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Studies on the Processing of Corn Waste as a Value Added Product

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Corn silk is the white and brown tipped tassels that surround an ear of corn which goes as a waste during processing. It is an excellent source of many bioactive compounds and natural antioxidants. The corn silks have been used in the traditional herbal medicine in South East Asian counties like China, Korea etc. There are ample opportunities to convert such a waste into value-added product to be used as a health supplement in the Indian market. The dried corn silk could be pulverized and effectively used to prepare herbal beverage. This study aimed to convert the raw corn silk extracted from fresh corn into a value added product by drying the whole as well as chopped corn silk at different temperatures viz., 40, 50 and 60°C in a cabinet dryer. The effect of drying on changes in the structure ascribed by shrinkage percentage and rehydration ratio was observed after drying. The dried corn silk was pulverised in a laboratory mill to a smooth fineness. Herbal drink was prepared from corn silk powder obtained at different temperatures of drying and the quality was assessed by subjective evaluation. The drying characteristics of corn silk revealed that at 60°C temperature, drying was faster for both whole and chopped corn silk. It took 120 min to dry whole corn silk from an initial moisture content of 100% (d.b) to final moisture of 13.7 % (d.b). Shrinkage percentage (12.5%) was highest for the sample dried at 60˚C in the case of whole corn silk, indicating more moisture depletion compared to 40 and 50°C temperature drying. The highest value of rehydration ratio (5.16) was observed for the whole corn silk dried at 60˚C. The sensory scores on taste, flavour, appearance and overall acceptability revealed that herbal drink prepared from whole corn silk dried at 60˚C temperature was highly preferred.

Key words: Corn silk, Drying, Structural changes, Herbal drink, Sensory scores

Globally, maize or corn is known as queen of cereals because it has the highest genetic yield potential among the cereals. It is cultivated in about 160 countries across the world and contributes to about 36% in the global grain production. The United States of America is the largest producer of maize contributing nearly 35% of the total production in the world. In India, maize is the third most important food crops after rice and wheat and contributes about 9% in the national food basket. In addition to staple food for human being and quality feed for animals, maize serves as the basic raw material for several industrial products. Corn silk is the white and brown tipped tassel of female flowers of corn, which is a trash thrown out in most kitchens. Fresh corn silk appears light green or yellowish brown, 10-20 cm long with very soft texture. Browning or withering of corn silk, indicates harvesting maturity. Dried corn silk has been reported to contain 9.65% moisture, 17.6% protein, 0.29% fat, 3.91% ash and 40% dietary fibre (Wang *et al.,* 2011). Corn silk is an excellent source of many bioactive compounds such as volatile oils, steroids, alkaloids and natural antioxidants including flavonoids and phenolic compounds (Liu *et al*., 2011) known for their use in traditional herbal medicine in South East Asian counties. Based on folk remedies, corn silk is used as an oral antidiabetic agent in China. Such products are known to ameliorate hypertension, tumor, hyperglycemia, hepatitis, cystitis, gout, kidney stones, diabetics, nephritis and prostatitis (Hu and Deng, 2011). Despite its medicinal uses, corn silk is still being discarded as a waste in India due to lack of awareness on its effective utilization. In this study, the best drying condition for corn silk has been optimized and a health drink was prepared from the dried corn silk and the quality attributes of the herbal beverage was assessed.

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Material and Methods

Raw material

Local variety of corn was procured from a farmers' market at Coimbatore. The outer sheath of the ear head was peeled off manually. The adhering corn silk was removed using a simple hand tool fitted with nylon brush for combing out the silk from the ear head. The moisture content of the sample was estimated by gravimetric method (Ranganna, 1995).

Moisture content was estimated by following the formula:

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Preparation of corn silk powder

The drying behaviour of corn silk was studied at different temperatures in a cabinet dryer, of size 36"×24"×21". The dryer consists of an insulated cabinet, equipped with a fan, an air heater and a space occupied by trays for drying. Temperature could be controlled by a thermostat. The drying chamber is of double walled with insulation to prevent heat loss. An air circulating fan helps in uniform distribution of the heat. The dryer is provided with aluminium trays to keep the samples for drying. Two variables *viz*., size (120 and 40 mm) and temperature (40, 50 and 60°C) were selected for standardizing the drying process. Samples were initially weighed and then placed in the aluminium trays. The aluminium trays were kept in the drier for drying process. The weight of the samples was noted at an interval of 30 minutes. The weight was taken until the concordant value was obtained. The dried corn silk samples were ground in a laboratory model mill. The samples were ground to fineness such that more than 90 per cent passed through 400 micron sieve.

Quality parameters of dried samples

S*hrinkage*

The initial length of corn silk was measured using a 0.01 mm accuracy vernier caliper. These measurements were taken both before and after the drying of the samples. Based on the dimensions, the initial and final length was calculated to find the shrinkage per cent as below:

$$Shrinkage = \frac{l_1 - l_2}{l_1} \times 100$$

Where, l_1= Volume (before drying)

= Volume (after drying)

Dehydration ratio

The dehydration ratio of dried corn silk sample was calculated by the following formula:

$$\text{Dehydration ratio} = \frac{\text{Weight of prepared material before drying}}{\text{Weight of dried sample}}$$

Rehydration ratio

Rehydration means refreshing the dehydrated or dried products in water. One part of dehydrated corn silk was taken in a beaker with 10 parts of one percent sodium chloride solution. It was boiled for 20 minutes and then cooled. The cooled material was then weighed (Ref: I.S.I Handbook of Food Analysis, 1984)

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated material}}{\text{Weight of dehydrated material}}$$

$$\text{Coefficient of reconstitution} = \frac{\text{Rehydration ratio}}{\text{Dehydration ratio}}$$

Corn silk herbal drink

Herbal drink was prepared from powdered corn silk by standardizing the ingredients based on preliminary experiments. Two table spoon corn silk powder and a pinch of ginger powder was added to 2 cups of boiling water. To this one table spoon of palm candy was added. The mixture was boiled and simmered for five minutes.

Sensory evaluation

The corn silk herbal drink was assessed for it's quality based on the sensory scores, assessed by ten members of semi trained judges. Sensory qualities like taste, flavour and appearance were studied based on 5 point hedonic scale ranging from excellent to poor. The number of scores to each treatment was added and compared to choose the best drying parameter. Data was subjected to statistical analysis using AGRES software.

Results and Discussion

Drying characteristics of corn silk

Corn silk was dried as whole filaments (120 mm length) and also chopped (40 mm length) and dried in a cabinet dryer at different temperatures. The effect of temperature on the drying characteristics of corn silk at 40°C is presented in figure 1. It took 450 minutes of drying whole corn silk from an initial moisture content of 100% (d.b) to a final moisture content of 14.2% (d.b). The drying time was longer due to low temperature and also based on the size of corn silk. In the case of chopped corn silk, it took 360 min. drying time from an initial moisture content of 100% (d.b) to a final moisture content of 14.46% (d.b).The drying time was shorter compared to whole corn silk. It shows that the drying time decreases substantially with the increase in temperature of the drying air. This can be explained by the increased heat transfer potential between the air and the whole corn silk enhancing the mass transfer within the sample and the evaporation of the water from its surface. Similar result was observed in mushroom drying (Dimitrios Argyropoulos *et al.*, 2008). At 50°C drying (Fig. 1), it was found that the initial moisture content was 100% dry basis and it took around 210 minutes to reach till 14.6% for whole corn silk whereas the chopped corn silk took only 180 min. to reach to moisture content of 14.59% (d.b) from an initial value of 100% (d.b). Similar drying characteristics were reported by (Abano et al., 2011; Shalini, 2008) for drying tomato slices and apple pomace. Drying of whole corn silk was faster at 60°C. It took 120 min to dry whole corn silk from an initial moisture content of 100% (d.b) to final moisture of 13.7 % (d.b) (Fig.1). In the case of chopped corn silk, it took 90 min to dry from an initial moisture content of 100% (d.b) to final moisture of 17% (d.b). Due to reduction in size drying was faster compared to the whole corn silk. Earlier studies on drying Moringa leaves revealed that drying was faster at 60°C temperature compared to other drying condition (Dawn *et al*., 2016). Change in drying

rate is a result of the reduction of moisture content of samples during the drying process, which was observed for lettuce leaves (Duangrat and Prasong, 2010).

Effect of drying on the physico-sensory characteristics of corn silk

The effect of drying condition on shrinkage is presented in the Table 1. Size and temperature had an impact on shrinkage percentage of dried corn silk. In the case of whole corn silk, the shrinkage was found to be more compared to chopped corn silk during drying at different temperature. The shrinkage percent was highest at 60°C (22.22%) for the whole corn silk. This may be due to the reason that at higher temperature, moisture depletion is faster resulting in more shrinkage of the material. Similar results were observed in the case of banana centre core dried in a cabinet dryer (Dawn *et al.,* 2015). In the case of chopped corn silk, there were slight changes in the structure during drying. The highest shrinkage was observed at 60°C (12.5%).

Table 1. Physico-sensory characteristics of corn silk at different drying conditions

Drying parameters	Shrinkage %	Rehydration ratio	Dehydration ratio	Coefficient of reconstitution	Sensory scores			
					Taste	Flavour	Appearance	Overall Acceptability
Whole corn silk at 40°C	11.48	1.88	2.222	0.846	2.5	2.7	3.5	2.9
Chopped corn silk at 40°C	7.5	1.56	2.829	0.551	1.5	2.5	2.0	2.1
Whole corn silk at 50°C	20.45	2.26	4.684	0.482	2.9	3.0	3.3	3.2
Chopped corn silk at 50°C	10	3.02	5.37	0.555	2.3	2.3	3.1	2.7
Whole corn silk at 60°C	22.22	5.16	4.267	1.209	3.5	3.0	3.2	3.3
Chopped corn silk at 60°C	12.5	3.02	4.694	0.643	2.9	2.9	3.1	2.8

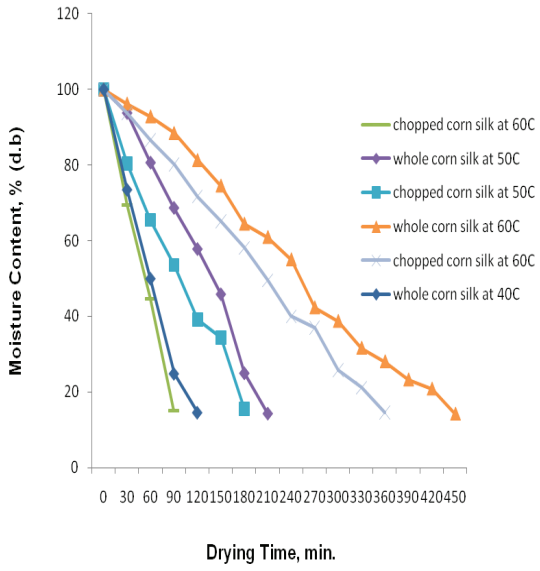

Fig.1. Effect of drying on corn milk at different sizes and temperatures

The rehydration characteristics of dried corn silk at different temperature were studied and the results are presented in Table 1.The rehydration ratio of corn silk varied according to size and temperature. The highest value was observed for the whole corn silk dried at 60°C (5.16). The rehydration ratio was found to be the least for the chopped corn silk at 40°C (1.56). The dehydration ratio was found to be highest (5.37) at 50°C for chopped corn silk. The lower temperature resulted in lesser value of dehydration ratio as seen from the above table. The highest coefficient of reconstitution was found to be 1.209 at 60°C dried whole corn silk.

The sensory scores of corn silk health drink analyzed by a panel of ten members are presented in table 1. Based on the scores for taste value, the highest mean value was recorded for the herbal drink prepared from whole corn silk dried at 60°C. Corn silk drink prepared from powder obtained from chopped corn silk at 40°C was preferred least among all the samples. Flavour score was on par for the samples at 50 and 60°C dried whole corn silk. There was no significant difference in the appearance of all the samples. Similar observation was observed for Kiwi slices at different temperatures of drying (Mahjoorian *et al*., 2017). Herbal drink prepared from whole corn silk dried at 60°C showed highest mean in the acceptance value (3.3) which was significantly different ($p<0.05$) compared to the sample prepared at 40°C drying temperature.

Conclusion

The above study attempted to effectively utilize corn silk, a waste discarded during the processing of corn by value addition. Corn silk also possesses medicinal properties. Drying of corn silk was carried out in a cabinet dryer at different temperature and size. The effect of drying on the structural quality and rehydration was analysed. The sensory scores on the herbal drink prepared from the dried samples revealed that the whole corn silk dried at 60°C was preferred compared to other samples.

References

Abano E.E., H. Ma and W. Qu. 2011. Influence of Air Temperature on the Drying Kinetics and quality of

tomato Slices. *Journal of Food Processing Technology,* **2**: 123

Dawn C.P Ambrose, R. Lakshman and R. Naik. 2015. Studies on the drying kinetics and quality assessment of banana pseudostem waste for effective utilization as avalue-added product.*International Journal of Farm Science,* **6(2)**: 276-285

Dawn C.P Ambrose, A.L. Daunty and R.Naik. 2016. Modelling and quality assessment of *Moringa oleifera* leaves under different drying conditions. *Applied Biological Research,* **18(1):** 8-15

Dimitrios, A., A.Heindl and J. Muller. 2008. Evaluation of processing parameters for hot-air drying to obtain high quality dried mushrooms in the Mediterranean region, presented in Tropentag 2008 University of Hohenheim, October 7-9, 2008, Conference on International Research on Food Security, Natural Resource Management and Rural Development.I.S.I Handbook of Food Analysis (Part VIII)- 1984, page 13.

Duangrat, P. and S. Prasong. 2010. Effect of pre-treatments on drying characteristics and colour of dried lettuce leaves. *Asian journal of food and agro industry,* **3(6):** 580 -586.

Hu, Q.L. and Z. Deng, 2011. Protective effects of flavonoids from corn silk on oxidative stress induced by exhaustive exercise in mice, *African Journal of Biotechnology*, **10**: 3163–3167.

Liu, J., C. Wang, Z. Wang, C. Zhang, S. Lu, and J. Liu. 2011. The antioxidant and free-radical scavenging activities of extract and fractions from corn silk (*Zea mays* L.) and related flavone glycosides, *Food Chemistry,* **126:** 261–269.

Mahjoorian, A., M. Mokhtarian, N. Fayyaz, F. Rahmati, S. Sayyadi and P. Ariaii, 2017.Modeling of drying kiwi slices and its sensory evaluation. *Food Science and Nutrition*, ***5*(3):** 466–473.

Ranganna, S. 1986. Manual of Analysis of Fruit and Vegetable Products. Tata McGraw-Hill Publishing Company Limited, New Delhi, India.

Shalini, R., R.A. Ranjan and N. Kumar. 2008. Studies on the drying characteristics of apple pomace on tray drier, 16th International Drying Symposium 2008, 9-12th Nov, 2008 Hyderabad, India pg: 1636- 1640.

Wang, C., T. Zhang, J. Liu, S. Lu, C. Zhang, E. Wang, Z. Wang, Y. Zhang and J. Liu. 2011. Subchronic toxicity study of corn silk with rats.*Journal of Ethnopharmacology,* **137**: 36-43.

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