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Development of Value-Added Nutritious Crackers Incorporated with Corn Silk Powder

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ABSTRACT

Recently, consumer demand for healthy snacks has increased. Crackers are popular healthy snacks with high potential to enhance the nutritional value by incorporating naturally available ingredients. Corn silks are a bundle of silky, long and yellowish strands which could be seen on top of both baby corn and corn fruit. Corn silk is a byproduct of corn with high nutritional value and antioxidant property, hence dried corn silk powder incorporated food products can be considered good for health and suitable for all age groups. Corn silk is used as a medicinal herb by practitioners of traditional medicine all over the world and is documented as a well-accepted traditional medicine in treating non-communicable diseases like Diabetes mellitus, cardiovascular diseases, kidney diseases and cancer. Incorporation of corn silk powder in food products results in increasing protein, fibre, minerals, cooking yield, moisture and fat retention while decreasing fat content. This study is aimed with the objective of formulating crackers by incorporating dried corn silk powder in different variations. The developed crackers were subjected to analysis of physical characteristics, sensory evaluation and the accepted variation was subjected to analyze nutritional compositions by using standard procedures. It was observed that the corn silk powder incorporated cracker was significantly rich in protein, fibre, vitamin C, calcium and magnesium compared to control crackers. Besides these properties, corn silk powder contains flavonoids. The antioxidant activity of flavones is associated with the prevention of cancer and cardiovascular diseases which is also promising. It was evident that the prepared crackers were more economical and affordable when compared with commercial soup mixes available in the market..

KEY WORDS: ANTIOXIDANT PROPERTY, DRIED CORN SILK POWDER, NUTRITIONAL VALUE, VALUE- ADDED FOOD PRODUCTS.

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INTRODUCTION

Globally, Corn, is the most widely grown and third most important cereal crop next to wheat and rice. Corn Silk, the silky hair-like structures protruding from the tip of the ear of corn, is essentially the elongated stigma of the female flower of Corn. Although often discarded as agricultural waste or byproduct of Corn cultivation, Corn Silk has also been used as traditional remedies in different parts of the world for the treatment of kidney stones, diuretic, bloating, liver problems, chronic cystitis, urethritis, and prostatitis, (and other prostate disorders). urinary infections and obesity (Liu et al. 2011). Corn Silk contains 9–22% protein content on a dry mass basis, depending on its stage of maturity and corn variety (Haslina et al. 2017). Corn silk has phenolic compounds, particularly flavonoids. It also consists of proteins, vitamins, carbohydrates, calcium, potassium, magnesium and sodium salts, volatiles oils and steroids such as sitosterol, stigmasterol, alkaloids, and saponins. Corn silk is also said to be an excellent source of vitamin K, which has been known to slow bleeding. Corn silk also helps in reducing blood pressure (Vijitha et al. 2017).

Food-derived bioactive peptides received growing attention from the international research community over the last two decades. These multifunctional peptides are used for the prevention of cardiovascular disease. Antioxidant peptides, both in the form of protein hydrolysates as a mixture and in the form of pure individual peptides, are recognized as potent, natural alternatives to synthetic antioxidants for application as food additives. Such peptides are also potential for the future development of functional food ingredients and therapeutic agents (Lammi et al. 2019). Crackers are snack products enjoyed by people of all age groups. Corn silk incorporated cracker is rich in calories, protein, fibre and minerals. The value added by incorporating corn silk powder will enhance the nutritional quality apart from quenching the craving for a snack. Hence, in this, it was proposed to exploit corn silk powder as a means of value addition in the favourite novel product, crackers (Wang et al. 2019).

MATERIAL AND METHODS

The fresh corn silk (Zea mays) was collected in the local market Salem and stored at room temperature. Processing of corn silk into powder can cause changes in the chemical characteristics of corn silk powder. The level of this change depends on the drying method used to optimize the drying process and maintain the quality of the dried product. The drying method most commonly used in the food industry is the conventional oven-drying method using hot air which works by evaporating water from the material. The corn silk was dried in hot air oven dryer for two and half hours at 60˚C to make it easy for made it into powder (Roshli et al. 2011). The corn silk powder stored in the refrigerator in an airtight container at 4˚C (Haslina et al. 2017).

Take processed dried corn silk powder (in different variations) to the required amount. Add whole wheat flour and also add milk powder, olive oil, baking powder, sugar powder, salt according to the quantity needed. Mix it well and make dough with a thick consistency and leave it for 5 minutes. Cut the dough into required pieces with a suitable shape. All the three different variations of developed crackers were baked in an oven at 170 ˚C for 15 minutes and stored in a sealed plastic pouch. After the preparation of crackers, the physiochemical characteristics, sensory evaluation and nutritional compositions of the developed crackers were analyzed.

RESULTS AND DISCUSSION

Development of crackers incorporating corn silk powder: To formulate crackers, blend corn silk powder in the required amount, whole wheat flour, milk powder, olive oil, baking powder, sugar powder, salt in required quantities to suit the different variations of crackers to be developed. The composition of ingredients used for developing crackers of different variations is shown in Table – 1

Table 1. Composition of ingredients for corn silk powder incorporated crackers

Ingredients	Control	Variation 1	Variation 2	Variation 3
Whole wheat flour	100g	90g	80g	70g
Corn silk powder	-	10g	20g	30g
Sugar powder	30g	20g	20g	20g
Milk powder	10g	10g		10g
Olive oil	15ml	15ml	15ml	15ml
Baking powder	1.5g	1.5g	1.5g	1.5g
Salt	1.5g	1.5g	1.5g	1.5g

Physical characteristics of the developed crackers: Height, weight, diameter and thickness of the control crackers and dried corn silk powder incorporated crackers were assessed (Baljeet et al. 2010). The Physical characteristics of the developed crackers are presented in Table -2.

Table 2. Physical characteristics of the developed crackers

Variations	Height (cm)	Weight (kg)	Diameter (cm)	Thickness (cm)
Control crackers	5.65	24.74	5.64	0.30
Variation 1	5.58	21.07	5.83	0.33
Variation 2	5.67	22.34	5.67	0.35
Variation 3	5.45	24.58	5.58	0.28

Compared to control crackers, crackers formulated with dried corn silk powder showed an increase in diameter and thickness. Corn silk powder added crackers had lower weight and there is a slight difference in height compared to control crackers.

Sensory evaluation of the developed corn silk powder incorporated crackers: The most widely used scale for measuring food acceptability through senses is the 9-point hedonic scale. This scale was used for evaluating the sensory properties of the crackers. Three variations of the crackers were developed by the incorporation of corn silk powder. Sensory evaluation was carried out by panel members, semi-trained consumers consisting of students and staff of the Department of Nutrition and Dietetics, Periyar University, Salem, Tamil Nadu, India. They evaluated crackers with respect to different sensory parameters, namely colour, texture, mouthfeel, taste, flavour, crispness and overall acceptability on a 9-point hedonic scale. Significance was established at $P \leq 0.05$ using statistics outlined below.

Table 3. Statistical analysis of sensory evaluation of the developed crackers

Samples	Colour	Texture	Flavour	Mouthfeel	Taste	Crispiness	OAC
Control	4.65 ± 1.23^{c}	5.77 ± 0.14^{a}	5.62 ± 0.28^{b}	5.12 ± 0.27^{ab}	3.40 ± 1.75^{a}	6.70 ± 1.81^{a}	5.21 ± 1.18^{ab}
Variation 1	7.10 ± 1.62^{ab}	7.40 ± 1.19^{a}	8.61 ± 1.32^{ab}	9.40 ± 1.20^{bc}	8.79 ± 1.26^{c}	7.26 ± 1.22^{ab}	8.40 ± 1.33^{a}
Variation 2	4.72 ± 1.11^{ab}	5.81 ± 1.1^{c}	6.40 ± 1.41^{ab}	3.98 ± 1.81^{ac}	5.61 ± 1.84^{ac}	4.81 ± 1.14^{a}	4.51 ± 1.72^{ab}
Variation 3	3.89 ± 0.84^{a}	4.20 ± 1.18^{a}	3.45 ± 1.82^{c}	2.51 ± 1.19^{bc}	4.15 ± 1.19^{a}	3.47 ± 0.31^{a}	4.23 ± 0.24^{ab}

Values are Mean ± SD of triplicate determination. Samples with different superscripts within the same column were significantly ($p \leq 0.05$) different.

The results of the above table revealed that the mean score obtained for the colour of V1 and V2 were found to be maximum score (7.10 ± 1.62^{ab} and 4.72 ± 1.11^{ab}) than control and V3. Mean score of texture was high (7.40 ± 1.19^{a}) in V1 compared to control and other variations. The results revealed that the mean score obtained for the flavour of V1 found to be superior (8.61 ± 1.32^{ab}) compared to control and other variations.

The decrease in the addition of corn silk powder had a satisfactory effect on flavour and mouthfeel of crackers. Variation I had the maximum mean scores of 9.40 ± 1.20^{bc} for mouthfeel, thus confirming that addition of corn silk powder at 10gm is more acceptable whereas V3 and V2 had scored lower than V1 due to the less addition of other ingredients which affected the mouthfeel of the end product.

Table 4. Nutritional composition of accepted variation of the crackers

S. No	Nutrients	Control crackers	Corn silk powder incorporated crackers (variation-1)	Deficient or excess
1.	Moisture (%)	2.07	5.67	+3.6
2.	Energy (Kcals)	384	398	+14
3.	Carbohydrate (g)	60.14	76.5	+16.36
4.	Protein (g)	1.1	7.90	+6.8
5.	Fat (g)	5.74	4.61	-1.13
6.	Fibre (g)	0.90	3.25	+2.35
7.	Vitamin C(mg)	-	2.6	+2.6
8.	Magnesium (mg)	0.24	1.5	+1.26
9.	Calcium (mg)	-	0.26	+0.26
10.	Flavonoids	-	++	-

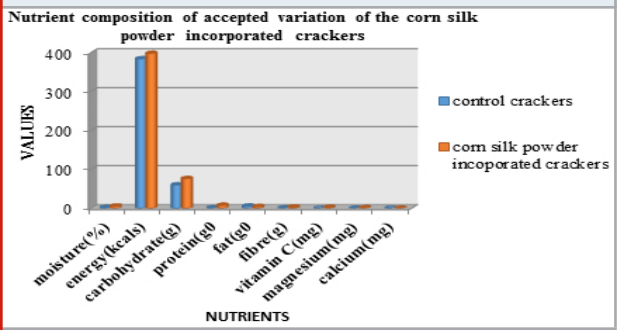
Mean taste scores of control crackers prepared with whole wheat flour, milk powder, olive oil, baking soda, sugar was low (3.40 ± 1.75a) compared with variation 1, 2 and 3 (8.79 ± 1.26c, 5.61 ± 1.84^{ac} and 4.15 ± 1.19^{a}) respectively. The crispiness of Variation 3 was low (3.47 ± 0.31^{a}) compared to variation 1 (7.26 ± 1.22^{ab}). As an overall result, the overall acceptability of the corn silk incorporated (10gm) cracker of variation 1 was high (8.40 ± 1.23^{a}) on a hedonic scale. Results on Duncan Multiple Range test showed that there was a significant difference ($p < 0.05$) between

control and the different variations of crackers on colour, texture, flavour, mouthfeel, taste, crispiness, and overall acceptability. Consumers are the judges of a product's fate and welfare in the market as their preference is of vital significance. Therefore, specific sensory properties of a product, along with its composition, may comprise a key for its uniqueness and support (Vieira et al. 2008).

Nutritional composition of accepted variation of the crackers: Based on the physical characteristics and sensory evaluation of the developed crackers, 10% of corn silk powder incorporated cracker (Variation 1) was highly accepted. Hence the nutrient analysis was done for variation 1. The nutrient analyses of control crackers and crackers formulated with 10% of dried corn silk powder are shown in table -4.

The Moisture content of the corn silk powder incorporated crackers ranged from 5.67%, which was higher than the control crackers because cornsilk contains higher moisture content. There was a slight change in the calorie content between the developed product and control. The developed product showed 7.90g of protein, whereas control crackers had 1.1g. The addition of corn silk powder to cracker formulation increased the protein content of the tested products. The carbohydrate content of the developed product showed 76.5g, which was higher than the control crackers. The magnesium content of the corn silk powder incorporated crackers had 1.5mg/100g. Calcium level present in the 10% incorporation of corn silk powder incorporated crackers was 0.26mg, whereas the control cracker does not have any calcium content which showed that corn silk powder incorporated crackers improved calcium level. Besides these nutritional properties, corn silk powder added crackers contain flavonoids. The antioxidant activity of flavones was associated with the prevention of cancer and coronary heart diseases.

Figure 1: Nutritional composition of accepted variation of the crackers



Cost calculation of the developed food products: The cost calculation for the production of 100gm of developed crackers revealed that the total production cost (100g) was Rs.55.00 by incorporating corn silk, whole wheat flour, milk powder, olive oil, sugar and baking powder. It was evident that the prepared crackers were more economical and affordable when compared with commercial crackers available in the markets.

CONCLUSION

In conclusion, corn silk could be considered as a good source of nutritional composition and antioxidant activity. Incorporation of corn silk powder resulted in increased protein, fibre, vitamin C, calcium and magnesium in the crackers. Crackers with 10% corn silk added were highly acceptable by the consumers. This novel corn silk for incorporation in crackers could permit a reduction of formulation cost without affecting sensory attributes of the developed product to which the consumer is familiarized. This byproduct is also being utilized as hypo glycemic agent, diuretic agent, antioxidant and other therapeutic functionalities. The benefits of corn silk in improving other pharma-nutritional functionalities, including prebiotics potential, can be recommended for future studies.

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Conflict of Interest: The authors declare no conflict of interest.

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