# ***Original Research Article***

Effects of addition of dried sweet potato peels powder on the quality characteristics of cupcakes.


**ABSTRACT**

The study was conducted to develop baked cakes using different pretreated sweet potato peels powders (such as fresh, boiled and citric acid) with various concentration (5%, 10% & 20%) and to evaluate the changes of quality characteristics. Sweet potato peel powder was investigated for the different nutritional and physiochemical properties were boiling and pretreatment effects also evaluated. Fresh peel, 0.5% citric acid treated and boiled sweet potato peel powder was utilized as sample powder for the studies. There were significant differences ($p < 0.05$) in fiber and ash content and Hunter color values between powders from fresh peeled, 0.5% citric acid treated and boiled sweet potato peels powders. However, fresh and boiled sweet potato peel powder had higher fiber content than treated. The highest amount of fibre content was found in cakes incorporated with 10% boiled treated sweet potato peels powders content highest fiber. Pretreated and boiled with citric acid samples were obtained overall acceptability in the hedonic rating test.



**Keywords:** Sweet Potato, Peels, Baked Cake.


**INTRODUCTION**

Sweet potato (*Ipomoea batatas*) is one of the major root crops which owing to present of an ample amount of numerous health-beneficial compounds. It has high nutritional value and a vital source of carbohydrates, protein, vitamins,

**Comment [Da1]:**

**Comment [Da2]:** Is it fibre OR fiber??

**Formatted:** Font: Italic

and minerals (Silva *et al*., 2017). It is ranked the seventh most important food crop around the world which fulfilled the highest amount of edible energy (Loebenstein, 2015). Due to limited production cost, it was widely cultivated in most developing countries (M.Van Hall, 2000). In Bangladesh 60000 acreage of land is under sweet potato cultivation within an annual production of 236000 metric tons in 2018-2019 where 59000 acreage of land is under sweet potato cultivation within an annual production of 247000 metric tons in 2017-2018 (BBS, 2018-2019). Due to higher production rate and lower price sweet potato flour can be made and used as wheat flour substitute all the year round (Silva *et al*., 2017). Generally, more than fifty percent of the sweet potato produced is consumed boiled and fried and the rest is used for the processing of different processed products. The processed products are bread, crisps, puff-puff, buns, cake, chips, jam, starch, chin-chin, (Okorie, 2012), cookies (Everton *et al*., 2017) and pasta, formulated infant foods, puree, fermented lacto juice, and lacto pickles, fries (Vithu, 2019). Nowadays people are searching about new, low cost and healthful food to adjust their changed lifestyles. Therefore, the new taste of lifestyles also reflects on their food production as well as food consumption. Lifestyle has changed along the way, from food production to food consumption.

**Comment [Da3]:** Use the correct citation style: Van Hall, 2000. Delete M.

Day by day baked goods are attracted considerable attention due to their excellent taste, ease of preparation, and nutritional value. Cake is a worldwide known baked item prepared from the mixture of different flours, butter, sugar, oil, egg, ~~etc~~. Nowadays it is transformed in different shaded of tastes as the ingredients are slightly modified. For example, whole grain, fiber

fortified, less salt, gluten--free baked items. As a result, valuable fruits and vegetables by products are incorporated into baked items to reduce carbohydrate intake as well as increase fiber content. In developing countries, wheat flours are partially combined with flours made from other locally grown crops as composite flours as a substitute for wheat flour or to encourage the use/application of locally grown crops. Composite flours actually improve the nutritional quality of the wheat flour. Previously it was shown that composite flours are attracting much attention for the preparation of baked goods (Noorfarahzilah,2014).

Every year the huge quantity of sweet potatoes is grown in Bangladesh. During peak season its production is very high in Bangladesh. In this connection, huge amount of sweet potato peels is discarded as wasted. Usually, sweet potato peels are not degraded into the soil. Therefore, these peels could be cause environmental pollution. Usually, sweet potato is used to make various baked products as already said but there are no products prepared from sweet potato peels. Although it was proven that sweet potato peel flour contains higher amount of nutrients as compared to their flesh flour (Maruf *et al*., 2011a). Therefore, Sweet potato peel flour may be used in the preparation of cake making.

After fruits and vegetables processing there are several waste materials are generating such as seeds, peels, leaves, roots, and stems which can be utilized as by-products. These by products have lots of nutritional value and inexpensive. Fruit peels powders have high bioactive compounds and

functional properties for food formulations (Sorifa *et al*., 2010). There are various fruits and vegetables by-products have been identified for being used in the production of baked cupcakes such as cakes from apple pomace (Masood *et al*., 2002); pea hulls (Kaack-Pedesen *et al*., 2005); pineapple waste ~~etc~~. It has already been established those sweet potatoes are rich in vitamin A and other bioactive compounds. Although it was proven that sweet potato peel had higher nutritional compositions as compared to its flesh (Maruf *et al*., 2010). There is no formulated food using sweet potato peel yet in Bangladesh. So, Sweet potato peel could be used as health booster due to source of different health beneficial compounds. In Bangladesh, people are very fond of sweet potato as boiled or fried and discarded a huge amount of peel as waste. However, sweet potato peel products are not available in local market in Bangladesh. Therefore, present research will open new era in food sector as well as reduce environment pollution or utilization of by-products in Bangladesh. Therefore, the aims of the present study to develop value-added cakes formulated by incorporating sweet potato peels at different ratios with wheat flour and to find out optimal condition of the cake and analyze various nutritional, physicochemical properties and sensory evaluation of backed cakes.



## MATERIAL AND METHODS

### Raw Materials, chemicals and other ingredients

Sweet potatoes (Ipomoea batatas) were collected from a local supplier at Dhaka in Bangladesh. Fruits of uniform size and shape, good color, free from insects, and without any mechanical damage were selected for the

experiment. The packaged wheat flour, oil, and sugar of “Pushti” brand, skimmed milk powder of “diploma” brand, and butter of “Akij Food and beverage” brand, eggs, baking powder, salt, powder milk, margarine and vanilla essence were collected from the local market. Citric acids and packaging materials were also collected from local company. All materials were kept at room temperature except butter and eggs which were stored in refrigerator. High density polyethylene bags were used for storage of peel powders and cakes samples.

**Preparation of Sweet potato peels powder**

In this research, we ~~the~~ utilized sweet potato peels in three groups where the first group, a sharp stainless-steel knife utilizes to peeled the fresh sweet potato and the peels collected in a fresh bowl. Then peels cut into small pieces and dried by an oven at 55±5°C until moisture content reach below 10%. Then the dried peels were blended by blender machine and sieved through 50 mesh size to obtain a fine powder. For the second group, after collecting the peels by knife, peels were dipped in citric acid aqueous solution (0.5% w/v) at ambient temperature for 2 min (May be references are needed for the procedures, and it can be modified or adopted??). After that drain out excess water and then dried and ground to make peel powder same as before. For the third group, peels were collected from boiled sweet potatoes and dipped in dipped in citric acid aqueous solution (0.5% w/v) at ambient temperature for 2 min, dried and ground to make treated boiled peel powders.

**Formulations of cake from sweet potato peels powders**

The basic formulations of developed cakes incorporated with sweet potato peels powders using different treatments and ratios are outlined in Table ~~0~~1. Sweet potato peels powders were incorporated into cakes in the following proportions: S1(control)-0%, S2-fresh 5%, S3-treated 5%, S4-treated boiled 5%, S5-treated boiled 10%, S6-treated 10%, S7-fresh 10%, S8-fresh 20%, S9- treated 20% and S10-treated boiled 20%. At first, grounded the sugars to make them fine powders. Then it was properly mixed with butter and dalda mixed. The eggs were beaten for 5 minutes with the hand bitter. Dried ingredients such as wheat flour, baking powder, salt, powdered milk and peels powder were mixed properly and then mixed to the butter to get soft mixer. At last vanilla essence was added. Then it was poured batter into cake mould box and baked in an oven at 170$^0$C for 17 min. Then it was cooled to room temperature and was packaged with high density polyethylene bags and stored in room temperature for further analysis.

**Comment [Da4]:** Better to define and note the S1, S2, etc...

**Formatted:** Superscript

**Proximate composition**

Association of Official Agricultural Chemists (AOAC) official methods are utilized as determining the proximate analysis for sweet potato peels powders and baked cakes (AOAC, 1998). Carbohydrate was determined by the difference from other nutrition such as fat, moisture, ash, and protein. The caloric value was calculated to conversion factors of four kcal per gram for proteins and carbohydrates, and nine kcal per gram for fats (Navacchi *et al.*,2012). All the analyses were done in triplicates.

**Determination of crude fiber**

The crude fiber contents of different sweet potato peel powders and cakes were determined by the method of AOAC Method: 991.43 (AOAC, 1998).

**Determination of total polyphenol content**

Determination of the total polyphenol content was done by Ahmed *et al*., (2010) and~~&~~ Saikia *et al*. (2012) method with some modifications where absorbance at 765 nm was measured using a spectrophotometer (T80 U/VIS, United Kingdom). Total phenols were calculated based on standard curves of gallic acid and expressed as milligram per gram.

**Cake Specific Volume**

Cake-specific volume determined by according to method described by AACC (2000) with adaptations to the different conditions of the product (Zavareze *et al*., 2010). A slide calipers utilized to determine the shape dimensions of the cakes.

**Hunter color values**

A spectrophotometer (CM-3500d, Minolta, Japan) was utilized to determine the hunter values such as L*, a*, and b* which are the color attributes of a product. Color change was calculated utilizing the following equation.

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

**Sensory evaluation**

Sensory evaluations of the entire sample baked cake were done by taste testing panel utilizing hedonic rating test where ten test panelists present. They were asked to evaluate different sensory parameters and scoring rate

on a nine-point hedonic scale where 09= Like extremely, 08= Like very much, 07= Like moderately, 06= like slightly, 05 = neither like nor dislike, 04= Dislike slightly, 03= Dislike moderately, 02 = Dislike very much and 01= Dislike extremely. The preference differences were evaluated by statistical analysis of the data for variance and consequently, Duncan's Multiple Range Test (DMRT). Procedures of the Statistical Analysis System (SAS, 1985) were used for statistical analysis.

**Statistical analysis**

The results were expressed as the mean, standard error of the mean (SEM), and coefficient of variation of each species for each parameter was determined. Data were statistically analyzed (R statistical software 3.4.1) by one-way analysis of variance (ANOVA). Mean comparisons were performed using DMRT for significant effect at $P < 0.05$.

**RESULTS AND DISCUSSION**

**Physical and chemical properties**

Table 02 represented the values of proximate analysis of control (market wheat flour) and different sweet potato peels powders such as fresh, treated, and boiled. The moisture content of all peel powders fluctuated from 7.30 % to 7.96% while the moisture content of market wheat flour was 7.94%. The extent of drying and compositional differences might be reasons for the differences of peels powders with the market wheat flour. The protein content of all peel's powders ranged from 6.77% to 9.45% protein and 74.88% to 80.66% carbohydrate whereas protein content and carbohydrate of wheat

flour was 13.70% and 70.51% respectively. All sweet potato peels powders contained lesser protein content and higher amount of superior carbohydrate than wheat flour.

From the table 02 we also found the fat content of all peel's powders ranged from 1.23% to 1.71% which was slightly lower than that of wheat flour (1.87%). Maruf, Sorifa, and Jong-Bang (2010) mentioned 0.59% to 1.29% fat content in peeled and unpeeled sweet potato powder. This variation in fat content might be due to the varietal difference, peel content, fat extraction by different chemicals and different milling procedure and machines. The ash content of peels powders ranged from 6.13% to 6.89% whereas wheat flour was 5.98%. The ash contents of all peel's powders significantly higher than market wheat flour. Different milling machines and environment may be responsible for this fluctuation.

**Total crude fiber content**

Table 02 represents the total crude fiber content of peels powders which ranged from 4.86% to 13.65% where as the crude fiber of wheat flour was 1.15%. The total crude fiber content of fresh peel had the highest value (13.65%) as compared to that of citric acid treated and boiled peels powders. This might be due to the loss of components which molecular weight comparatively lower than other. The lower molecular weight molecules such as sugars, vitamins, minerals and soluble dietary fiber loss during processing of treated and boiled peels powders.

**Total Polyphenol content of peels powders**

The total polyphenol content of sweet potato peels powders ranged from 8.35 to 14.42 mg gallic acid equivalent/ 1g (Table 02). Due to peels are rich in different phenolic content, unpeeled sweet potato powder had better phenolic content than peeled flour which has similar observations were found by Maruf, Sorifa, and Jong-Bang (2010). The total polyphenol content was highest in fresh peels powders and lowest in boiled peels powders. Similar observations were obtained from persimmon peel where blanched samples had lower total phenolic content. Different oxidation such as enzymatic or chemically or water leaching responsible for this massive loss of the phenolic content (Sorifa *et al*., 2010).

**Proximate compositions of baked cakes**

The data obtained from the table 03. proximate analysis of baked cakes integrating three different concentrations such as (5%, 10%, 20%) sweet potato peels powders with citric acid treated and fresh(untreated) samples are shown in Table 03. The moisture content of the control cake (wheat flour cake) was 22.75% whereas all cakes samples were ranged from 12.06% to 21.15%. The protein content and fat content of wheat flour cake were 8.53% and 28.83% respectively where as all peels powders cakes samples had 7.46% to 9.25% protein content and 26.59% to 30.60%. However, the values were not significantly different from each others for all samples. The ash and carbohydrate percentage of control cake was 0.85% and 39.04%, respectively and these percentages increased with the increased of sweet potato peels powders concentrations (5%, 10%, 20%) and with the different

treatments. In addition, the ash content increased with increase in peel powder concentration and the higher concentrations (20%) had higher amount of ash and carbohydrate content also.

**Total polyphenol and total crude fiber content of baked cakes samples**

Total crude fibre contents of backed cake from sweet potato peel powders ranged from 0.51 to 7.85 g per 100 g (Table 03). Sample S3 contained highest amount of total crude fibre and sample S9 had the lowest level of protein. There were significant differences in total crude fibre contents of all samples at different backed cake which was fortified by different concentrations sweet potato peels powders.

Table 03 represents the total polyphenol content of control cake sample (wheat flour cake) was 1.13 mg gallic acid equivalent/1g. On the other hand, the total polyphenol content of all cake samples ranged from 1.53 to 4.69 mg gallic acid equivalent/1g. It was observed that the total phenolic content of cake samples was increased with increase in the concentrations of sweet potato peels powders and it was higher in cakes prepared from boiled peels powders. However, the content of polyphenol content of peels powders is much superior to any kind of baked cakes because polyphenol degrade due to different processing conditions and baking temperature.

**Hunter Color values**

Hunter color was represented by L*, a*, b*, and ΔE where L* is a measure of lightness, a* redness, b* yellowness and ΔE color difference. The Hunter

color parameters L*, a*, b*, and ΔE have been widely used to describe color changes during dehydration of fruits and vegetable products. These values of sweet potato peels powders with different pretreatments such as citric acid and boiling and cakes samples prepared with various concentrations (5%, 10%, and 20%) of treated peels powders were measured (Table 04 and Table 05). Fresh peels powders had higher lightness (L* values) than treated and bolied samples. L* values were positively correlated with phenolic content. Although all the values of lightness (L* values) of peels powders were not significantly different from each other. This is due to heat exposure during drying because fresh peels need lower time as compared to treated peels. There is no significant difference in L* values of the all cakes samples made with peels powders. The hunter a* values (redness) were significantly higher in boiled treated peels powders as compared to the fresh and treated peels powders. The browning which was greater in boiled treated samples might be responsible for this. This observation was similar to that obtained previously (Ahmed *et al*., 2010b). However, the* values were not significantly different from each other for the cakes samples except 20% peels powder incorporated samples. Hunter b* values (yellowness) were significantly lower in boiled treated peels powders than those of treated and untreated samples, which might be due to losses of solid content during boiling. There were no significant differences were observed for all the cakes samples. The flour colors can best be described by the change in total color difference, ΔE values. The lower ΔE values (38.46) were found in treated boiled peels powders as compared to fresh and treated peels powders. The lower ΔE values may be due to the loss of phenolics and oxidation during boiling

treatment (Ahmed *et al*., 2010c). There were no significant differences in ΔE values among all cakes samples.

**Specific volumes of backed peels cake**

Different cakes specific volumes and expansion rate of all cakes samples were estimated and the results are shown in Table 05. It was found that the addition of various concentrations (5%, 10%, and 20%) of sweet potato peels powders has affected on specific volume and expansion rate and the values were higher than control cake. In addition, it was observed that the specific volume and expansion rate were higher for the sweet potato peels powders addition of 10% concentration for all peels powders such as boiled, treated with citric acid and untreated peels powdershad higher specific volume of the baked cake had higher expansion rate as compared to control (wheat flour cake). Due to high protein and low moisture content in the market flour which is highly recommended for cake manufacturing can be minimized it in a certain point by utilizing sweet potato peels powder.As a result, higher moisture content in cakes samples made from sweet potato peels powders. The cakes made from citric acid treated 10% sweet potato peels powders was evaluated the highest specific volume (0.26 $inch^3/g$), lowest density (3.91 $inch^3/g$) and the highest expansion rate is associated with the excellent texture and other quality attributes of the baked cakes. In addition, the specific volume of baked cakes and expansion rate were increased up to the 10% of sweet potato peels powders substitution/ incorporation with boiled treated with citric acid and untreated samples. Hence, for all samples containing 20% sweet potato peels powders had the weak/lessgluten for cake

formulations and therefore affecting the product cake quality especially specific volume, expansion rate and sensory qualities.

**Sensory evaluation**

A panel of 10 judges tested the texture, aroma, color, Taste, and overall acceptability of baked cake made from different sweet potato powder in the various ration. The mean scores for texture, aroma, color, Taste, and overall acceptability of different types of cakes sample presented in Table 06. A two-way analysis of variance ANOVA was carried out for color preference, and results revealed that there was significance ($p<0.05$) difference in color acceptability among the baked cakes. The results of DMRT showed that there was no significance for texture difference among the formation of $S_1$, $S_6$ and $S_7$ (Table 06). In the case of color preference among the sample, the sample $S_4$ was more acceptable than other samples. Sample $S_4$ secured the highest score of 7.8 and ranked as “Like very much.” Sample $S_1$, $S_6$ and $S_7$ are rated as “Like moderately” and obtaining rating 7.2. The presence of sweet potato peels powder in baked cake was 0.5% which 05% Boiled and Treated by 0.5% citric acid. In case of aroma preference among the sample, ANOVA analysis showed that there was significance ($p<0.05$) difference in flavor acceptability among the baked cake. From table 06, it is seen that sample $S_1$, $S_3$, $S_4$ & $S_6$ secured the highest score 7.2 for flavor and was ranked as “Like very much” and followed by the sample $S_7$ obtaining score 7.0. In the case of color among the sample showed that there was significance ($p<0.05$) difference in color, as shown in table 06. Sample $S_1$ secured the highest

score of 7.8 for composition and was ranked as “Like very much.” The sample $S_4$ scored 7.6 and listed as “Like moderately.” In the case of taste preference among the sample showed that there was significance ($p<0.05$) difference in taste, as shown in table 06. Sample $S_1$ & $S_7$ secured the highest score of 7.2 for taste and ranked as “Like very much.” The sample $S_9$ & $S_{10}$ scored 5.2 and posed the lowest score. It was apparent from the results of the ANOVA there was significance ($p<0.05$) difference in overall acceptability of the sample tested as the calculated F value (14.70) is higher than the tabulated F value (2.98). This indicates that so far as overall acceptability is a concern, the samples were equally acceptable. It can be seen from table 06 that the sample $S_1$ & $S_4$ is the most acceptable product receiving 7.8 out of 9.0 composed to the other sample and ranked as “Like very much.” The sample $S_5$, $S_6$ & $S_7$ securing 7.2 and was ranked as “Like moderately.” After sample $S_1$ sample $S_4$ secured the highest score for texture, aroma, color, taste and overall acceptability among all the samples and was closely followed by sample $S_3$. So, the sample $S_4$ product may be regarded as the best product.

**CONCLUSION**

The nutritional and sensory attributes can be enriched by utilizing sweet potato peels in different confectionary products which can be employing any kind of manufacturing factory in any region. In this study physicochemical, sensory attributes and nutritional features are investigated in different conditioned and treated sweet potato peels which represent it is an excellent source of nutrition that can be utilized in the manufacturing area in different concentrations where the effect of boiling and citric acid-treated samples

represents better results than control and fresh samples. From the study, we found different quantitative and qualitative advantages from market flour which is significant to ash and fiber content. In nine points scale hedonic rating test results “Good” scored 78% by different panelists. In this study, we it can be concluded that sweet potato peels are an excellent source that can be utilized as an alternative nutritional source which was cheap, easy to add, and better for our healthy and nutritional life.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

**REFERENCES**

Ahmed, M., Akter, M.S., Lee, J.C. and Eun, J.B. 2010. Encapsulation by spray drying of bioactive components, physicochemical and morphological properties from purple sweet potato. LWT-Food Science and Technology, 43(9):1307-1312.

Ahmed, M., Sorifa, A.M. and Eun, J.B. 2010b. Effect of pretreatments and drying temperatures on sweet potato flour. International journal of food science & technology, 45(4):726-732.

Ahmed, M., Akter, M.S. and Eun, J.B. 2010c. Peeling, drying temperatures, and sulphite- treatment affect physicochemical properties and nutritional quality of sweet potato flour. Food chemistry, 121(1):112-118.

Ahmed, M., Akter, M.S. and Eun, J.B. 2011a. Optimisation of drying conditions for the extraction of β-carotene, phenolic and ascorbic acid content from yellow-fleshed sweet potato using response surface methodology. International journal of food science & technology, 46(7):1356-1362.

Akter, M.S., Ahmed, M. and Eun, J.B. 2010. Effect of blanching and drying temperatures on the physicochemical characteristics, dietary fiber composition and antioxidant-related parameters of dried persimmons peel powder. International journal of food sciences and nutrition, 61(7):702-712.

AOAC (1984). Official Methods of Analysis. Fourteenth Edition. Association of official analytical chemists. Washington, D.C.

AOAC (1998). Official Methods of Analysis. Fourteenth Edition. Association of official analytical chemists. Washington, D.C.

AOAC Official Methods of Analysis. (1998). Method 991.43, total, soluble, and insoluble dietary fiber in foods. Association of Official Analytical Chemists International, Gaithersburg.

BBS. 2019. Statistical Year Book of Bangladesh. Bangladesh Bureau of statistics. Stat. Div., Min. Plann, Govt. Peop.Repub.

Chavan, J.K., Kadam, S.S. and Reddy, N.R. 1993. Nutritional enrichment of bakery products by supplementation with nonwheat flours. Critical Reviews in Food Science & Nutrition, 33(3):189-226.

Loebenstein, G. 2015. Control of sweet potato virus diseases. Advances in virus research, 91:33-45.

Hug-Iten, S., Escher, F. and Conde-Petit, B. 2001. Structural properties of starch in bread and bread model systems: Influence of an antistaling α-amylase. Cereal Chemistry, 78(4):421- 428.

Navacchi, M.F.P., de Carvalho, J.C.M., Takeuchi, K.P. and Danesi, E.D.G. 2012. Development of cassava cake enriched with its own bran and Spirulina platensis. Acta Scientiarum. Technology, 34(4):465-472.

Noorfarahzilah, M., Lee, J.S., Sharifudin, M.S., Fadzelly, M.A. and Hasmadi, M. 2014. Applications of composite flour in development of food products. International Food Research Journal, 21(6), p.2061.

Okorie, S.U. and Onyeneke, E.N. 2012. Production and quality evaluation of baked cake from blend of sweet potatoes and wheat flour. Academic Research International, 3(2), p.171.

Peckham, G.C. and Freeland-Graves, J.H. 1979. Foundations of food preparation. Macmillan.

Saikia, S., Dutta, H., Saikia, D. and Mahanta, C.L. 2012. Quality characterisation and estimation of phytochemicals content and antioxidant capacity of aromatic pigmented and non-pigmented rice varieties. Food Research International, 46(1):334-340.

Silva, J.S., Marques, T.R., Simão, A.A., Corrêa, A.D., Pinheiro, A.C.M. and Silva, R.L. 2014. Development and chemical and sensory characterization of pumpkin seed flour-based cereal bars. Food Science and Technology, 34(2):346-352.

Shahidi, F., Janitha, P.K. and Wanasundara, P.D. 1992. Phenolic antioxidants. Critical reviews in food science & nutrition, 32(1):67-103.

Surojanamethakul, V., Lohana, T., Auttaviboonkul, P. and Niyomvit, B. 1999. Utilization of powdered cellulose as a fiber source in chiffon cake and cookie products. Ahan.

Vithu, P., Dash, S.K. and Rayaguru, K. 2019. Post-harvest processing and utilization of sweet potato: a review. Food Reviews International, 35(8):726-762.

Wennberg, M., Ekvall, J., Olsson, K. and Nyman, M. 2006. Changes in carbohydrate and glucosinolate composition in white cabbage (Brassica oleracea var. capitata) during blanching and treatment with acetic acid. Food Chemistry, 95(2):226-236.

Zavareze, E.D.R., Moraes, K.S. and Salas-Mellado, M. 2010. Technological and sensory quality of cakes produced with milk whey. Ciência e Tecnologia de Alimentos, 30(1):100-105.



**Tables**

Table 1: Percentage compositions of control and sweet potato peels powders incorporated cakes

| Ingredients | Sample (gram) | | | |
|---|---|---|---|---|
| | Control | 05% | 10% | 20% |
| Sweet potato peels powders | 0 | 1.10 | 2.20 | 4.40 |
| Flour | 22 | 20.90 | 19.80 | 17.60 |
| Sugar | 25.00 | 25.00 | 25.00 | 25.00 |
| Egg | 25.63 | 25.63 | 25.63 | 25.63 |
| Fat | 25.00 | 25.00 | 25.00 | 25.00 |
| Milk Powder | 1.50 | 1.50 | 1.50 | 1.50 |
| Baking Powder | 0.50 | 0.50 | 0.50 | 0.50 |
| Salt | 0.10 | 0.10 | 0.10 | 0.10 |
| Vanilla essence | 0.27 | 0.27 | 0.27 | 0.27 |
| Total | 100 | 100 | 100 | 100 |

Table 02: Proximate compositions and Total Polyphenol content of the peel's powders

| Powder sample | Moisture content (%) | Protein content (%) | Fat Content (%) | Ash content (%) | Carbohydrate Content (%) | Total crude fibre content (%) | Total Polyphenol content (mg gallic acid equivalent /1g) |
|---|---|---|---|---|---|---|---|
| Control (Market Flour) | 7.94±0.01$^{a}$ | 13.70±0.01$^{a}$ | 1.87±0.01$^{a}$ | 5.98±0.01$^{b}$ | 70.51±0.01$^{a}$ | 1.15±0.01$^{b}$ | 0$^{d}$ |
| Fresh sweet potato peel powder | 7.86±0.01$^{a}$ | 6.77±0.01$^{b}$ | 1.71±0.01$^{a}$ | 6.86±0.01$^{a}$ | 76.86±0.01$^{a}$ | 13.64±0.39$^{a}$ | 14.42±0.02$^{a}$ |
| Treated sweet potato peel powder (0.5 % citric acid) | 4.96±0.01$^{b}$ | 7.02±0.02$^{b}$ | 1.23±0.01$^{b}$ | 6.13±0.01$^{a}$ | 80.66±0.01$^{a}$ | 4.86±0.06$^{a}$ | 10.03±0.01$^{b}$ |
| Boiled Treated sweet potato peel powder (0.5 % citric acid) | 7.30±0.01$^{a}$ | 9.45±0.01$^{a}$ | 1.48±0.01$^{ab}$ | 6.89±0.01$^{a}$ | 74.88±0.01$^{a}$ | 8.28±0.05$^{a}$ | 8.35±0.01$^{c}$ |

All values are express as mean ± SD.

Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

Table 03: Proximate compositions and Total Polyphenol content of the baked cake sample

| Cake type | Moisture content (%) | Protein content (%) | Fat Content (%) | Ash content (%) | Carbohydrate Content (%) | Calorie value (Kcal/g) | Total crude fibre content (%) | Total Polyphenol content (mg gallic acid equivalent/1g) |
|---|---|---|---|---|---|---|---|---|
| Sample $S_1$ | 22.75±0.346$^{a}$ | 8.53±0.01$^{ab}$ | 28.83±0.01$^{abc}$ | 0.85±0.0042$^{f}$ | 39.04$^{d}$ | 449.75 | 6.9±1.84$^{ab}$ | 1.13±0.02$^{e}$ |
| Sample $S_2$ | 20.26±0.111$^{abc}$ | 9.02±0.01$^{a}$ | 26.59±0.01$^{c}$ | 0.89±0.0002$^{ef}$ | 43.24$^{bc}$ | 448.35 | 3.8±0.23$^{abc}$ | 1.63±0.01$^{de}$ |
| Sample $S_3$ | 19.46±0.330$^{abc}$ | 9.07±0.01$^{a}$ | 27.32±0.01$^{c}$ | 0.90±0.0004$^{cdf}$ | 43.25$^{bc}$ | 455.16 | 7.9±0.77$^{a}$ | 1.99±0.01$^{de}$ |
| Sample $S_4$ | 15.97±0.018$^{cde}$ | 9.25±0.01$^{a}$ | 27.99±0.01$^{abc}$ | 0.99±0.0001$^{cde}$ | 45.80$^{ab}$ | 472.11 | 0.7±0.02$^{c}$ | 2.9±0.01$^{bc}$ |
| Sample $S_5$ | 21.15±0.015$^{ab}$ | 8.32±0.02$^{abc}$ | 29.01±0.01$^{abc}$ | 1.01±0.0004$^{cde}$ | 40.51$^{cd}$ | 456.41 | 1.3±0.96$^{bc}$ | 1.53±0.01$^{de}$ |
| Sample $S_6$ | 18.53±0.378$^{abcd}$ | 7.93±0.02$^{bc}$ | 30.28±0.02$^{ab}$ | 1.03±0.0002$^{cd}$ | 42.23$^{bcd}$ | 473.16 | 2.5±0.60$^{abc}$ | 2.18±0.01$^{cd}$ |
| Sample $S_7$ | 14.77±0.094$^{de}$ | 8.82±0.01$^{ab}$ | 30.60±0.02$^{a}$ | 1.12±0.0001$^{c}$ | 44.69$^{ab}$ | 489.44 | 6.2±1.20$^{ab}$ | 3.01±0.01$^{bc}$ |
| Sample $S_8$ | 12.06±0.010$^{e}$ | 9.05±0.02$^{a}$ | 29.24±0.01$^{abc}$ | 1.2676±0.0001$^{b}$ | 48.38$^{a}$ | 492.89 | 0.8±0.40$^{c}$ | 3.08±0.02$^{bc}$ |
| Sample $S_9$ | 17.87±0.100$^{bcd}$ | 8.73±0.02$^{ab}$ | 27.15±0.01$^{c}$ | 1.4271±0.0001$^{a}$ | 44.82$^{ab}$ | 458.56 | 0.5±0.34$^{c}$ | 3.57±0.02$^{b}$ |
| Sample $S_{10}$ | 16.77±0.094$^{bcd}$ | 7.46±0.02$^{c}$ | 26.81±0.01$^{c}$ | 1.5406±0.0001$^{a}$ | 47.42$^{a}$ | 460.81 | 1.3±0.33$^{bc}$ | 4.69±0.01$^{a}$ |

All values are express as mean ± SD.

Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

Sample $S_1$ = Control (Market Flour); Sample $S_2$ = 05% Fresh sweet potato peel powder; Sample $S_3$ = 05% Treated sweet potato peel powder (0.5%

citric acid);Sample $S_4$ = 05% Boiled Treated sweet potato peel powder (0.5% citric acid); Sample $S_5$ = 10% Fresh sweet potato peel powder; Sample $S_6$ = 10% Treated sweet potato peel powder (0.5% citric acid);Sample $S_7$ = 10% Boiled Treated sweet potato peel powder (0.5% citric acid);Sample $S_8$ = 20% Fresh sweet potato peel powder; Sample $S_9$ = 20% Treated sweet potato peel powder (0.5% citric acid); Sample $S_{10}$ = 20% Boiled Treated sweet potato peel powder (0.5% citric acid)

Table 04: Hunter color values of the powder sample

| Hunter color values | L* | a* | b* | ΔE |
|---|---|---|---|---|
| Fresh sweet potato peel powder | 46.14±1.900[a] | 5.69±0.147[b] | 12.03±0.569[a] | 48.02±1.644[a] |
| Treated sweet potato peel powder (0.5% citric acid) | 40.11±8.331[a] | 6.833±0.722[b] | 11.64±0.758[a] | 42.34±8.188[a] |
| Boiled Treated sweet potato peel powder (0.5% citric acid) | 36.17±4.532[a] | 8.74±0.840[a] | 9.71±1.086[b] | 38.46±4.727[a] |

All values are express as mean ± SD.
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

Table 05: Hunter color values, Expansion rate (%), specific volumes (inch³ g-1) and density (g inch$^{-3}$) of the rough dough and cakes samples.

| Cake type | L* | a* | b* | ΔE | Specific volume of the rough dough (inch$^3$/g) | Specific volume of the backed cake (inch$^3$/g) | density of the rough dough (g/inch$^3$) | density of the baked cake (g/inch$^3$) | Expansion rate (%) |
|---|---|---|---|---|---|---|---|---|---|
| Sample $S_1$ | 36.36±5.302[ab] | 17.31±2.765[ab] | 21.40±6.895[a] | 45.70±8.422[a] | 0.02 | 0.13 | 40.76 | 7.55 | 342.77±49.97[b] |
| Sample $S_2$ | 32.64±2.305[ab] | 16.16±1.115[abc] | 17.87±2.666[a] | 40.58±3.454[a] | 0.02 | 0.16 | 70.76 | 6.28 | 437.43±74.35[b] |
| Sample $S_3$ | 37.72±1.695[ab] | 18.07±0.660[a] | 23.16±1.784[a] | 47.83±2.099[a] | 0.02 | 0.21 | 41.81 | 4.87 | 606.9±77.62[ab] |
| Sample $S_4$ | 38.73±4.000[ab] | 15.95±0.586[abc] | 22.88±3.067[a] | 47.77±4.507[a] | 0.03 | 0.19 | 35.64 | 5.17 | 485.90±34.49[b] |
| Sample $S_5$ | 36.82±1.916[ab] | 17.76±0.206[a] | 22.01±1.905[a] | 46.44±2.480[a] | 0.02 | 0.21 | 40.76 | 4.83 | 639.50±173.49[ab] |
| Sample $S_6$ | 35.84±3.782[ab] | 14.55±1.115[bcd] | 20.21±3.463[a] | 43.71±4.341[a] | 0.02 | 0.26 | 40.76 | 3.91 | 810.93±212.87[a] |
| Sample $S_7$ | 29.44±8.9172[b] | 13.41±1.988[cde] | 20.47±0.806[a] | 38.61±6.788[a] | 0.03 | 0.21 | 35.64 | 4.86 | 557.54±87.23[ab] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample $S_8$ | 40.65±4.231[a] | 12.40±1.187[de] | 21.53±2.529[a] | 47.67±4.795[a] | 0.02 | 0.16 | 40.76 | 6.32 | 447.4±32.14[b] |
| Sample $S_9$ | 33.68±1.025[ab] | 10.84±0.394[ef] | 17.39±1.118[a] | 39.43±1.401[a] | 0.02 | 0.13 | 40.76 | 7.98 | 364.06±98.25[b] |
| Sample $S_{10}$ | 40.53±4.120[a] | 9.19±0.055[f] | 18.07±0.596[a] | 45.33±3.886[a] | 0.03 | 0.17 | 35.64 | 5.95 | 442.74±150.02[b] |

All values are express as mean ± SD.
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)
Sample $S_1$ = Control (Market Flour); Sample $S_2$ = 05% Fresh sweet potato peel powder; Sample $S_3$ = 05% Treated sweet potato peel powder (0.5% citric acid);Sample $S_4$ = 05% Boiled Treated sweet potato peel powder (0.5% citric acid); Sample $S_5$ = 10% Fresh sweet potato peel powder; Sample $S_6$ = 10% Treated sweet potato peel powder (0.5% citric acid);Sample $S_7$ = 10% Boiled Treated sweet potato peel powder (0.5% citric acid);Sample $S_8$ = 20% Fresh sweet potato peel powder; Sample $S_9$ = 20% Treated sweet potato peel powder (0.5% citric acid); Sample $S_{10}$ = 20% Boiled Treated sweet potato peel powder (0.5% citric acid)

Table 06: Mean score for texture, aroma, color, taste and overall acceptability of backed cake.

| Cake type | Color | Aroma | Taste | Texture | Overall acceptability |
|---|---|---|---|---|---|
| Sample $S_1$ | 7.8[a] | 7.2[a] | 7.2[a] | 7.2[b] | 7.8[a] |
| Sample $S_2$ | 5.6[d] | 6.6[c] | 6.8[c] | 5.4[e] | 6.4[d] |
| Sample $S_3$ | 7.2[c] | 7.2[a] | 7.0[b] | 7.0[c] | 7.2[c] |
| Sample $S_4$ | 7.6[b] | 7.2[a] | 7.2[a] | 7.8[a] | 7.8[a] |
| Sample $S_5$ | 6.6[c] | 6.8[c] | 6.4[c] | 6.4[d] | 7.4[b] |
| Sample $S_6$ | 6.8[c] | 7.2[a] | 7.0[b] | 7.2[b] | 7.4[b] |
| Sample $S_7$ | 7.2[c] | 7.0[b] | 7.2[a] | 7.2[b] | 7.4[b] |
| Sample $S_8$ | 4.4[d] | 5.8[d] | 5.4[d] | 4.2[d] | 5.0[d] |
| Sample $S_9$ | 4.4[d] | 6.6[c] | 5.2[d] | 4.4[d] | 5.2[d] |
| Sample $S_{10}$ | 4.6[d] | 6.6[c] | 5.2[d] | 4.8[d] | 5.4[d] |
| LSD ($p<0.05$) | 22.68 | 1.57 | 7.57 | 9.68 | 14.70 |

All values are express as mean ± SD;
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

Sample $S_1$ = Control (Market Flour); Sample $S_2$ = 05% Fresh sweet potato peel powder; Sample $S_3$ = 05% Treated sweet potato peel powder (0.5% citric acid); Sample $S_4$ = 05% Boiled Treated sweet potato peel powder (0.5% citric acid); Sample $S_5$ = 10% Fresh sweet potato peel powder; Sample $S_6$ = 10% Treated sweet potato peel powder (0.5% citric acid);Sample $S_7$ = 10% Boiled Treated sweet potato peel powder (0.5% citric acid);Sample $S_8$ = 20% Fresh sweet potato peel powder; Sample $S_9$ = 20% Treated sweet potato peel powder (0.5% citric acid); Sample $S_{10}$ = 20% Boiled Treated sweet potato peel powder (0.5% citric acid)