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Formulation and analysis of khakra fortified using corn silk as a source of protein

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Abstract
Khakra was fortified with corn silk along with wheat flour and a standard khakra was formulated using whole wheat flour. Corn silk was washed and dried in hot air oven at 80 ^{0} C for 6 hours and grounded to a powder form. It had two variation, V1-20g and V2 - 30g of Corn Silk Powder (CSP). Proximate analysis such as moisture, ash, carbohydrate and protein analysis of the variations were carried out. The moisture content, total carbohydrates and the protein of the variations and the standard showed a significant difference ($p<0.05$).The protein content of the khakra increased with increase in CSP. The ash content did not vary significantly among the variations and standard ($p>0.05$). Sensory analysis was conducted for the khakra by analyzing the parameters such as colour, flavor, texture, taste. The shelf life study was conducted for 7 days and the sensory evaluation was done on the alternative days. In sensory analysis, the corn silk khakra scored the highest when compared to standard khakra. The sensory analysis showed that the acceptability of the standard and the variations (V1 and V2) did not vary significantly ($p>0.05$).Therefore, corn silk incorporated khakra have protein content which can be utilized better from the waste.

Keywords: corn silk, protein, waste utilization

1. Introduction
Snack food is a portion of food which is smaller than regular meal and can be consumed between meals. It is convenient because it is quick and easy to eat. Snack food comes into variety such as processed food and traditional foods. Most of the snack foods are intended for immediate consumption and have a short shelf life of 1-2 days. The shelf life can be extended by using suitable packaging techniques (Anupama N. Devkatte)

Khakras are individually rolled out thin chapattis which are flattened and made crisp over a griddle or tawa. Originated from the state of Gujarat, it is a part of the Jain Gujarati cuisine. Khakras are made from mat bean, wheat flour and oil and they are usually served during breakfast. It is also a popular tea time snack. It is eaten along with different chutneys and pickles. There are several varieties of Khakra available like methi, bajri, masala, pavbhaji, panipuri etc. (Sugantha Rajamani *et al*., 2013) [9].

Maize or Corn is the most important cereal in the world after wheat and rice. It is the third most planted food crop and one of the major energy sources (Vijitha T P *et al*., 2017) [12]. Production of corn was reported to increase from 713 thousand metric tons in 2006/2007 to nearly 820 thousand metric tons in 2010/2011 (USDA-FAS, 2008). It possesses high nutritive value and is important as a coarse grain. Large quantities of maize are imported for fodder, as a staple food of man, a livestock feed, a raw material for many industrial products such as infant foods. Maize is an easily grown crop and the cultivation has been popular among farmers as a cost effective crop with limited fertilizers (Perera, K.T.G.K).

Corn silk (Zea mays L.) also known as Maydis stigma refers to the collection of stigmas of the maize female flowers. The corn silk threads are normally discarded during the processing of baby corn as a vegetable. Statistical information on baby corn production is limited because many producing countries either do not report baby corn production or include it within the sweet corn category (W.I. WAN ROSLI). Corn silk contain various chemicals, including proteins, vitamins, alkaloids, tannins and mineral salts, carbohydrates, steroids, and flavonoids as well as other volatile chemicals (Kwag *et al*. 1999). Ell as other volatile chemicals (Kwag *et al*. 1999). Corn silk is also said to be an excellent source of vitamin K which has been known to slow bleeding (Vijitha T P *et al*., 2017) [12]. The therapeutic activities of corn silk constituents are well reported in the literatures. These include antibiotic and (Maksimovic & Kovacevic 2003), diuretic activities and it has been known to be effective for weight loss and obesity.

Corn silk is considered as a waste byproduct of maize (corn). Corn silk has been found to be a good source of proteins, vitamins, carbohydrates, and also an excellent source of fixed and volatile oils, steroids like sitosterol, stigma sterol, alkaloids, saponins and other natural antioxidants like flavanoids. The male flowers known as tassels produce yellow pollen. The female flowers produce corn silk. The silks function as a stigma of a female flower and as the fruit develops, the silk elongates beyond the cob covering the edible part of the plant. Initially, the colour of corn silk is light green, which later turns to red, yellow or light brown Vijitha T P *et al*., 2017) [12]. Corn silk are bundle of silky, long and yellowish strands which could be seen on top of both baby corn and corn fruit (Nurhanan Abdul Rahman *et al*., 2013). In today's market, since people are more interested in natural products corn silk is expected to have a remarkable growth in various forms of foods and medicine. Corn silk is considered as a waste byproduct of maize (corn). (Nurhanan Abdul Rahman *et al*., 2013).

The objective of the present study was to effectively utilize the waste by-product Corn silk, by its incorporation in khakra, predominantly discarded together with other parts of the plant due to lack of effective utilization and to evaluate the protein content in corn silk incorporated khakra, a value added product.

2. Materials and Method

2.1 Sample preparation

The fresh corn silks collected were oven dried at 80°C until brownish threads were obtained. The brownish dried corn silks were ground into powder form and kept in screw cap bottle at 4°C before further analyses.

2.2 Preparation of Khakra

Table 1: Formulation of Khakra

Sl.no	Wheat flour (g)	Corn silk(g)	Salt(g)	Chilli powder(g)	Ghee (g)
Standard	100	0	8	5	5
V1	80	20	8	5	5
V2	70	30	8	5	5

A standard khakra using wheat flour and a corn silk fortified khakra were formulated.

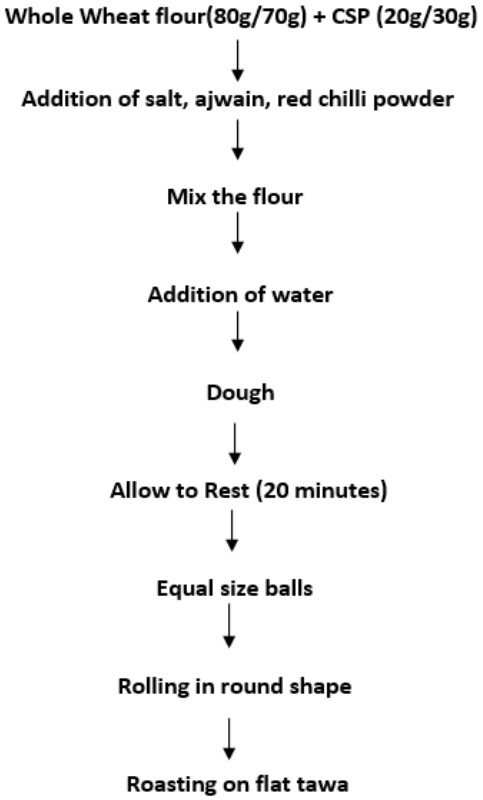

Fig 1: Standard Khakra Variation 1 (20g) Variation 2 (30 g)

3. Experimental procedure

3.1 Nutrient analysis

The nutrient analysis was carried out for the standards and variations using standardized protocols (AOAC, 2000) [2]. The parameters analyzed include moisture by hot-air oven method, the ash content was analyzed by charring and placed it in the muffle furnace, the protein content was analyzed by kjeldahl method and total carbohydrate was analyzed by phenol sulphuric method.

3.2 Shelf life analysis

The shelf life analysis was carried out by storing the product in the air tight containers at room temperature. Sensory evaluation was carried out at definite time intervals, on the day of preparation (0 day), third day, fifth day and seventh day by a panel of 20 members using numerical scoring method from like extremely to dislike extremely. The sensory parameters include colour, flavour, texture, taste and overall acceptability

3.3 Sensory analysis

Samples were analyzed for its sensory characteristics like colour, flavour, taste and texture using 5-point hedonic scale (5- like extremely to 1- dislike extremely)

4. Results and Discussion

4.1 Proximate Analysis

Table 2: Results of the Proximate Analysis

Proximate Analysis	Standard	V1	V2
Moisture	4.85 ± 0.09	6.81 ± 0.12	7.72 ± 0.22
Ash	4.49 ± 0.18	4.46 ± 0.05	4.43 ± 0.15
Protein	11.6 ± 0.20	12.5 ± 0.20	16.3 ± 0.30
Carbohydrates	68.3 ± 0.35	67.4 ± 0.14	66.2 ± 0.25

The khakra were prepared in two variations (V1=20g and V2=30g) and they were analyzed for its proximate, sensory and shelf life study. The moisture content showed a significant difference among the variations and standard ($p<0.05$). As reported by Nurhanan Abdul Rahman (2013) and Ocheme Boniface (2017) [6] the moisture content of the corn silk was higher when compared to wheat flour and the present khakra showed a significant difference ($p<0.05$) as well. There was no significant difference between the ash compositions of standard and variations of the khakra ($p>0.05$). The result thus reflects to be in line with those reported by Nurhanan Abdul Rahman (2013) on the ash value differences between corn silk and wheat flour.

The total carbohydrates content of the variations decreased with an increased addition of CSP. Nurhanan Abdul Rahman (2013) had investigated that the CSP had low total carbohydrate content and a significant difference among the variations ($P<0.05$). However, wheat flour contains high carbohydrate content when compared to CSP and hence corn silk incorporated khakra had gradual decrease in the carbohydrate content and showed a significant difference ($p<0.05$).

Significant increase in protein content of wheat flour was recorded with increasing CSP ($p < 0.05$). Highest protein content of 16.3% was recorded in blend with 30% CSP. The protein content of the variations gradually increased with the addition of CSP which shows that the CSP has higher protein content when compared to whole wheat flour (Haslina *et al*., 2017, P. Kumar *et al*., 2011) [3, 8]. Vegetable

proteins in forms of flour, concentrates, and isolates have been incorporated in many food systems for better nutritional values and functionality than products produced solely from wheat flour as reported by Idowu, A. O. (2014) [4]. The increase in protein on the one hand, and the decrease in carbohydrate on the other hand, was a direct consequence of increasing and decreasing CSP and wheat flour, respectively (Ocheme Boniface (2017) [6].

4.2 Sensory analysis

From the sensory analysis, Khakra prepared from 30% CSP (V2) was found to be acceptable followed by Khakra prepared from 20% CSP (V1). The results have been represented below.

Table 3: Shelf life study of the Khakras for 7 days

Sensory parameter	Storage period (7 days)											
	Day 1			Day 3			Day 5			Day 7		
	STD	V1	V2	STD	V1	V2	STD	V1	V2	STD	V1	V2
Colour	4	3.5	3.7	4	3.4	3.7	3.8	3.1	3.6	3.7	3	3.5
Flavour	3.9	3.2	3.9	3.9	3.1	3.9	3.8	3.1	3.8	3.8	3.2	3.8
Texture	3.8	3.3	3.8	3.8	3.2	3.7	3.6	3.3	3.6	3.5	3.2	3.5
Taste	4	3.3	3.6	4	3.3	3.6	3.6	3.3	3.5	3.6	3.3	3.5
Overall acceptability	4	3.5	4	3.8	3.5	4	3.6	3.4	3.8	3.6	3.4	3.7

The overall mean score of khakra ranged from 3.7 to 4.0 on 5 point hedonic scale. This indicated that the recipes were found to fall under the category of 'like extremely to like moderately'. Amongst the test recipes, sensory scores of khakra prepared with 30% level of CSP has been ranked highest for all sensory attributes, i.e., 3.6 (color), 3.8 (flavour), 3.6 (texture), 3.5 (taste) and 3.8 (overall acceptability), than the khakra prepared with 20% level of CSP. Statistical data revealed that there was no significant difference in taste, color, flavour, texture, taste and overall acceptability of khakra ($p>0.05$).

There was a gradual decrease in the colour and texture of all the three variations during the storage period. This was due to the moisture absorption in the variations. The flavour and taste showed no differences during the storage period.

There were no drastic changes in the sensory parameters during the storage period of seven days. Thus, the product can be stored for a period of seven days in an air tight container. The shelf life of the khakras can further be increased by storing in a vacuum package.

Thus, it study concludes the overall acceptability of the corn silk incorporated khakrawas equivalent to the standard.

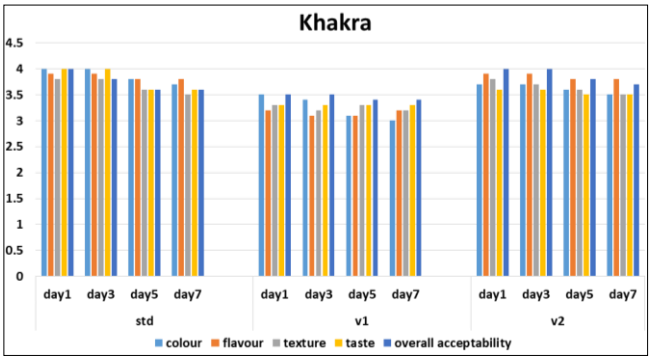

Fig 2: Changes in the Sensory Parameters during Storage Period

4. Conclusion

This study has demonstrated that addition of increasing levels of Corn Silk Powder (CSP) in the khakra increased the protein percentage and was accepted by the panelists. This also helps in developing products from the food processing waste. Khakra with 30% CSP contains the highest amount of protein. The findings of the present study may help in developing commercial processing technology for effective utilization of CSP especially for preparation of khakra. Therefore, results suggest that there is a great scope for use and marketing of value added khakra using Corn Silk and it can be concluded that Corn Silk incorporated khakra have a good protein content which paves way for the utilization of corn silk as a source of protein in day to day commodities.

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