSPM I, CSPM II and CSPM III (corn silk powder incorporated muffins) were sensorily evaluated for appearance, texture, colour, taste, and flavour using nine-point hedonic rating scale method. A sample size of 30 is often considered large enough to make statistically sound conclusions about a population. Hence, 30 semi-trained respondents were used for organoleptic evaluation.

TABLE-2. STATISTICAL ANALYSIS OF ORGANOLEPTIC VALUES OF THE CONTROL AND CORN SILK POWDER MUFFINS

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Vol. 5(1), June 2025, pp. 50-58

VARIATIONS	APPEARANCE	TEXTURE	COLOUR	TASTE	FLAVOR
Control	7.20 ± 0.74^{b}	7.60 ± 0.6^{c}	7.05 ± 0.74^{b}	7.00 ± 0.79^{b}	6.70 ± 0.92^{a}
CSPM I	6.80 ± 0.83^{b}	6.95 ± 0.12^{b}	6.90 ± 0.8^{b}	7.10 ± 0.8^{b}	7.15 ± 0.7^{a}
CSPM II	8.10 ± 0.64^{c}	7.50 ± 0.51^{c}	8.30 ± 0.8^{c}	8.05 ± 0.8^{c}	7.90 ± 0.7^{b}
CSPM III	6.35 ± 0.79^{a}	6.05 ± 0.2^{a}	6.25 ± 0.7^{a}	6.40 ± 0.7^{a}	8.05 ± 0.8^{b}

Samples with different superscripts within a column are significantly different from one another at ($p \leq 0.05$).

Results of organoleptic evaluation of the muffins prepared with 25%, 50% and 75% variations are presented in the above table. ANOVA Duncan multiple range tests results prove that there was a significant difference in the evaluated sensory parameters of the control and all the variations of corn silk powder muffins.

TABLE-3. CONFIDENCE INTERVAL CALCULATIONS BY ATTRIBUTE

VARIATIONS	APPEARANCE	TEXTURE	COLOUR	TASTE	FLAVOUR
Control	[5.75,8.65]	[6.40,8.80]	[5.61,8.49]	[5.46,8.54]	[4.90,8.50]
CSPM I	[5.17,8.43]	[6.71,7.19]	[5.34,8.46]	[5.54,8.66]	[5.79,8.51]
CSPM II	[6.86,9.34]	[6.50,8.50]	[6.74,9.86]	[6.49,9.61]	[6.54,9.26]
CSPM III	[4.80,7.90]	[5.65,6.45]	[4.87,7.63]	[5.02,7.78]	[6.49,9.61]

For each attribute (appearance, texture, color, taste, and flavour) across the four muffin groups, the mean ± (1.96 × SE) to find a 95% CI.The 95 % confidence interval (CI) for each quality score provides a range that likely contains the true average rating for that quality in each muffin group.

Table 3 lists the confidence intervals for appearance, texture, color, taste, and flavour ratings across four groups: Control, CSPM I, CSPM II, and CSPM III. CSPM II has the highest confidence intervals for all attributes, indicating it's rated the most positively. Control and CSPM I show moderate intervals, meaning they are rated favourably but less consistently than CSPM II. CSPM III has the lowest intervals, especially for appearance and texture, suggesting it's rated the least favourably. We conclude that, CSPM II is perceived most positively, while CSPM III has the lowest overall ratings.

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NUTRITIONAL ANALYSIS OF CORN SILK POWDER MUFFINS: From the three formulations of corn silk muffins, CSPMII was subjected to nutritional and phytochemical analysis as it had the highest rating in terms of organoleptic evaluation.

TABLE-4. COMPARISON OF NUTRIENT COMPOSITION BETWEEN CONTROL AND ACCEPTED VARIATION OF CORN SILK POWDER INCORPORATED MUFFINS

S. NO	PARAMETERS	CONTROL	CSPM II	DIFFERENCE
1	**Energy (Kcal)**	220	203.65	-16.35
2	**Carbohydrate(g)**	33	41.9	+8.9
3	**Protein (g)**	3	7.6	+4.6
4	**Fat (g)**	3	0.85	-2.15
5	**Dietary Fiber(g)**	1	6.4	+5.4
6	**Ash (g)**	0.35	1.6	+1.25
7	**Calcium (mg)**	163	200	+37
8	**Potassium (mg)**	92	317	+225
9	**Copper (mg)**	0.1	1.2	+1.1
10	**Iron (mg)**	0.72	0.88	+0.16

Table 4 signifies that the energy obtained from the accepted variation of muffins was found to be 203.65kcal/100g of muffins. The energy gained through the control muffin was 220kcal, which is higher than the accepted variation of muffin (CSPM II). The carbohydrate present in the CSPM II was 41.9g. The carbohydrate content in the control muffin was found to be 33g, which is lower than the corn silk muffins. The protein obtained from the accepted variation of muffins was found to be 7.6g. The protein content in the control muffin was found to be 3g, which is lower than the corn silk muffins, while in the corn silk incorporated crackers the protein content was 7.19g (Priyadharshini & Parameshwari., 2020). The fat content in the accepted variation of corn silk powder muffin was found to be 0.85g and the control muffin was found to be 3g, which is higher than the accepted variation of muffin. Hemanth Kumar and Khaleel, (2023) examined the fat content in the pomegranate pomace incorporated muffins and found that 21.09g of fat was present in the muffins.An average of 15.29% protein and 0.55% of fat was recorded in corn silk powder (Singh *et al.,* 2022).

The dietary fiber present in the CSPM II was found to be 6.4g. The dietary fiber in the control muffin was 1g, which is lower than the corn silk muffins. The calcium and potassium present in CSPM II was found to be 200mg and 317mg respectively. The copper obtained from the accepted variation of muffin was 1.2mg/100g. The copper present in the control muffin was found to be 0.1g, which is lower than the corn silk muffin. he iron present in the accepted variation of muffin was 0.88mg/100g. The iron present in the control muffin was found to be 0.72mg which is lower than the corn silk muffin.

PHYTOCHEMICALS IN CORN SILK POWDER MUFFINS

TABLE -5 PHYTOCHEMICALS IN CORNSILK MUFFINS

S. NO	PHYTOCHEMICALS	PRESENT/ABSENT
1	Polyphenols	++
2	Flavonoids	++
3	Tannins	++
4	Saponins	++

The qualitative test of corn silk powder muffins shows the presence of polyphenols, flavonoids, tannins and saponins in table 5. Corn silk is a good source of antioxidants like polyphenols, flavonoids, and ascorbates, which are anti-inflammatory, anti-diabetic, and antiviral in nature. It is understood from the present study and previous literatures that corn silk has a countless potential in the foodand nutraceutical industry, pharma industry and cosmetic industry, for prevention of hypertension, diabetes, and nephritis (Singh *et al.,* 2022).

CONCLUSION

The present study concludes that the corn silk powder is a rich source of essential nutrients and fibre. The functional properties of corn silk powder prove that along with wheat flour or refined wheat flour it can be very well utilized for formulation of appetizing, and nourishing bakery food products. Corn silk powder can also be utilized in Indian staple food formulations like chapati, dosa and dhal. The nutritional analysis of corn silk muffins showed that in comparison with the control muffins the carbohydrates were increased by 12%, protein was 44% higher, fibre was 72% increased, while ash was 64% increased and calcium, potassium, copper, iron was 10%, 56%, 84% and 84% increased respectively. Thus, it may be recommended to convert corn silk from waste into value-added foods as corn silk powder has proved to be source of nutrients, that could alleviate dietary nutritional deficiencies at a very low cost. Also, the

presence of soluble and insoluble fibre in adequate amounts will help to alleviate non-communicable diseases. As a result, the cost-effective commercial supply of the corn silk powder incorporated foods is feasible.

CONFLICT OF INTEREST

The authors have nil conflicts of interest**.**

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