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Chemical, Microbiological and Antioxidant Effects of Banana Peels on Butter Cake

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A large amount of banana peel garbage collected every day by juice enterprises in addition to fruit markets represents a significant bio-resource that is an important task for environmental protection. Rather than being discarded in a landfill, it is possible to turn into valuable material, reducing environmental extra economic problems. In this research, we focused on adding banana peels to cake as a low-cost and natural source of antioxidants and antimicrobials, which led to maintaining and prolonged shelf life. The powder of banana peel contains phenols, flavonoids, fiber, and the IC_{50} of DPPH radical scavenging with their respective values of 24.22 mg GAE/g, 19.12 mg/g, 16.40%, and 1.4. Banana peel is also rich in minerals such as phosphorus (216.01 mg/100 g), calcium (264.52 mg/100 g), and potassium1560 mg/100 g. Banana peel powder was added to the butter cake in proportions 4, 8, 12, and 16 %., Increasing the supplementation level of banana peel powder increased the specific volume of cakes as compared with the control. The addition of banana peel powder to the butter cake resulted in a higher percentage of protein, ether extract, fiber, and ash compared to the control butter cake. Also, the cake containing the highest percentage of banana peels 16% had the lowest value of peroxide (0.99 ± 0.1 meq. peroxide/Kg fat) and microbial load (96±8.7 CFU) at the end of the storage period.

Keywords: Banana peels, Bioactive components, Natural antioxidant, Antimicrobial activity, Cake.

Introduction

Bananas (*Musa sapietum*) are a member of the Musaceae family and are one among the most popular of common tropical fruits on the market. In industries that manufacture banana-based items, large quantities of banana peels, equal to 40% of the total weight of fresh bananas, are produced as waste (Zoair et al., 2016). Fruit processing generates a considerable amount of waste in the form of peels and seeds. For economic, environmental, and food security considerations, this waste is a major global issue (Emaga et al., 2007). Since by-products are high-value products, their further use in the manufacturing of functional foods or supplements with high nutritional value has piqued interest, the peel of banana contains a significant proportion of starch (3%), crude protein (6%-9%), crude fat (3.8-11%), and total dietary fiber (43.2-49.7%) and a plentiful supply of pectin, essential amino acids, polyunsaturated, micronutrients and fatty acids (Mohapatra et al., 2010).

Banana peels contain natural bioactive substances, such as dietary fiber, polyphenols, and carotenoids, which provide health benefits such as protection against cancer, cardiovascular disease, and other degenerative diseases (Oguntoyinbjo, 2020). The biggest disadvantage of using synthetic antioxidants is that they can cause health problems. The strongest antioxidant

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and antibacterial activity were reported in banana peel against gram-positive and negative bacteria, fungus, and yeast (Aboul-Enein et al., 2016). Mature banana peel flour can be added to a gluten-free Rissole with a positive impact on its nutritional, texture, and color properties without changing its typical characteristics (Gomes et al., 2020).

The influence of banana peel extract (BPE) on the shelf life and qualitative attributes of ripe bananas is investigated by Rahman et al. (2020). According to storage research, spraying BPE on the exterior surface of ripe bananas can improve their shelf life by about 2-3 days. Bananas left untreated deteriorated totally on the fifth day of storage, whereas bananas treated with BPE of 80 % ethanol, distilled water, and acetone spoiled 31.25, 50.00, and 69.23% on that day, respectively. The samples treated with BPE of 80% ethanol retained the most color, flavor, and texture. The antioxidant, cytotoxic, and antibacterial properties of hydroalcoholic extracts from banana peels are demonstrated in vitro by Avram et al. (2022). The existence of many bioactive chemicals was established by Capillary Zone Electrophoresis (CZE) analysis of the extracts. BP has high antioxidant activity in vitro, which is linked to a significant cytotoxic and antibacterial action.

The main goals of this research were to assess the composition of nutrients in banana peels in order to enhance the peels' value. Studying the consequence of adding dried banana peels to the butter cake at different levels on the chemical composition (Moisture content, ash, crude protein, total lipids, and crude fiber), minerals, total flavonoid, phenolic compound, radical scavenging ability, peroxide value (PV), total bacterial count, total Mold, and Yeast count. Hence, in this research, the possibility of employing locally and economically agro-waste substrates as natural antioxidants and antimicrobials by them to butter cake was evaluated.

Materials and Methods

Materials, chemicals and reagents

Commercial wheat flour (72% extraction rate) and butter, white sugar, baking powder, egg, corn oil, and banana were obtained from local markets, AL- Fayoum Governorate, Egypt. All chemicals and solvents were obtained from AL-Gomhoria Company, Cairo, Egypt.

Banana peels preparation and discoloration

Banana peels were prepared directly after being separated from the washed fruits and cut into small pieces. Peels were divided into four groups: group1 dipped in 0.5% (w/v) citric acid solution for 20 min, group two submerge in sodium metabisulphite at 600 ppm, group three was placed in boiling water for 10 mins, group four was exposed to water vapor for 10 mins. In order to prevent a browning response, and the best treatment is chosen (sodium metabisulphite 600 ppm), the peels were loaded on a perforated stainless-steel tray and left to dry in a hot air oven (55°C) overnight. To make banana peel flour, dried peels were pounded into powder in a mixer and sieved with a mesh size of 0.50 mm. The peel powder is packed in polyethylene bags and stored under cooling for further analysis.

Analytical Methods

Chemical composition

Banana peels, wheat flour (72%) and cake were analyzed for moisture, protein, ash, crude fiber and ether extract contents according to AOAC (2010). Nitrogen free extract (NFE) was calculated using the following equation:

NFE = (100- (protein+ ash+ crude fiber and ether extract)

Minerals of banana peels

The minerals: iron (Fe), sodium (Na), potassium (K) and calcium (Ca) were determined using Scientific Atomic Absorption Spectrophotometer Model 210 VGP. Determination of phosphorus in the samples was performed according to Ademoroti (1996).

Sample extracts in solvents

For assessment of polyphenol, flavonoids and antioxidant activity, samples were extracted with methanol (80:20). A10 g sample was placed in 100 ml solvent, allowed to extract over night with agitation, centrifuged with 3000 rpm and filtered. All analysis was carried out in freshly collected extracts.

Determination of total phenolic content

The total phenolic (TP) content in banana peel extracts were spectrophotometrically determined by Folin-Ciocalteau reagent assay using gallic acid as standard (Alothman et al., 2009). A 0.5 ml aliquot within the extract solution, 0.2 mL of Folin-Ciocalteau reagent, and a saturated solution of Na_2CO_3 (0.5 mL) was added. This was increased with distilled water to 10 ml then incubated at 27°C/30 min. The absorbance was determined at 750 nm using spectrophotometer (Unicum UV 300). The total phenolic content

in the samples was expressed as mg gallic acid equivalents (GAE/g) dry weight sample. All samples were analyzed in triplicates.

Determination of total flavonoid content

The method used to calculate the total flavonoid content was according to (**Arvouet-**Grand et al., 1994). A combination of 5.0 ml of 2 % aluminum trichloride ($AlCl_3$) in methanol and the extract solution was utilized in the same volume. After 10 minutes, absorption values at 415 nm were collected against a blank sample made up of 5 ml extract solution and 5 ml methanol without $AlCl_3$. The total flavonoid content was determined using a standard curve with quercetin as the standard. The total flavonoid content was measured in milligrams of quercetin equivalents/100 g of sample.

Radical DPPH scavenging capacity

The free radical scavenging capacity of banana peels extracts was determined using the stable 1-1dipheny 2,2 picrylhydrazyl radical (DPPH) according to Yu et al. (2002). The quantity of antioxidant required to reduce the initial DPPH concentration by 50% (IC50) was calculated by plotting the percentage of remaining DPPH versus g dry extract/g DPPH and the antiradical efficiency (ARP) is calculated as follows: ARP=1/IC_{50}.

Physical properties of cake

Volume (cm^3) and specific volume were determined according to Türker et al. (2016). Cakes were weighed in grams (g) by laboratory balance. The volume (cm3) of cakes was estimated by Alfalfa seeds displacement. Specific volume was determined using the following equation: Specific volume = Volume (cm3) / Weight (g).

Keeping quality of cake

Peroxide value

To evaluate the oxidative rancidity, the samples were stored for 15 days at (4ºC). About fifty grams of cake samples grinded, extracted three times with 150 ml n-hexane, the extract was filtered through filter paper Whatman No.1 over anhydrous sodium sulphate. From this extract 10 ml were pipetted into a weighted dried dish, the solvent was also eliminated at 100ºC, then the residue was weighted and the percentage of fat in 10 ml extract was calculated. Peroxide value was determined and calculated as milliequivalent peroxides in kilogram fat according to the method described in AOAC, (2010).

Microbiological analysis

Total bacterial count and total mold and yeast were determined according to the method described by APHA (1992).

Sensory evaluation

The sensory evaluation of cake was done, using a panel taste according to Sudha et al. (2007). A numerical hedonic scale ranging from 1 to 10 (1 is very bad and 10 for excellent) was used for sensory evaluation. The panelists were asked to assess the cake for color, surface character, crumb color, mouth feel, odor and taste. The results were forced to the statistical analysis according to Snedecor & Cochran (1980). The least significant difference test (LSD) at $p = 0.05$ level was used to verify distinctions between therapies.

Processing of cake

Wheat flour in the formulation was replaced with 0 (control), 4, 8, 12, and 16 % banana peel powder. A 120g wheat flour (72 % extraction), 100g sugar, 100g whole egg, 14g milk powder, 25g shortening, 0.5g baking powder, 1.0g vanillin, and 2.3g salt were used in the cake recipe. While blending, the ingredients were mixed using the creaming method. Baking at 180°C, after 30 minutes the temperature was reduced to 160°C for10 minutes. Cakes were brought to room temperature before being placed in polyethylene bags and kept refrigerated for 15 days (4°C) **(Singh et al., 2006).**

Statistical analysis

SPSS version 16 was used for statistical analysis. All data are expressed as mean ± standard deviation. Statistical analysis for parametric data was performed by ANOVA for comparisons between groups, and repeated measures ANOVA for comparisons within groups between periods.

Results and Discussion

Proximate Composition of banana peels and wheat flour:

The contents of moisture, protein, ether extract, ash, crude fiber, and nitrogen-free extract (NFE) were determined in wheat flour (70%) and banana peel, the results are shown in Table 1. The moisture and protein content in wheat flour (72%) and banana peel were 11.23, 6.92, 11.54, and 11.40 %, respectively. The results clearly show that the protein content of banana peel is comparable to that of flour protein. These results are, to some extent, in agreement with the data obtained by Puraikalan (2018), who denoted that the protein content was 9.4 and 11.7% in banana peels from USA and India, respectively.

Concerning ether extract and ash, percentages were 0.94± 0.07, 6.65±0.98, 0 .67±0.02 and 12.21±0.09 for wheat flour and banana peel, respectively as shown in Table 1. We found that banana peel is rich in its fat and ash content, compared to flour. The findings obtained are consistent with those discovered by Nagarajaiah & Prakash (2011**)** who demonstrated the ether extract and ash of three varieties of banana peels ranged from (5.13 to 11.26) and (8.98 to 12.96), respectively. While the crude fiber and nitrogen-free extract (NFE) in wheat flour and banana peels were 0.66, 16.40, 74.96 and 45.78, respectively. As is evident from the results, banana peel is characterized by its high content of crude fibers. Such findings coincide with that obtained by Puraikalan (2018) who found that the crude fiber in banana peels from USA and India was 11.51 and 14.41, respectively. Dietary fiber is known to help humans' digestive systems, which is the indigestible portion of plant material that helps enhance roughage and volume in stool, keeps the intestine healthy, and reduces the amount of time waste material spends in the gastrointestinal tract (AACC, 2000).

Mineral Content of banana peels.

The banana peels were high in phosphorus, calcium and potassium but low in iron and sodium as shown in Table 2. The peel can be a wonderful source of phosphorus, calcium and potassium. Calcium (264.52 mg/100 g) and phosphorus (216.01 mg/100 g) are essential for strong bones and teeth, extra development, blood clotting, heart function, and cell metabolism (Rolfes et al., 2009). The potassium content was 1560 mg/100 g, necessary component for the body's growth and development of muscles (Adeolu & Enesi., 2013), while Iron and sodium content were 11.21 and 36.6 mg/100 g. These results agree with that published by Nagarajaiah & Prakash (2011).

Total phenolic compounds, antioxidant properties and DPPH Scavenging capacity of banana peels:

In this study, 80 % methanol extracts of banana peels were used for determination of total phenols content (expressed as mg gallic acid / g dry matter) and antioxidant activity expressed as antiradical power (ARP), the obtained results are presented in Table 3 and Fig. 1. The total phenols and total flavonoids contents of banana peels were 24.22 GAE/g and 29.12 mg/g, respectively. These results are similar with that of Aboul-Enein (2016) and Oguntoyinbo (2020) who revealed that the total phenols content of banana peels was 17.89 and 26.96 GAE/g respectively, total flavonoids was 21.04 mg/g by Aboul-Enein (2016) while the

TABLE 1. Proximate Composition of wheat flour and banana peels as dry matter basis.

Parameter (%)	Wheat flour (72%)	Banana peels
Moisture	11.23±0.23	6.92±0.27
Protein	11.54±0.40	11.40±0.15
Ether extract	0.94± 0.07	6.65±0.98
Ash	0 .67±0.02	12.21±0.09
Crude fiber	0.66±0.36	16.40±0.36
*NFE	74.96	45.78

* Calculated by the difference

TABLE 2. Mineral's composition of banana peels.

Parameter (mg/100gm)	Banana peels
Iron	11.21
Phosphors	216.01
Calcium	264.52
Sodium	36.6
Potassium	1560

value of total flavonoids is much higher than those found by Oguntoyinbo (2020) who denoted that the total flavonoids was 3.31 mg/g in banana peel. Free radical scavenging expressed as IC_{50} value was 1.4 and the antiradical power (ARP) was 0.71 ARP values differ from IC_{50} values in that the higher the IC_{50}, the lower the ARP, and vice versa. These results are lower than those recorded by Oguntoyinbo et al. (2020) who denoted that IC_{50} in Banana peel powder ranged from 2.89-4.35%.

Proximate composition of cake supplemented with different levels of banana peels.

The contents of moisture, Ether extract, protein, Crude fiber, ash and NFE determined in cake supplemented with different proportions (4, 8, 12 and 16%) of banana peels as shown in Table 3. The moisture content of food is a significant factor in determining its shelf life and preservation method. The moisture content was ranged from 17.77 to 19.84 %, the highest values were observed in the cake samples with the highest percentage (16%) of banana peel added, as shown, there are significant differences between the control sample, the lowest percentage of supplementation with banana peel (4%) and samples with high percent of banana peel 8, 12 and 16%. Cake samples supplementation with banana peel 16% had the highest percent of ether extract (19.45 %), while the lowest percentage of ether extract (13.93 %) for the control sample followed by samples treated with 4% (16.36 %), 8% (17.64 %) and 12% (18.28%). There were clearly significant differences ($p \geq 0.05$) between all samples. The protein content varied between 7.47 and 12.22 %, with 12% of treated samples having the highest value (12.22 %) while the control sample had the lowest value (7.47 %). There were significant differences ($p \geq 0.05$) between all samples. The proteins in the banana peel are enzymes that help the fruit mature (Zhang et al., 2012).

TABLE 3. Total phenols, flavonoids content and DPPH Scavenging capacity of banana peels.

Parameters	Banana peel
Total phenols (mgGAE/g)	24.22
Total flavonoids (mg/g)	19.12
IC_{50}	1.4
ARP	0.71

IC_{50}: The half maximal inhibitory concentration, ARP: Antiradical power

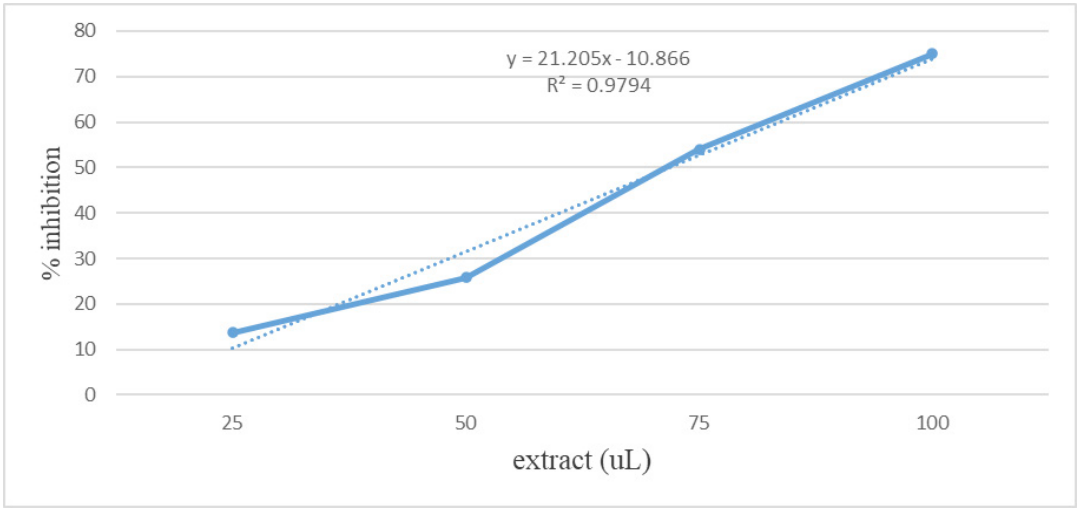

Fig. 1. Exponential curve of the percentage of remaining DPPH as function of ug sample per ug DPPH of the banana peels

Regarding the percentage of crude fiber present in the samples that were tested, the highest percent of crude fiber was 3.12 % in cake samples with 16% banana peel followed by cake samples with 12% (2.12 %), 8% (1.58 %), and 4% (1.55 %) banana peel, while the crude fiber percentage of the control samples was the lowest (1.33 , Table 3). There was no significant difference (p≥0.05) among the samples except for samples supplemented with 12 and 16% banana peel. These data are parallel to that achieved by Oguntoyinbo (2020) who indicated that the crude fiber varied between 2.70-3.2%.

The influence of varying banana peel concentrations on the ash content of cake samples is shown in Table 3. The valuation of ash content was increased by increasing the banana peel's concentration in cake samples, it's possible because of the high percent (12.21%) of ash in the peel of a banana as shown in Table 1. Values were 0.73, 0.74, 1.66, 1.95 and2.19 % in cake samples supplemented with 0, 4, 8, 12 and 16% peel from a banana. There was no discernible change (p≥0.05) among the samples except samples supplemented with 8 and 16% banana peel. The values obtained were significantly lower than 6.96-7.46%, as reported by Oguntoyinbo (2020) but it is close to 1.93-4.29%, as reported by Nwosu (2010). The nitrogen-free extract (NFE) in cake samples were ranged from 43.17 to 58.77 %, control samples had the highest values (58.77%), while the lowest value (43.17 %) for cake samples treated with 16% banana peel. Between all samples, there were strong significant differences (p≥0.05).

Physical properties of cake supplemented with different levels of banana peel.

Volume, specific volume, and height are the physical properties which were determined in cake supplemented with different levels of banana peel **(**4, 8, 12 and 16%) as shown in Table 5. It's worth noting that the baked cake's specific volume reflects the amount of air that can remain in the finished product. A higher specific volume is achieved as the commodity retains more gas and more expands (Chaiya & Pongaswatmanit, 2011). It was clear that increasing the supplementation level of banana peels (4, 8, 12 and 16%) the increasing the supplemented cake specific volumes as compared with the control. The specific volume was 2.34 **(**cm3/gm) for cake supplemented with banana peel 4%, and increased to 2.4, 2.73 and 2.64 (cm3/gm) in cake supplemented with 8,12 and 16% of banana-peel, respectively, compared to specific volume in control cake 2.28 (cm3/gm). Except for cake samples enriched with 12 percent banana peel, there was no significant difference (p0.05) across the samples. The results were strikingly similar to those previously reported by Zoair et al. (2016).

Keeping quality of cake

peroxide value (PV)

Peroxide value (PV) is a unit of measurement for oxidative rancidity that is defined as milliequivalents (meq.) peroxide/Kg fat. The effect of adding different levels of banana-peel to the cake on peroxide values during storage for 15 days at (4 °C) as shown in Table 6. The values of PV gradually increased during the storage period and the highest values at the end of the storage period were 4.84 and 3.87 (meq .) peroxide/ Kg fat) for control and cake supplemented with 4% respectively. While the lowest values of PV were 2.46±0.39, 1.37±0.05 and 0.99±0.1 (meq. peroxide/Kg fat) for cake supplemented with 8, 12 and 16%, respectively, after of 15 days of storage period. This is due to the high content of banana peel from phenolic and antioxidants substances (Aboul-Enein et al., 2016; Aquino et al., 2016 and Oyeyinka & Afolayan, 2020).

Microbial properties

The total microbial counts of different supplemented banana peels cake under investigation were followed up directly after preparation and during the storage time at (4 °C) for 15 days. The obtained data are presented in Table 7. From these results, It could be observed that the total bacterial count increased gradually during the storage period and the highest value was (312 cell/ g) for the control after 15 days of storage at (4 °C), while the lowest value was (96 cell/ g) for the cake supplemented with 16% banana peel. Also, the lowest count of fungi and yeasts after 15 days of storage at (4 °C), were in the cake samples supplemented with banana peel 8, 12 and 16%, where the values were 78.66, 53.54 and 26.46 cell/ g respectively, while the highest values were in the control cake and were 116.76 cell/ g. This is probably because the banana peel contains effective compounds such as, phenolic, and tannins which have antimicrobial activity (Aboul-Enein et al., 2016).

Sensory valuation of cake supplemented with different levels of banana peel.

The sensory evaluation qualities of the cakes supplemented with 4,8,12 and 12% of banana-peel, were assessed by ten panelists. The sample used as a control, as well as other supplemented cakes, was evaluated for taste, odor, Mouth feel,

crust colour, Crumb color, Surface character and overall acceptability Table 7. The findings of the sensory evaluation test clearly showed that cakes supplemented with 8, 12, and 12% of banana-peel were superior to the control in terms of overall acceptability, and there were clear significant differences between these levels of addition and control. The cake supplemented with 12% banana peel had the best sensory evaluation characteristics in terms of taste, odor, Mouth feel, crust colour, Crumb color and overall. These results are slightly higher than those found by Zoair et al. (2016).

TABLE 4. Proximate Composition of cake supplemented with different levels of banana peels.

Parameter %	Cake (Wheat + banana peels flour)				
	0%	4%	8%	12%	16%
Moisture	17.77±0.27^{c**}	17.79±0.15^{c}	18.43±0.48^{b}	19.77±0.23^{a}	19.84±.056^{a}
Ether extract	13.93±0.47^{e}	16.36±0.15^{d}	17.64±0.9^{c}	18.28±0.23^{b}	19.45±0.21^{a}
Protein	7.47±0.03^{e}	8.16±0.05^{d}	9.17±0.05^{c}	11.22±0.26^{b}	12.22±0.26^{a}
Crude fiber	1.33±0.03^{c}	1.55±0.03^{c}	1.58±0.04^{c}	2.12±0.07^{b}	3.12±0.07^{a}
Ash	0.73±0.01^{c}	0.74±0.06^{c}	1.66±0.04^{b}	1.95±0.31^{ab}	2.19±0.23^{a}
NFE *	58.77±0.2^{a}	55.39±0.32^{b}	51.52±.99^{c}	46.66±.53^{d}	43.17±0.66^{e}

* Calculated by the difference

Mean ± Standard deviation triplicate determination. Mean with the same alphabet in a row are not significantly different ($p \geq 0.05$).

** Values denoted by different letters within each column are significantly different ($P< 0.05$).

TABLE 5. Physical properties of cake supplemented with different levels of banana peel

Parameters	Cake (Wheat + banana peels flour)				
	0%	4%	8%	12%	16%
Volume (cm^3)	762±40.15^{c}	838.95±30.90^{b}	921.51±21.25^{a}	968.42±6.86^{a}	931.26±29.43^{a}
Specific volume(cm3/gm)	2.28±0.26^{c}	2.34±0.03^{c}	2.49±0.02b^{c}	2.73±0.02^{a}	2.64±0.07a^{b}
Height(cm)	3.89±0.07^{d}	4.29±0.02^{c}	4.84±0.03^{b}	5.45±0.09^{a}	4.93±0.04^{b}

Mean ± Standard deviation triplicate determination. Mean with the same alphabet in a row are not significantly different ($p \geq 0.05$).

** Values denoted by different letters within each column are significantly different ($P< 0.05$).

TABLE 6. Peroxide values (PV) of cake supplemented with different levels of banana peel during storage at (4 °C) for 15 days.

Storage (day)	Cake (Wheat + banana peels flour)				
	0%	4%	8%	12%	16%
0	0.27±0.03j	0.36±0.05ij	0.32±0.06j	0.38±0.0.3ij	0.32±0.1j
5	2.01±0.17e	1.39±0.07f	1.01±0.08g	0.54±0.02hi	0.45±0.03hij
10	3.02±0.12c	2.03±0.07e	1.37±0.16f	0.88±0.04g	0.62±0.03h
15	4.84±0.09a	3.87±0.11b	2.46±0.39d	1.37±0.05f	0.99±0.1g

Mean ± Standard deviation triplicate determination. Mean with the same alphabet in a row are not significantly different ($p \geq 0.05$).

** Values denoted by different letters within each column are significantly different ($P< 0.05$).

TABLE 7. Total bacterial and fungal counts (cell/ g) of cake supplemented with different levels of banana peel during storage at (4 °C) for 15 days

Parameter %	Cake Wheat + banana peels flour				
	0%	**4%**	**8%**	**12%**	**16%**
TBC*					
0	0 ±0.00m***	0±0.00m	0±0.0m	0±0.0m	0 ±0.0m
5	18±2.0jk	12±2.0kl	10 ±2.0l	1.33±0.05m	0 ±0.0m
10	49±3.5f	42±2.0g	32±3.0h	26.6±1.51hi	21±2.0ij
15	312±12.17a	277±3.05b	174±7.21c	112.68±6.43d	96±8.71e
Y&M**					
0	0±0.00i	0±0.00i	·0.0±0i	0±0.00i	0±0.00i
5	7.33±1.15gh	2.00±0.00i	00.00i	0±0.00i	0±0.00i
10	26.0±0.46e	18.0 ±2.00f	12±2.2g	5.34±1.15hi	2.56±0.18hi
15	116.67±4.16a	102 ±3.05b	78.66± 2.03c	53.54±6.43d	26.46±2.34e

*TBC: Total bacterial count **Y&M: yeast and mold count

Mean ± Standard deviation triplicate determination. Mean with the same alphabet in a row are not significantly different ($p \geq 0.05$).

*** Values denoted by different letters within each column are significantly different ($P < 0.05$).

TABLE 8. Sensory evaluation of cake supplemented with different levels of banana peel

Parameter %	Cake (Wheat + banana peels flour)				
	0%	**4%**	**8%**	**12%**	**16%**
Taste (20)	16.93±0.04b	16.63±bc	15.70±0.02d	17.50±0.03a	16.37±0.053c
Odor (20)	16.87±0.02b	16.30±0.2c	16.99±.11b	17.6±0.2a	16.16±0.02c
Mouth feel (20)	16.16±0.02b	15.69±0.1c	15.43±0.03d	17.8±0.05a	15.67±.15c
Crust color (10)	7.96±0.02a	7.73±0.1b	7.76±.11b	7.99±0.1a	7.23±0.1c
Crumb color (10)	8.5±0.1b	7.00±.08d	9.2±0.1a	8.6±0.1b	8.14±0.02c
Surface character (10)	7.85±0.05a	7.8±0.14a	7.92±0.41a	8.09±46a	7.71±0.24a
Overall (10)	8.26±0.02b**	7.93±0.07cd	8.05±13c	8.46±0.02a	7.89±0.07d
Total scores	82.53	79.08	81.05	86.04	79.17

n.s*: non-significant

Mean ± Standard deviation triplicate determination. Mean with the same alphabet in a row are not significantly different ($p \geq 0.05$).

** Values denoted by different letters within each column are significantly different ($P < 0.05$).

Conclusions

In place of artificial additives, butter cake could benefit from the use of banana peel powder as a natural antioxidant and antimicrobial microbial additive. Additionally, adding banana peel powder could improve the cake's sensory qualities and enrich it with essential minerals including calcium, phosphorus, potassium, and iron.

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التأثير الكيميائي والميكروبيولوجي والمضاد للأكسدة لقشور الموز على الكيك

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تمثل قشور الموز الناتجة كمخلف والتي يتم جمعها يوميًا من مصانع الأغذية ومن قبل شركات العصيروكذلك الأسواق مشكلة بيئية كبيرة . وعلى الجانب الأخر فان لها اهمية غذائية كبيرة من حيث أحتوائها على الألياف الغذائية وكذلك العديد من المواد التي لها تأثير مضاد للأكسدة ومضاد للميكروبات التي لها دورهام في تحسين جودة المنتجات الغذائية بالأضافة الى دورها في تحسين الصحة العامة للأنسان . وتهدف هذه الدراسة إلى تقييم مدى امكانية الاستفادة من قشور الموز من خلال استبدال جزء من الدقيق الداخل فى صناعة الكيك بمسحوق قشور الموز باعتبارها منخفضة التكلفة ومصدرًا طبيعيًا لمضادات الأكسدة ومضادات الميكروبات ، مما أدى إلى الحفاظ عليها واطالة عمرها الافتراضي. اوضحت النتائج أن مسحوق قشور الموز يحتوي على القيم التالية من الفينولات الكلية والفلافونويدات والألياف و IC50 وكانت ٢٤,٢٢ مجم GAE / جم و ١٩,١٢ مجم / جم و ١٦,٤٠٪ و ١,٤ على التوالي. كما أن قشور الموز غنية بالمعادن مثل الفوسفور (٢١٦,٠١ مجم / ١٠٠ جرام) والكالسيوم (٢٦٤,٥٢ مجم / ١٠٠ جرام) والبوتاسيوم ١٥٦٠ مجم / ١٠٠ جرام. وإضافة مسحوق قشور الموز إلى خلطة الكيك بنسب ٤ و ٨ و ١٢ و ١٦٪ ، أدى إلى زيادة مستوى الحجم النوعي للكيك مع زيادة نسب الأضافة من قشور الموز مقارنةً بالكنترول . كما أن الكيك المحتوي على أعلى نسبة من قشور الموز ١٦٪ كان له أقل قيمة من رقم البيروكسيد (٠,٩٩ ± ٠,١ ميللم كافئ بيروكسيد / كجم دهن) والحمل الميكروبي (96 ± 8.7 cfu) في نهاية فترة التخزين.